LIMITED CIRCULATION

ANRS Investment Office

Potential Survey, Identification of Opportunities and Preparations of Projects Profiles and Feasibility Studies

Part One: Potential Assessment Survey

Soil Survey
Draft Report

Development Studies Associates (DSA) and Shawel Consult International (SCI)

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1. Introduction

1.1. General

This report presents the findings of the soil resources survey of the Amhara Region. The study was based mainly on field survey, secondary data collection, field verification and analysis of previous land resources studies in the Region. Soil mapping units which were designated separately by different studies were converted and unified.

The outcome of the study is the preparation of soil resources study report and maps at a quarter million scale covering the whole Region including existing information, field surveys, laboratory analysis and mapping interpretation for land development.

The terminology used in this report for soil description and taxonomic soil classification is explained in Keys to soil Taxonomy, USDA (1996), FAO-ISRIC Soil and Terrain Data Base (SOTR, 1995) and FAO 1990.

1.2. Objective and Scope

The Investment Office of the Amhara National Regional State required the identification of the potential and constraints of the soils to facilitate decision-making on the allocation of land for different investment endeavors. The approach to achieving these goals is to identify, describe and map the soils of the Region at the appropriate level of intensity.

Within the overall Region wide comprehensive inventory of the natural resources, the objective of the land resources study is to identify, describe and map the soils at a scale of 1:250,000.

2. Study Methodology

2.1. General

The study methodology of the soil resources of the Amhara Region has been based on the objective of the study and scope of work. The prime objective of the study is to determine the overall distribution of the different types of soils in the Region and mapping them at a scale of 1:250,000 inorder to identify the potential and constraints of the land resources for economic development. To achieve the intended goal, the study was phased into three district activities.

2.2. Pre Field Activities

Review of previous soil studies was carried out and all available relevant documents to this study including:

(i) River basin development master plan studies
(ii) Comprehensive large area land resources studies and
(iii) Site specific project studies
(iv) Primary data collected from field surveys.

The review of the previously established data bases, however, revealed that there were areas of the Region where very little or no land resources information was available such as the northern Awash Basin which falls within the Amhara Region.

Areas to be studied were delineated on the 1:250,000 scale topographic maps provided from the Ethiopian Mapping Authority. Soil profile pits and auger borings were located in areas which were considered to be representative for a larger area with similar retentions between land terrain and soil characterstics.

The different soil surveys in the Region used different soil survey systems and therefore, required reconciliation and rationalization inorder to unify them. The unifying system employed to accommodate all the different soil survey systems was basically based on the combination of soil type and landform as mapping unit.

A generalized verification plan was prepared for the areas where soil studies have already been conducted. The data basis of the previous studies were carefully investigated and were used to compile the maps and the accompanying reports.

2.3. Field Soil Survey

The field soil survey was conducted by two groups operating in different parts of the Region where the data gap has been identified. The soil survey activities employed a combination of field verification of the previously surveyed areas and field soil study in selected areas which were considered to have very little or no soil survey information in nineteen weredas falling within North Wello zone, South Wello Zone, Oromiya Zone and North Shewa Zone.

Soil profile pits and auger borings were located in areas which are considered to be representative for a larger area with similar relations

between terrain and soil characteristics. The soil profile pits were described in detail following FAO pit description guidelines. In addition mini pits of about 0.60m depth were dug in several sites where the soils variability is high and where confirmation was required to classify large areas with shallow depth such as Leptosols. Augerholes were bored to a depth of 1.2 meters or to the bedrock and profile pits were excavated to a depth of 2 meters to the bedrock, whichever was shallower.

At each observation site, important site characteristics such as elevation, landform, micro topography, slope, land use, land cover, parent material, surface characteristics, surface coarse fragments, erosion status, drainage, flooding, groundwater level, human influence and crops were recorded. Soil profile characteristics such as soil depth, moisture, colour, texture, structure, consistence, porosity, cutans, mineral nodules, roots, biological features, carbonates, cementation and compaction were recorded.

Standard soil samples from the representative soil prfile pits were taken on the basis of the existing soil horizons for chemical and physical analysis and were submitted to the National Soil Research Center laboratory in Addis Ababa.

2.4. Post Field Work Activities

Immediately after returning from the field work, the remaining batches of soil samples were handed over to the National Soil Research Centre.

All field data were rewritten on the standard Soil Profile Description and Soil Horizon Description forms. All information was transferred from the field 1:250,000 scale topographic maps to original transparencies. The tracing of the previously prepared soil maps from different studies and the maps prepared by the present study added up to 8 sheets at 1:250,000 scale.

All the physical data collected from the field, obtained from previous studies including the chemical data from the laboratory and previous studies were entered into a computer database. The GIS center of the project support to the soil study was enormous. This has taken the form of digitizing existing topographic and thematic mapping, interpretation overlays and creating databases. The data capture activities mainly concentrated on the 1:250,000 scale mapping of the soils of the Region. initial analysis of the data was facilitated by the GIS.

It was decided to use landform soil association as mapping unit. It was, therefore, necessary to convert some of the previous studies to the

landform – soil association format. The different soil surveys in the Region have, therefore, been reconciled and rationalized into the new format. A unified soil legend was developed to accommodate the different mapping units employed by the different studies.

Data has been collected from a number of sources including:

(a) FAO/LUPRD, 1985

Soil Survey of the Borkena Area (Wello)

(b) Amhara Region – BOA, 1994
Soils of the Upper Borkena Catchment

(c) Ministry of Water Resources, 1998, Tekeze River Basin Integrated Development Master Plan Project, Soils and Terrain (Parts 1 & 2).

(d) Ministry of Water Resources, 1998, Abbay River Basin Integrated Development Master Plan Project, Land Resources Development, (Part 1&2).

(e) FAO/LUPRD, 1999, Physiography and Soils of Hykoch and Butagira and Yerer and Kereyu Awrajas (Shewa)

(f) Development Studies Associates, 2001, Soils of the Debark Area

(g) FAO, 1965, Survey of the Awash River Basin (Volume 2, Soils and Agronomy)

The physical description data collected in the field and the laboratory analytical data have been analyzed. The output from the analysis has been used to characterize and describe the different soils and mapping.

2.5. Soil Classification and Mapping

The soils of the Region were classified based on topomaps, geomorphology, slope, geology and previous studies. The soil units determined during the previous studies were adopted by the present study after being unified with the rest of the studies. The profile pit descriptions, auger observations and site mini pit observations in the field were employed to identify and delineate soil mapping units. The laboratory results were also used during the soil classification. The soils were classified based on the revised FAO-UNESCO-ESRIC legend to the

Soil Map of the World (1998). Each soil Mapping Unit has been discussed with respect to the major physical and chemical characteristics.

The results of the soil study are the soil map at 1:250,000 scales and the accompanying report. The soil unit has been defined progressively into landform, the landform components and the soil component. Each mapping unit therefore represents one unique combination of landform, lithology and soil characteristics. The legend of the maps and its explanation has been presented.

3. The Soils of the Amhara Region

3.1. General

The previous studies and the field work during the present study revealed that in general the Amhara Region consists of a wide range of landforms. The major soil groups and soil units were classified based on the soil properties observed in the field and soil analytical results of both previous studies and the present fieldwork. Landforms within one of the three classes of level land, sloping land, or steep land are single landforms. Composite landforms consist of a combination of two or more single landforms in different classes. A particular combination of landform and lithology have, therefore, been subdivided and delineated on the basis of soil characteristics.

The bulk of the information that forms the basis of the soil report and the mapping is that generated by two major integrated basin development master plan studies of the Abbay basin and the Tekeze basin. Systematic soil surveys were carried out in the two river basins at the scale of 1:250,000.

The soil surveys during the master plan studies employed aerial photograph interpretation, satellite imagery interpretation and national topographical maps interpretation using GIS technology. For each of the land units defined and mapped the appropriate association of soils has been included. The other previous studies of different mapping scales and the present soil survey to bridge the identified gaps have all been reconciled and converted to include soil landform; and geology. The old mapping unit and the new mapping unit have been presented next to each other for easy reference.

3.2. Soil Classification and Mapping

Based on the outcomes of several soil studies previously carried out in the Region and the present field soil study, the land units were compiled and defined. For each of the land units presented and mapped, the appropriate association of soils has been indicated.

The summary of land unit description has been presented on Table 3.1. The table gives the dominant soil, the main associated soils and any significant inclusions. The dominant soil unit occupies at least 40% of the land unit, associated soils occupy between 15 and 40% and inclusions comprise less than 15%. Land units with only one soil component occur. In some aspects, during the field soil surveys, results of the representative landform sites were extrapolated to similar areas coverage by less intensive field work (areas difficult to access), although most of the areas with poor access have been surveyed using helicopter in both the Abbay and Tekeze master plan studies.

4. Soil Mapping Units

4.1. General Physiography of the Region

The Amhara Region is made up of four major physiographic types:

(i) Flat to rolling high altitude plateau including hills, mountains and side slopes
(ii) Gorges
(iii) Low land plains, and
(iv) Rift valley

The plateau highlands lie between elevations of 2000 masl and exceeding 3,000 masl. Within this range, one could see rugged mountains, undulating plains, numerous mountain peaks and hills. The plateaus descend in the west towards peripheral lowlands. The mountain peaks rise as high as 4,620 masl at Mount Ras Dashen. The plateau highlands cover the central and eastern part of the Region. Along the western border of the high plateaus, the topography drops of suddenly and gently declines towards the Ethio-Sudanese border. The streams flowing from the highlands cut deep gorges and ultimately end up in the Abbay or Tekeze rivers.

The major rivers and their tributaries within the Region along the weak zones of the plateaus and mountains have formed the gorges and

canyons. The streams flowing along the gorges and canyons have cut deep the geological formations along their coarse resulting in interfluvial ridges and inter ridge valleys. Interfluvial ridges are the old ruminants of plateaus, which are highly dissected by the major rivers and their tributaries within the Region forming a number of ridges. The major rivers and their tributaries form the interridge valleys. They are mainly formed of alluvial colluvial fans. The deep gorges could have very steep or genly sloping sides. The Abbay and the Tekeze river gorges are spectacular and are very deep (upto 1500 m). In reality, the Region has been divided into a number of blocks by deeply incised gorges of the Tekeze and Abbay rivers and their tributaries.

Low to medium altitude, undulating to hilly plains and moderate relief hills with low altitude alluvial colluvial plains. The plains are mostly found in the western and northwestern parts of the Region. in the extreme west along the Ethio-Sudanese boarder, the land forms a very gently undulating to almost flat landscape except where it is cut by streams.

Rift Valley occupies a relatively small area south of Woldiya. This includes the broacken land and plains in the vicinity of the Kesem and Borkena rivers. This landform is a complex of steep, rough and rocky escarpments and gently undulating terraces (stepped plateau) and includes shallow soils on severely eroded side slopes and almost flat land on the colluvium and alluvium along the Borkena river. Table 1 shows the different landforms used for classification.

4.2. Geology

The general geological succession of the Amhara Region is summarized below based on the available geological information (V. Kazmin, 1975, Mohr 1971).

Precambrian Rocks

Vast Quantities of lavas effused from fissures and volcanoes covered the Precambrian Basement Complex starting from the end of Eocene.

Since the Precambrian Rocks have been formed under high pressure and relatively high temperature, they have a well separated mineral components and have a strongly banded appearance. The rocks which were observed in the Abbay and Tekeze basins are rich in field spays and quartz and have the assemblage mainly of granite and gneiss.

The basement complex in the higher lying areas of the Amhara Region essentially composed of various grades and types of schist and gneiss, as well as almost unaltered sedimentary rocks and igneous intrusions. They underlay the whole of the Region forming an intensively folded and foliated metamorphic basement. The direction of folding and schistosity generally tend north-south or northeast southwest. They are tentatively divided by an unconformity into an older more metamorphosed group and a younger weakly metamorphosed group.

Paleozoic and Mesozoic Rocks

Apart from some minor occurrences (unconformity) the Paleozoic facies are not very common in the Region. Some sandstone, siltstone and shale deposits of Paleozoic age have been reported in the Abay Gorge.

Regarding Mesozoic, the most common are the Jurasic-Cretaceous regressive sandstone facies. The limestone of this age thins towards the west between two sandstone horizons. Then occur the Triasit – Jurasic transgressive sandstone facies, followed by shale and then gypsum horizons. Some of the sandstones in the Amhara Region are correlated with the Adigrat sandstone of Jurrassic age, which rest unconformably over the basement complex, below the Tertary basalt flows of the Trap series.

Cenozoic Volcanic Rocks

Following the Mesozoic period, thick flood basalts called Trap series and shield volcanic activities occurred in the high plateaus lying towards the northeastern part of the Amhara Region. The Trap Series consists of two groups, the Ashangi and the Shield.

Pleistocene and Holocene Rocks

The actual erosive period is marked by the deep incision of the most recent lava streams and by the deepening and extension of the existing incision.

Earlier alkaline and silicic lavas and pyroclasts followed by recent basaltic fissure eruptions. These lava flows exhibit scoriaceous, vesicular, highly jointed and jagged surfaces localized areas of fluvial and extensive lacustrine sediments occur along lakes, riverbeds and part of the Rift valley contained within the southern part of the Region. The rocks are traversed by faults trending to different directions.

In recognition of geology being important characteristics in the soil formation of the Region, the description of the parent material employed in the Tekeze and Abbay master plan studies has been used to describe the soils of the Region (see Table 4.2). Almost all the parent materials identified for the soils formation of the Region fall within the 16 geological groups provided in the Table.

4.3. Mapping Unit Characterization

Each mapping unit is described with respect to landform, geology.

Table 4.1: Landform Classification

Land form	Gradient %
1. Level Land	
Plain	< 8
Plateau	< 8
Low gradient foot slopes	< 8
Valley floors	< 8
Marsh bottom land	< 2
2. Sloping Land	
Medium gradient hills	8-30
3. Steep Land	
High-gradient mountains	> 30
High-gradient hills	> 30
High-gradient escarpment zone	> 30
High-gradient elongated ridges	> 30
High-gradient valleys	> 30
High-gradient concentric ridges	> 30
4. Composite Landforms	
Rolling plain	< 15
Hilly plain	Variable
Dissected plain	Variable
Rolling plateau	< 15
Hilly plateau	Variable
Narrow plateau	Variable
Terraces	< 8
Low & medium gradient elongated ridges	< 30
Concentric ridges	< 30
Valleys	Variable
Gorges and canyons	Variable
Dissected side slopes and	Variable
Piedmont zones	

Table 4.2: Description of Parent Material

Code No.	Description
1	Alluvium/colluvium (Pleistocene to present) including marsh soils and lacustrine deposits
2	Acid to intermediate Volcanic rocks (Amba Alaji Rhyolites, lower Ashange, Tana Zuria)
3	Basic volcanic and intrusive rocks (Ashange basalts, Termaber basalts, post tectonic granites)
4	Coarse grained acid plutonic rocks (undifferentiated or poorly defined)
5	Laterite (laterite on Amba Alaji Rhyolite)
6	Fine grained clastic rocks, shale (Tsaliet, Tembien, Chelga, Agula)
7	Shale/dolerite and diorites (dolerite and granodiorite complex)
8	Limestone, mare (Antalo Limestone)
9	Coarse grained clastic rocks, sandstone, conglomerate (Abbay Gorge, Adigrat sandstone, Tembien Clastics)
10	Metasediments (non-carbonate)
11	Metacarbonates
12	Metavolcanics
13	Ultrabasic metamorphic rocks
14	Variable parent material
15	Undifferentiated lower complex
16	Backswamp deposits

Soil depth, drainage, colour, texture, surface stones, rock outcrops, fragments, pit, exchangeable sodium percentage, organic carbon percentage, cation exchange capacity and base saturation. Moreover, a particular inclusion and association of soils characterize each mapping unit. Summary of the soil type and corresponding area in ha is given in Table 4.3.

The soil survey of the study area has been conducted in two separate activities. Both the master plan studies and the present study carried out physical and chemical laboratory analysis of the soils.

Parameters for the following characteristics were determined using their respective methods.

- Soil Texture
- Organic Carbon (OC)
- Acidity/Alkalinity (PH)
- Electrical Conductivity (EC)
- Total Nitrogen
- Available potassium

- Exchangeable bases (Ca, Mg, K, Na)
- Cation Exchange Capacity (CEC)
- Available Phosphorus

The summary of both previous and present laboratory analytical results has been presented as attachments to this report. In the present study, soil analysis for soil samples collected from the Northern Awash River Basin were delayed so much that it was not possible to complete the reports according to the study plan.

4.4. Description of the Mapping Units

The mapping of the soils of the Amhara Region has employed the Soil and Terrain Mapping Unit (SOTER). To compile the soil maps, soil survey information including the landform and geology was used. For most of the units, a representative profile has been presented in the attachments with this report. The representative profiles contain site and soil horizon information. Each soil unit has been represented by the geology, slope, effective soil depth, drainage, surface texture, rockiness, stoniness, and soil erosion status. A table containing all the soil units with their corresponding characteristics has been provided as an attachment to this report.

The soil map of the Amhara Region is presented in eight sheets of 1:250,000 together with the legend. The description of each mapping unit (number code) is presented as follows.

Soil Mapping Unit 1

This mapping unit mainly comprises Eutric vertisols, mollic Leptosols and Calcic Vertisols developed on alluvium, colluvium, lacustrine deposits and laterite. They usually occur on plain, plateau and piedmont landforms. The soils are deep, fine textured, imperfectly drained, with none to slight erosion hazard.

The laboratory data indicates that the soils in this mapping unit have very high base saturation, low electrical conductivity values, very high CEC, very high calcium, low to medium organic matter, low available phosphorous and low exchangeable sodium percentage. The PH and EC values indicate that the soils are free from salinity and alkalinity. Calcium carbonate is trace in these soils. Application of phosphorus, nitrogen and potassium fertilizer is likely in these soils. These soils widely occur in Semien Shewa, Debub Gonder, Semen Wollo, Waghumera zone, Debub Wollo and Oromiya zones.

The mapping unit covers an area of 726,297.16 ha. or about 4.61% of the Region.

Soil Mapping Unit 2

This soil mapping unit comprises Eutric Cambisols and Eutric Leptosols developed on basic volcanic and interusive rocks. They mainly occur on plain topography where erosion is moderate. There are also sites where Eutric Leptosols occur with very shallow (< 25 cm) and severely eroded.

The laboratory data indicates that the soils have medium content of sodium, very high content of calcium and magnesium. The cation exchange capacity is high. The base saturation is also very high. Total nitrogen is low and available phosphorus is very low. There is also significant content of calcium carbonate in these soils. Application of nitrogen and phosphorus fertilizers is essential. The soils occur in Debub Gonder, Semen Wello, and Northwestern part of Semen Gonder.

The mapping unit covers an area of 69,128.95 ha or about 0.44% of the Region.

Soil Mapping Unit 3

The soil components of this unit mostly comprise Haplic Nitisols, Haplic Alisols and Eutric Leptosols developed on alluvium basalts, calstics and sandstone.

Table 4.4: Area Distribution of Soil Units

Soil Units	Area (Km^2)	Percent of Region Area
Eutric Vertisols	26302.07	16.69
Calcic Vertisols	1089.1	0.69
Dystric Vertisols	108.3	0.07
Haplic Nitisols	1805.09	1.15
Rhodic Nitisols	473.06	0.3
Haplic Luvisols	4814.1	3.05
Chromic Luvisols	4551.14	2.89
Haplic Alisols	12306.9	7.81
Haplic Acrisols	432.47	0.27
Luvic Phaeozems	90.25	0.06
Eutric Fluvisols	903.4	0.57
Calcaric Fluvisols	86.3	0.05
Eutric Gleysols	147.43	0.09
Mollic Gleysols	36.21	0.09

Soil Units	Area (Km²)	Percent of Region Area
Vitric Andosols	35.48	0.02
Mollic Andosols	38.79	0.02
Umbric Andosols	173.8	0.11
Luvic Calcisols	130.9	0.08
Vertic Cambisols	1358.17	0.86
Humic Cambisols	1394.9	0.88
Calceric Cambisols	256.96	0.16
Eutric Cambisols	918.83	0.58
Haplic Arenosols	15097.87	9.59
Eutric Regosols	791.2	0.50
Calcic Solonetz	1713.95	1.09
Eutric Leptosols	135.78	0.09
Rendezic Leptosols	55138.73	34.99
Umbric Leptosols	1668.63	1.06
Lithic Leptosols	9212.62	5.84
Dystric Leposols	9431.1	5.98
Mollic Leptosols	133.12	0.08
Vertic Cambisols Haplic Luvisols	3121.01 642.33	1.98 0.41
Water body	3134.78	1.99
Total	**157,638.48**	**100**

Table 4.5: Distribution of Mapping Units

Mapping Unit Code	Area (ha)	Percent of Region Area
0	313477.8197	1.99
1	726297.1568	4.61
2	69128.94726	0.44
3	138525.451	0.88
4	103086.3078	0.65
5	90339.77058	0.57
6	844244.1535	5.36
7	336464.5487	2.13
8	455113.5651	2.89
9	2327.196676	0.01
12	79979.21884	0.51
14	511799.5094	3.25
16	135817.1839	0.86
18	42464.69269	0.27

Mapping Unit Code	Area (ha)	Percent of Region Area
19	199786.1612	1.27
22	79119.51543	0.5
23	99623.75322	0.63
24	171395.2765	1.09
25	344787.8612	2.19
26	386446.1811	2.45
27	436727.7066	2.77
28	163566.0871	1.04
29	24380.57322	0.15
30	16180.33527	0.1
31	9576.116794	0.06
32	40772.16393	0.26
33	13785.92028	0.09
34	916915.431	5.82
35	427794.4036	2.71
36	42223.34505	0.27
37	3621159.544	22.97
38	4346.95558	0.03
40	16044.18538	0.1
41	20418.04213	0.13
42	28197.23844	0.18
43	61161.90012	0.39
44	38628.5685	0.25
45	3548.330376	0.02
46	98386.56553	0.62
47	92315.44232	0.59
48	675194.5086	4.28
49	8677.432054	0.06
50	9025.070876	0.06
51	6267.436189	0.04
52	13311.94497	0.08
53	1651.05462	0.01
55	3878.661126	0.02
56	16042.33607	0.1
57	708991.7318	4.5
58	11213.00785	0.07

Mapping Unit Code	Area (ha)	Percent of Region Area
59	180547.1252	1.15
61	5118.269321	0.03
62	108910.3541	0.69
63	3296.861958	0.02
65	13506.61198	0.09
67	312100.6452	1.98
68	13581.92555	0.09
69	592241.0142	3.76
70	10830.726	0.07
72	25696.12996	0.16
75	394211.0232	2.5
79	3984.709282	0.03
81	8630.021006	0.05
82	1086.738895	0.01
83	13578.32297	0.09
84	1926.23039	0.01
85	690196.1647	4.38
86	3165.831372	0.02
88	9651.687104	0.06
89	1475.270656	0.01
90	286174.6602	1.82
91	14742.89499	0.09
92	115790.1804	0.73
93	57823.86358	0.37
94	64233.13063	0.41
95	13089.52592	0.08
96	17379.61651	0.11
97	25472.46184	0.16
98	17774.73985	0.11
99	97025.40795	0.62
Total	**15763848.5**	**100**

The landform consists of plains, plateau, hills and side slopes. The soils are mostly well drained and erosion is slight to moderate.

Soil laboratory analysis results indicate that the texture is clay; exchangeable sodium is low whereas exchangeable potassium, calcium and magnesium are generally on the higher side. The cation exchange capacity (CEC) and the base saturation are medium. Total nitrogen and organic matter are low to medium. Available phosphorus is medium and exchangeable sodium percentage is low indication that salinity and alkalinity hazards are not likely to occur. Application of macronutrients may not be imperative during few copping seasons after establishing crop cultivation in a new area. The soils commonly occur in Debub Gonder, Semen Wello, Awi zone, Mirab Gojjam zone and to a smaller extent in Eastern part of semen Gonder and Wag Humra zone.

The mapping unit covers an area of 138,525.45 ha or 0.88% of the Region.

Soil Mapping Unit 4

This soil mapping unit comprises Haplic Luvisols, Chromic Luvisols and Haplic Nitisols developed on basalts. They occur on high plateau and plains. Their texture is dominantly clay. Their drainage condition is moderate.

The laboratory data indicates that soil reaction is strongly acidic sodium is low, exchangeable potassium is medium while calcium and magnesium are high. CEC is also high. The base saturation is medium, nitrogen and organic matter are medium, and available phosphorus is medium where as exchangeable sodium percentage is low. Hence application of fertilizers may not be essential in a smallholder low input cultivation. The soils occur in Awi, Mirab Gojjam, and Semen Shewa zones.

The mapping unit covers an area of 103088.31 ha or about 0.65% of the Region.

Soil Mapping Unit 5

This soil mapping unit consists of imperfectly drained to well drained Eutric Fluvisols and Eutric Vertisols on plains. The soils have been formed from alluvium, colluvium, basalts and granites. Erosion is slight to moderate.

The laboratory analysis results indicate that soil reaction is slightly alkaline. The total nitrogen is medium while available phosphorus and organic matter are low. The exchangeable sodium is medium, potassium is very high, calcium is very high and magnesium is high. The CEC is high and the base saturation is very high indicating that the fertility status of the soils is good.

The soils occur in Quara and Alefa weredas, Awi zone, Mirab Gojjam zone, Semen Gonder zone, Wag Humra zone, Debub Gonder and Semen Wello zones, including Semen Shewa zone.

The mapping unit covers an area of 90339.77 ha. of about 0.57 percent of the Region.

Soil Mapping Unit 6

This soil mapping unit comprises Haplic Alisols, Haplic Nitisols and Chronic Luvisols developed on alluvium, colluvium, basalts, sandstones and undifferentiated lower complex. They are commonly found on hills, plains, plateau and valleys. They well drained, clay to silty clay and with no stones or rocks on the surface.

The laboratory data indicates that their texture is clay, soil reaction is strongly acidic sodium and organic matter are low, exchangeable potassium is high, calcium and magnesium are medium, CEC is medium, base saturation is medium, total nitrogen is also medium. Available phosphorus is medium, where as exchangeable sodium percentage is low indicating no salinity or alkalinity pose toxicity problems. There is a need for macronutrients augmentation. The soils mainly occur in Awi, Mirab Gojjam, Eastern part of Semen Gonder and Wag Humra zones.

The mapping unit covers 844,244.15 ha or about 5.36% of the Region.

Soil Mapping Unit 7

The mapping unit consists of Haplic Luvisols, Dystric Cambisols and Haplic Nitisols developed on Colluvium, basalts, clastics and Tsaliet group. They occur on low land plains. They are well drained, with moderate erosion, few surface rocks and common surface stones.

The PH in this soil unit is slightly acidic, sodium is low, potassium, calcium and magnesium are generally high. The CEC is high where as the base saturation is medium. The total nitrogen is medium, the organic matter is high where as the available phosphorus is high. The

exchangeable sodium percentage is low indicating low salinity hazard. The soils occur in Awi and Mirab Gojjam zones.

The mapping unit covers an area of 336,464.55 ha or about 2.13% of the Region.

Soil Mapping Unit 8

The mapping unit consists of Chromic Luvisols and Haplic Nitisols developed on alluvium colluvium, basalts and sandstone, which occur on lowland plains. The unit is dominated by well to moderate drainage, moderate erosion, common surface stones and clay texture.

Regarding the content of exchangeable bases, sodium and potassium are low, while calcium and magnesium are high. The CEC is high, base saturation is also high. The soil PH is slightly acidic while the total nitrogen is medium where as organic matter and available phosphorus are high. Exchangeable sodium percentage is low. The soils dominantly occur in Awi, Mirab Gojjam, South Western part of Semen Gonder, Debub Gonder, Semen Wello, Eastern part of Semen Gonder and Wag Humra zones.

The mapping unit covers an area of 455,113.56ha of 2.89% of the Region.

Soil Mapping Unit 9

The mapping unit consists of Calcaric Cambisols, Calcic Vertisols and Eutric Leptosols developed on basalts and volcanic, which occur on low land plains and piedmonts. The unit is dominated moderately well drainage, moderate erosion, few surface stones and clay texture.

The sodium content is high while potassium, calcium and magnesium are very high. The CEC is very high base saturation is high, total nitrogen is low. The organic matter is moderate, available P is very low. The exchangeable sodium is medium. Application of nitrogen and phosphorus fertilizers is essential. The soils mainly occur in Semen Shewa zone.

The mapping unit covers an area of 2327.20 ha or 0.01% of the Region.

Soil Mapping Unit 12

The mapping unit consists of Calcaric Cambisols developed on basic volcanic and intrusive rocks, which occur on plateau. The unit is characterized by clay texture, moderate erosion, few surface rocks and few surface stones.
The surface PH is moderately alkaline. Electrical conductivity and organic matter is low. Total nitrogen and available phosphorous is very low. Cation exchange capacity is medium whereas base saturation is high. Exchangeable sodium and Potassium are medium and high respectively. Exchangeable magnesium is low while calcium is high.

These soils dominantly occurring in eastern part of Semen Gonder, wag Humra and northwestern part of Semen Gonder.

The mapping unit covers an area of 79,979.22 ha of about 0.51% of the Region.

Soil Mapping Unit 14

This soil mapping unit comprises Eutric Vertisols associated with Eutric Cambisols developed on alluvium, colluvium, alkali trachytes and lacustrine deposits. They occur on plains, plateau, piedmonts and basins. Its texture is clay, imperfectly drained, slight to moderate erosion and generally with no rockiness or stoniness.

The laboratory data indicates that the soil reaction is moderately acidic, CEC is very high, calcium and magnesium are also very high, calcium and magnesium are also very high, sodium is low, base saturation is high, nitrogen is very low, organic matter is low, available phosphorus is high. The exchangeable sodium percentage is low indicating relatively low risk of salinity and sodicity risk. Nitrogen fertilizer is essential. The soils occur in Misrak Gojjam, Semen Shewa, Awi, Mirab Gojjam, Debub Gonder, Semen Wello, Debub Wello and Oromiya zones.
The mapping unit covers 511,799.51 ha or about 3.25% of the Region.

Mapping Unit 16

This soil mapping unit consists of Luvic Calcisols associated with Calcic Vertisols and Eutric Leptosols developed on volcanic and basalts, which mainly occur on plains and piedmonts. Luvic Calcisols are well drained,

moderately deep, clay texture, slight to moderate erosion, few rocks and stones on the surface.

The chemical and physical analysis of the soil samples collected from the sites indicates that PH is neutral, sodium is high, potassium is very high, calcium is very high, magnesium is also very high. Organic matter is medium. Available phosphorous and total nitrogen are very low and low respectively. CEC and base saturation are high.

The soils occur in Semen Shewa, Debub Gonder and Semen Wello zones. The mapping unit covers 135817.18 ha of 0.86% of the Region.

Mapping Unit 18

This soil mapping unit consists of Vertic Cambisols associated with Eutric Leptosols developed on basic volcanic and intrusive rocks. They occur on hilly plateau. Their texture ranges from clay to clay loams. They are moderately well drained soils. Erosion is moderate. There are few stones on the surface.

The laboratory data of the soils sampled from the areas under this soil mapping unit indicate that the PH is moderately acidic, the electrical conductivity is low, sodium is high, potassium is medium, calcium is high, magnesium is medium. The CEC and base saturation are high. The total nitrogen is medium while organic matter is low. Available phosphorus is very high and exchangeable sodium percentage (ESP) is low indicating very low risk of sodality of alkalinity.
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These soils occur in Semen Shewa, Debub Gonder, Semen Wello, Debub Wello and Oromiya zones.

The mapping unit covers 42664.70 ha or about 0.29% of the Region.

Soil Mapping Unit 19

This soil mapping unit consists of Eurtic Vertisols associated with Eutric Cambisols developed on aluminum colluvium, sandstone. They occur on low gradient foot slopes. They are well drained with few stones at the surface. Erosion is slight, imperfectly drained.

The laboratory data indicates that the CEC is very high, sodium is high, and potassium is also high. Calcium is very high, magnesium is also high, base saturation is very high. The organic matter and total nitrogen are low whereas available phosphorus is somewhat low and available

potassium is high. Exchangeable sodium percentage is low indicating very low risk of sodality of alkalinity.

The mapping unit covers 199786.16 ha or about 1.27% of the Region.

Soil Mapping Unit 22

This mapping unit comprises Haplic Arenosols associated with Cambic Arensols and Eutric Cambisols developed on basalts and coarse grained clustics. The soils are moderately well drained and occur on river gorges and canyons. They contain few rocks and few stones at the surface. Their texture varies from clay loam to loam. Their erosion status is moderate.

The laboratory data of the soils sampled from the areas under the soil mapping unit indicate that the PH is neutral, the electrical conductivity is low, sodium is high, potassium is very high, calcium is high, magnesium is medium. The CEC is medium whereas base saturation is very high. The total nitrogen is low, organic matter is medium, available phosphorus is very high and exchangeable sodium percentage (ESP) is medium. Although the sodium content is high, there may not be immediate risk of salinity of alkalinity. There may not be much response to potassium and phosphorous fertilizer applications. There is, however, a clear indication that there should be significant application of nitrogen fertilizer.

The soils occur in Eastern part of Semen Gonder, Wag Humra and Semen Shewa zones.

The mapping unit covers 79119.51 ha or about 0.50% of the Region.

Soil Mapping Unit 23

This soil mapping unit consists of Eutric Vertisols associated with Eutric Cambisols developed on variable parent materials. They occur on valley floods. Their texture is clay. They are moderately well drained containing few rocks and few stones on the surface. Their erosion status is slight.

The laboratory data indicates that the PH is alkaline, the electrical conductivity is low, sodium is medium, potassium is low, calcium is high, magnesium is also high the cation exchange capacity is high indicating good fertility of the soils. The base saturation is very high. The nitrogen content is very low, organic matter is very low, available phosphorus is low, and exchangeable sodium percentage is medium, the calcium carbonate is significant in presence.

These soils occur in northwestern part of Semen Gonder, Eastern part of Semen Gonder, Wag Humra, Debub Gonder, and Semen Wello Zones.

The mapping unit covers 99623.75 ha or 0.63% of the Region.

Soil Mapping Unit 24

This soil mapping unit contains Eutric Regosols associated with Eutric Leptosols and Lithic Leptosols developed on rhyolite, sandstone and basalts. They occur on ridges, gorges and canyons. The soils are somewhat excessively drained with few rocks and common stones on the surface. The erosion status is slight to moderate.

The laboratory data indicates that soil reaction is slightly acid, calcium content is high, and magnesium is medium. CEC and organic matter content are low whereas the nitrogen content is very low. Available phosphorus is very low while available potassium and base saturation are medium. Exchangeable sodium percentage is low confirming that the soil toxicity is minimum.

These soils occur in Misrak Gojjam, Mirab Gojjam, Awi, Debub Wello, Oromiya, northwestern part of Semen Gonder, eastern part of Semen Gonder and Wag Humra and Semen Shewa zones.

The mapping unit covers an area of 171396.28 ha or about 1.09% of the Region.

Soil Mapping Unit 25

This soil mapping unit consists of Eutric Leptosols and Eutric Vertisols developed on basic volcanic and intrusive rocks which occur on sloping land. The soils are excessively drained with many rocks and stones on the surface. The erosion status is severe.

The laboratory data indicates that soil reaction is somewhat alkaline and the electrical conductivity is low. The sodium potassium content is high whereas calcium and magnesium are very high. The cation exchange capacity is very high indicating a good fertility status of the soils. The base saturation is also very high. Total nitrogen content is very low. The organic matter is low. Available phosphorus is low and the exchangeable sodium percentage is low indicating low risk of alkalinity builds up in the soils.

These soils occur in Debub Wello, Oromiya, northwestern part of Semen Gonder, Eastern part of Semen Gonder, Wag Humra, Debub Gonder, Eastern part of Semen Gonder and Wag Humra, Debub Gonder and Semen Wello zones.

The mapping unit covers an area of 344787.86 ha or about 2.19% of the Region.

Soil Mapping Unit 26

This soil mapping unit consists of Haplic Alisols associated with Dystric Cambisols and chromic Luvisols developed on basalts, sandstones and granites which occur on hills, plains and plateaus. The soils are well drained with slight to moderate erosion status.

The laboratory results indicate that the soil reaction is acidic. Electrical conductivity, calcium and magnesium are very low whereas sodium and potassium are low. The cation exchange capacity is very high. The base saturation is low. The total nitrogen content is low. The organic matter is medium, available phosphorus is very high with no trace of calcium carbonate.

These soils occur in Misrak Gojjam, Awi and Mirab Gojjam zones and covers an area of 386446.18 ha or about 2.45% of the Region.

Soil Mapping Unit 27

This soil mapping unit comprises Haplic Luvisols associated with Eutric Cambisols, Eutric and Lithic Leptosols, and Haplic Nitisols developed on basalts, rhyolits, alkali trachytes, and clustic rocks which occur on escarpments, hills, mountains and side slopes. The soils are excessively drained, with moderate erosion.

The laboratory results indicate that soil reaction is acidic, electrical conductivity is low, sodium is low, potassium is medium, calcium is very high, magnesium is very high. The cation exchange capacity, available phosphorus and base saturation are very high while nitrogen and organic matter low and very low respectively. Exchangeable sodium percentage is low indicating low risk of soil toxicity.

These soils occur in Misrak Gojjam, Mirab Gojjam, Awi, Debub Wello, Oromiya and Semen Shewa Zones and covers an area of 436727.71 ha or about 2.77% of the Region

Soil Mapping Unit 28

This soil mapping unit comprises Rendezic Leptosols associated with Lithic Leptosols and Cambisols (rudic) developed on basalts, limestone, sandstone and undifferentiated lower complex. They occur on high gradient escarpments and strongly dissected and structural landscape. The soils are excessively drained and the erosion status is moderate to severe.

The laboratory results indicate that the soil reaction is alkaline, electric conductivity is low, sodium, potassium are high whereas calcium and magnesium are very high. The cation exchange capacity and base saturation are very high while total nitrogen content and organic matter content is low. The available phosphorus is high, whereas the exchangeable sodium percentage is medium. The overall nutrient status of the soils is good. There is, however, a need to increase the organic mater of the soils and to apply nitrogen fertilizer.

These soils occur in Misrak Gojjam, Debub Wello, Oromiya and Semen Shewa zones and covers an area of 163566.01 ha or about 1.10% of the land area of the Region.

Soil Mapping Unit 29

This mapping unit comprises somewhat excessively drained Eutric Cambisols associated with Haplic Calcisols on sloping land. These soils have been derived from organic rocks. Erosion is severe.

The laboratory analysis of the soil samples indicates that soil reaction is alkaline. The organic matter content is very low while total nitrogen is low. Available phosphorus is high. Exchangeable sodium and potassium are low whereas exchangeable calcium and magnesium are very high and medium respectively. The CEC is medium and the base saturation is very high.

These soils occur in Semen Gonder zone and covers an area of 24380.57 ha or about 0.15% of the Region.

Soil Mapping Unit 30

The soil mapping unit 30 consists of shallow, somewhat excessively drained Eutric Cambisols associated with Eutric Leptosols on sloping lands. These soils are formed from coarse grained clastics. Slope ranges from 8-15 percent. Erosion is severe.

The laboratory analysis results indicate that the soil reaction is neutral, sodium is low, potassium is medium, calcium is low, and magnesium is low. The cation exchange capacity is low, base saturation is very high total nitrogen is low, organic matter is low, available phosphorus is very low, exchangeable sodium percentage is low.

These soils occur in eastern part of Semen Gonder and Wag Humra zones and covers an area of 16180.33 ha or about 0.10% of the land area of the Region.

Soil Mapping Unit 31

The mapping unit comprises well drained Calcaric Cambisols associated with Lithic Leptosols on sloping land. The soils have been derived from non-carbonate meta sediments. Erosion is severe.

The laboratory results indicate that soil reaction is neutral; organic matter is medium, nitrogen content is low whereas available phosphorus is also low. The exchangeable sodium is high. CEC and base saturation are medium and high respectively. The exchangeable magnesium is medium whereas both exchangeable calcium and potassium are very high. The soils require fertilizer application with nitrogen and phosphorus as major constituents.

These soils occur in Semen Gonder zone and Wag Humra zones and covers an area of 9576.12 ha or about 0.06 percent of the Region.

Soil Mapping Unit 32

The soil mapping unit 32 consists of moderately well drained Haplic Luvisols associated with Haplic Alisols on Plateaus, plains, hills and side slopes. The soils have been formed from basalts, alkali trachytes and rhyolite. Erosion is moderate.

The laboratory analysis results indicate that the soil reaction is slightly acidic, sodium is very low, potassium is medium, calcium is very high, and magnesium is also very high. The cation exchange capacity is very high, base saturation is low, nitrogen content is low, organic matter is medium. The available phosphorus is very high, while exchangeable sodium percentage is low indicating low toxicity from alkalinity. Fertilizer application is essential for enriching the soil with nitrogen.

These soils occur in Awi and Mirab Gojjam zones covers an area of 40772.16 ha or about 0.26 % of the Region.

Soil Mapping Unit 33

This mapping unit comprises well drained Haplic Nitisols associated with Haplic Alisols and Eutric Vertisols on Plains, Plateaus, hills and sideslopes. The soils have been derived from volcanic, sanstones and undifferentiated lower complex.

The laboratory results indicate that organic matter; total nitrogen and available phosphorus are medium. The exchangeable sodium is very low. The potassium is high. Calcium and magnesium are both medium. The CEC is high and the base saturation is medium.

The soils occur in Awi one and Gojjam zones and covers 13785.92 or about 0.09 percent.

Soil Mapping Unit 34

Soil mapping unit 37 consists of excessively drained clay loam textured Umbric Leptosols associated with Eutric Cambisols and Eutric Leptosols on high land plateau mountains. The soils have been formed from basic volcanic and intrusive rocks. Soil erosion is severe.

The soil reaction is moderately alkaline. The electrical conductivity is very low indicating low salinity level. Exchangeable sodium is low whereas exchangeable potassium is medium to very high. Exchangeable Calcium, magnesium is very high. The cation exchange capacity is high while base saturation is very high. Total nitrogen and available phosphorous is low whereas organic matter is very low. The ESP is low indicating no risk of alkalinity in the soils.

These soils occur in Misrak Gojjam, Mirab Gojjam, Awi, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones.

The mapping unit covers an area of 916915.434 ha or about 5.82 percent of the Region.

Soil Mapping Unit 35

This mapping unit consists of excessively to somewhat excessively drained Eutric Leptosols associated with Eutric Regosols and Eutric Cambisols on gorges, canyons and escarpments. The soils have been formed from coarse grained acid plutonic rocks, basalts and rhyolities. Erosion in the area is moderate to severe.

The soil reaction value of the soils in this mapping unit is neutral. The electrical conductivity is very low. Sodium is medium while calcium and magnesium are very high. The cation exchange capacity is very high indicating a good fertility level of the soils. Base saturation is very low. Total nitrogen and organic matter content are low. Exchangeable potassium is medium to high whereas available phosphorus is low. The exchangeable sodium percentage is low, indicating low alkalinity hazard. Increasing the organic matter of the soils is essential to build up the nutrients buffering capacity. Artificial fertilizer of nitrogen and phosphorus is also essential.

These soils occur in Debub Wello, Oromiya, Debub Gonder, Semen Wello and Semen Shewa zones and covers 427794.40 ha or about 2.71% of the area of the Region.

Soil Mapping Unit 36

This mapping unit consists of moderately well drained Eutric Cambisols associated with Eutric Leptosols on high gradient hills. The soils have been formed from acid to intermediate volcanic rocks. Erosion in the mapping unit is severe.

The soil laboratory analysis results indicate that the soil reaction is slightly acidic. Exchangeable sodium and potassium are very low while exchangeable calcium and magnesium are low. The CEC is low whereas base saturation is high. Total nitrogen and organic matter is very low while available phosphorus is low. The nutrient level of the soils of this unit is very low and requires soil husbandry and artificial fertilizer application.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, and Semen Wello and Semen Shewa zones and covers an area of 42223.34 ha or about 0.27% of the Region.

Soil Mapping Unit 37

Soil mapping unit 37 consists of somewhat excessively drained Eutric Leptosols associated with Eutric Cambisols and Eutric Regosols on lowland plains. The soils have been formed from alluvium, colluvium, lacustrine deposits and basic volcanics. Soil erosion is moderate.

The soil reaction is slightly acid to neutral. The electrical conductivity is low indicating low salinity level. Exchangeable sodium is low whereas

Calcium and magnesium are very high. Exchangeable potassium is medium to very high. The cation exchange capacity is very high while base saturation is high. Nitrogen is high whereas organic matter is medium. The available phosphorus is very high. The ESP is low indicating no risk of alkalinity in the soils.

These soils occur in Misrak Gojjam, Mirab Gojjam, Awi, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones.

The mapping unit covers an area of 3621159.54 ha or about 22.97 percent of the Region.

Soil Mapping Unit 38

This mapping unit consists of excessively drained Umbric Leptosols occurring on high gradient hills. These soils have been formed from coarse grained acid rocks. Erosion in the mapping unit is severe.

The soil laboratory analysis results indicate that the soil reaction is slightly alkaline. Exchangeable sodium and potassium are medium while exchangeable calcium and magnesium are very high. The CEC is very high whereas base saturation is high. Total nitrogen is medium while organic matter is low and available phosphorus is very low. The nutrient level of the soils of this unit is very low and requires soil husbandry and artificial fertilizer application.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, and Semen Wello and Semen Shewa zones and covers an area of 4346.96 ha or about 0.03% of the Region.

Soil Mapping Unit 40

This mapping unit consists of excessively drained Lithic Leptosols on high gradient hills. The soils have been formed from organic rocks. Erosion in the mapping unit is severe.

The soil laboratory analysis results indicate that the soil reaction is neutral and electrical conductivity is very low. Exchangeable sodium and potassium are low while exchangeable calcium and magnesium are very high and high respectively. CEC, organic matter and base saturation are

high while potassium and total nitrogen are medium. Available phosphorus is very low. The nutrient level of the soils of this unit is very low and requires soil husbandry and artificial fertilizer application.

This soil occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, and Semen Wello and Semen Shewa zones and covers an area of 16044.19ha or about 0.1% of the Region.

Soil Mapping Unit 41

This mapping unit consists of excessively drained Eutric Leptosols on high gradient hills. These soils have been formed from coarse grained clastic rocks. Erosion in the mapping unit is severe.

The soil laboratory analysis results indicate that the soil reaction is slightly acidic. Exchangeable sodium is very low whereas potassium is very high. Exchangeable calcium is very high while magnesium is high. The CEC, total nitrogen and organic matter are very high whereas base saturation and available phosphorus are high.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, East Gojjam, Debub Gonder, and Semen Wello zones and covers an area of 20418.04 ha or about 0.13% of the Region.

Soil Mapping Unit 42

This mapping unit consists of well drained Haplic Nitisols associated with Haplic Alisols, Haplic Acrisols and Chromic Luvisols on plains, piedmonts, plateaus, hills and side slopes. The soils have been formed from basalts, syntectonic granodirites and diorite rocks. Erosion in the mapping unit is slight.

The soil laboratory analysis results indicate that the soil reaction is strongly acidic. Exchangeable sodium is very low while potassium is very high. Exchangeable calcium and magnesium are high. The CEC and base saturation is high while exchangeable potassium and available phosphorous are very high. Total nitrogen and organic matter content are medium.

These soils occur in East Gojjam, west Gojjam, semen Gonder and Awi zones and covers an area of 28197.24 ha or about 0.18% of the Region.

Soil Mapping Unit 43

This mapping unit consists of excessively drained Lithic Leptosols associated with Eutric Leptosols, Haplic Luvisols and Haplic Nitisols on plateaus. The soils have been formed from basaltic rocks. Erosion in the mapping unit is slight.

The soil laboratory analysis results indicate that the soil reaction is neutral and electrical conductivity is very low. Exchangeable sodium is very low whereas exchangeable calcium and magnesium are high. The CEC is low whereas base saturation is high. Total nitrogen is low while organic matter is very low. Available phosphorus and exchangeable potassium is very high.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, and Semen Shewa zones and cover an area of 61161.9ha or about 0.39% of the Region.

Soil Mapping Unit 44

This mapping unit consists of well drained Rhodic Nitisols associated with Haplic Alisols and Haplic Acrisols piedmonts, hilly plains, undulating to rolling lowland plains and low plateaus. The soils have been formed from basaltic rocks. Erosion in the mapping unit is slight.

The soil laboratory analysis results indicate that the soil reaction is slightly acidic. Exchangeable sodium is very low whereas exchangeable potassium, calcium and magnesium are low, very high and medium respectively. The CEC is very high whereas base saturation is high. Total nitrogen is high while organic matter is very high. Available phosphorus is medium.

These soils occur in northwestern part of Semen Gonder, Debub Gonder, East Gojjam, and West Gojjam zones and covers an area of 38628.57 ha or about 0.25% of the Region.

Soil Mapping Unit 45

This soil mapping unit consists of very poorly drained Mollic Gleysols associated Eutric Histosols on marsh bottomlands. The soils have been formed from back swamp deposits. Mostly there is no erosion on these sites.

The soil reaction is acidic. The exchangeable cations are high to very high. The cation exchange capacity (CEC) is high, base saturation is very high. The nitrogen content is high whereas organic matter is very high. The available phosphorus is low. The exchangeable sodium percentage (ESP) is high indicating presence of risk of alkalinity.

These soils occur in Debub Wello, Oromiya, northwestern part of Semen Gonder zones and covers 3548.33 ha or 0.02 percent of the area of the Region.

Soil Mapping Unit 46

This soil mapping unit consists of excessively drained Lithic Leptosols associated with Eutric Vertisols and Calcaric Vertisols on high gradient escarpments. The soils have been formed from variable parent materials. Erosion is severe.

Soil chemical and physical analyses results indicate that the PH is neutral, exchangeable cations are medium to very high. The CEC is high. Base saturation is very high. The nitrogen content and organic matter are medium. The available phosphorus and ESP are very low. Artifical fertilizrs are essential for optimum production.

These soils occur in the Mirab Gojam, Debub Wello, Oromiya, north-western part of Semen Gonder, Humra, Debub Gonder, Semen Wello and Semen Shewa zones and covers 675194.51 ha or 4.28 percent of the Region.

Soil Mapping Unit 47

This soil mapping unit consists of excessively drained Lithic Leptosols on high gradient valleys. The soils have been formed from variable parent materials. Erosion is severe.

Soil chemical and physical analyses results indicate that the PH is neutral. Exchangeable sodium is very low whereas exchangeable potassium, magnesium and calcium are low, high and very high respectively. The CEC is high while base saturation is very high. Total nitrogen and organic matter content are low. The available phosphorus is very high.

These soils occur in the Awi, Mirab Gojjam, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones.

The mapping unit covers 92315.44ha or 0.59 percent of the Region.

Soil Mapping Unit 48

The soil mapping unit 48 consists of excessively drained Lithic Leptosols associated with Eutric Cambisols on high gradient elongated ridges. The soils have been formed from basic volcanic and intrusive rocks. Erosion is severe.

Soil chemical and physical analyses results indicate that the PH is neutral, exchangeable cations are medium to very high. The CEC is high. Base saturation is very high. The nitrogen content is low. The organic matter is medium. The available phosphorus and ESP are low while available potassium is high. Artificial fertilizers are essential for optimum production.

These soils occur in the Awi, Mirab Gojjam, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones, and covers 675194.51 ha or 4.28 percent of the Region.

Soil Mapping Unit 49

This soil mapping unit consists of well drained Rhodic Nitisols associated with Haplic Alisols and Haplic Acrisols (rudic) on low to moderate relief. The soils have been formed from undifferentiated lower complex and granite rocks. Erosion is moderate.

The laboratory results indicate that the soil reaction is acidic. The EC is very low indicating no salinity hazard. The exchangeable cations are low to medium. The CEC is medium. The base saturation is low. The total nitrogen and organic matter content is low. The available phosphorus is medium while available potassium is very high. Application of fertilizers is essential.

These soils occur in Awi and Mirab Gojjam zones and covers 8677.43 ha or 0.06 percent of the Region.

Soil Mapping Unit 50

Soil mapping unit 50 comprises well drained Luvic Phaeozems associated with Eutric Fluvisols on alluvial fan. The soils have been developed on alluvium. No erosion has been noticed.

Soil reaction is slightly acid. The electrical conductivity is very low. The exchangeable cations are medium to very high. The organic matter is medium. Available potassium high while phosphorus is low. The ESP is medium. The application of phosphorus fertilizer is essential. Care should be taken to avoid agricultural practices that cause build up of sodicity and alkalinity.

These soils occur in Debub Wello and Oromiya zones, and covers 9025.07 ha or about 0.06 percent of the Region.

Soil Mapping Unit 51

This soil mapping unit consists of excessively drained Eutric Leptosols associated with Chromic Luvisols on high gradient elongated ridges. The soils have been formed from non-carbonatic metasediments. Erosion is severe.

The soil laboratory analysis results indicate that the soil reaction is slightly acidic. Exchangeable sodium is very low whereas potassium is very high. Exchangeable calcium is very high while magnesium is high. The CEC, total nitrogen and organic matter are very high whereas base saturation and available phosphorus are high.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Debub Gonder, and Semen Wello zones and cover an area of 6267.44ha or about 0.04% of the Region.

Soil Mapping Unit 52

This soil mapping unit consists of somewhat excessively drained Dystric Leptosols associated with Eutric Leptosols on hills, escarpments and high plateaus. These soils have been formed from basaltic rocks. Erosion is severe.

Soil laboratory results indicate that the PH is neutral. The Total nitrogen and organic matter contents are very high. Available phosphorous is very high whereas exchangeable potassium is medium. Exchangeable sodium is low whereas exchangeable magnesium and calcium are medium and high respectively. The CEC is very high while base saturation is low. The available phosphorus is very high.

These soils occur in the Mirab Gojjam, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones and covers 13311.94ha or 0.08 percent of the Region.

Soil Mapping Unit 53

This soil mapping unit consists of excessively drained Eutric Leptosols on high gradient elongated ridges. The soils have been formed from meta volcanic rocks. Erosion is severe.

Soil chemical and physical analyses results indicate that the PH is neutral. Total nitrogen and organic matter content are low. Exchangeable sodium is very low whereas exchangeable magnesium and calcium are high. The CEC is very high while base saturation is high. The available phosphorus is very high whereas exchangeable potassium is high.

These soils occur in the Mirab Gojjam, Debub Wello, Oromiya, and northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder and semen Wello zones and covers 1651.05ha or 0.01 percent of the Region.

Soil Mapping Unit 55

This soil mapping unit consists of well drained Vitric Andosols on rolling to hilly landform with plains. The soils have been developed on pumice gravels. The erosion over the land unit is moderate.

The laboratory data indicates that soil reaction is slightly acid. Exchangeable cations are high to very high. The CEC is high. The base saturation is low. The nitrogen content is low whereas the organic matter is medium. The available phosphorus is low. There is a need to use fertilizer inorder to augment the soil nutrients. The soils occur in Semen Shoa Zone.

The mapping unit covers 3878.66 ha or about 0.02 percent of the Region.

Soil Mapping Unit 56

This soil mapping unit consists of imperfectly drained Eutric Vertisols on rolling plains. The soils have been developed on alluvium/colluvium deposits. The erosion over the land unit is moderate.

The laboratory data indicates that soil reaction is moderately acidic. Exchangeable sodium is low whereas exchangeable calcium and

magnesium are very high. The CEC and base saturation are very high while total nitrogen is low. Organic matter is medium. The available phosphorus is high whereas exchangeable potassium is very high.

The soils occur in Semen Gonder Debub Gonder Zones and covers 16042.34ha or about 0.1 percent of the Region.

Soil Mapping Unit 57

This soil mapping unit consists of imperfectly drained Eutric vertisols on plains, plateaus and piedmonts. The soils have been developed on alluvium, colluvium, sandstone and rhyolite. The erosion is moderate.

The soil reaction is neutral. The exchangeable cations (sodium, potassium, calcium and magnesium) range from high to very high. The CEC and base saturation are very high. The nitrogen and organic matter content are very low whereas available phosphorus is low. The major nutrients content of the soils is low and therefore requires the application of fertilizers.

These soils occur in Misrak Gojjam, Awi, Mirab Gojjam, Debub Wello, Oromiya, northwestern part of Semen Gonder, eastern part of Semen Gonder, Debub Gonder, Semen Wello and Semen Shewa.

The mapping unit covers 708991.73 ha or about 4.50 percent of the Region.

Soil Mapping Unit 58

This mapping unit consists of well drained Eutric Vertisols associated with Eutric Cambisols (rudic) on rolling plains. The soils have been formed from coarse grained acidic plutonic rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is moderately acidic. The electrical conductivity is very low indicating low salinity hazard. The exchangeable sodium is very low whereas exchangeable potassium, calcium and magnesium are very high. The CEC and base saturation are very high and high respectively. The nitrogen content is medium while organic matter is high. The available phosphorus is high. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity.

These soils occur in northwestern part of Semen Gonder zone and covers an area of 11213.01 ha or about 0.07 percent of the Region.

Soil Mapping Unit 59

This mapping unit consists of imperfectly drained Eutric Vertisols associated Eutric Cambisols and Eutric Leptosols on plains, plateaus, piedmonts, basins and depressions. The soils have been formed from basalts, alkali trachytes, rhyolites and sandstone fine grained clastic rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is strongly acidic. The electrical conductivity is very low indicating low salinity hazard. The exchangeable sodium low while other cations range between high to very high. The CEC is very high while base saturation is high. The nitrogen content is high whereas organic matter is very high. The available phosphorus is high. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity.

These soils occur in northwestern part of Semen Gonder zone and cover an area of 180547.13ha or about 1.15 percent of the Region.

Soil Mapping Unit 61

This mapping unit consists of well drained Eutric Cambisols associated with Eutric Leptosols on rolling plains. The soils have been formed from coarse grained clastic rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is moderately acidic. The electrical conductivity is very low indicating low salinity hazard. The exchangeable sodium is very low whereas exchangeable calcium and magnesium are very high. CEC is very high to very high while base saturation is medium. Total nitrogen and organic matter content are low while available phosphorus and potassium are very low and low respectively. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity.

These soils occur in northwestern part of Semen Gonder zone and cover an area of 5118.27ha or about 0.03 percent of the Region.

Soil Mapping Unit 62

This mapping unit consists of imperfectly drained Calcaric Vertisols associated Eutric Leptosols on plains plateaus, piedmonts basins and depressions. The soils have been formed from basaltic rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is moderately alkaline. The electrical conductivity is low indicating low salinity hazard. The exchangeable sodium is low while other cations are very high. CEC and base saturation are very high. Total nitrogen and organic matter content are medium while available phosphorus. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity.
These soils occur in northwestern part of Semen Gonder zone and cover an area of 108910.35 ha or about 0.69 percent of the Region.

Soil Mapping Unit 63

Soil mapping unit 63 consists of somewhat excessively drained Rendezic Leptosols associated with Eutric Leptosols on steep side slopes. The soils have been formed from basalts. Erosion in the area is severe.

The laboratory data of the soil samples from representative profile pits shows that soil reaction is slightly acid. The exchangeable cations are high to very high. The CEC is very high. Base saturation is high. The nitrogen content is low. The organic matter content is medium. Available phosphorus is low. Application of fertilizers is essential particularly nitrogen and phosphorus fertilizers.

These soils occur in Semen Shewa Zone and cover an area of 3490.10 ha or about 0.02 percent of the Region.

Soil Mapping Unit 65

This mapping unit consists of imperfectly drained Eutric Vertisols associated with Eutric Cambisols on hilly plains. The soils have been formed from basic volcanic and intrusive rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is acidic. The electrical conductivity is very low indicating low salinity hazard. The exchangeable cations range between low and very high. The CEC is high to very high. Base saturation is low. The nitrogen content is medium to high. The organic matter is also medium to high. The available phosphorus is low to high. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity. The soils occur in northwestern part of Semen Gonder zone.

The mapping unit covers an area of 13506.61 ha or about 0.09 percent of the Region.

Soil Mapping Unit 67

This soil mapping unit consists of excessively drained Eutric Leptosols associated with Lithic Leptosols on medium gradient hills. The soils have been formed from basaltic rocks. Erosion status is severe.

Soil chemical and physical analyses results indicate that the PH is slightly acidic. Total nitrogen is high while organic matter content is very high. Exchangeable sodium is low whereas exchangeable magnesium and calcium are high and very high respectively. CEC and base saturation are high while available phosphorus and potassium are very high.

These soils occur in the northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, semen shewa and Debub Gonder zones and cover 312100.65ha or 1.98percent of the Region.

Soil Mapping Unit 68

This mapping unit consists of well drained Eutric Cambisols on rolling plateaus. The soils have been formed from basic volcanic and intrusive rocks. The erosion status of the mapping unit is moderate.

The laboratory data indicates that the soil reaction is strongly acidic. The electrical conductivity is very low indicating low salinity hazard. The exchangeable sodium, calcium and magnesium are medium. CEC and base saturation are high whereas total nitrogen, available phosphorus and potassium are very high. Organic matter content is low. The exchangeable sodium percentage is low indicating a minimum risk of alkalinity and sodicity.

These soils occur in northwestern part of Semen Gonder and Debub Gonder zones and cover an area of 13581.93ha or about 0.09 percent of the Region.

Soil Mapping Unit 69

This mapping unit consists of excessively to somewhat excessively drained Eutric Cambisols (rudic phase) on hilly plains, escarpments, hills, side slopes, mountains and piedmonts. The soils have been formed from rhyolites, basalts, alluvium, sandstone, basic volcanic and intrusive rocks. The erosion is moderate.

The laboratory data indicates that the soil reaction is slightly acidic whereas exchangeable cations very between medium and very high. The CEC is high. The base saturation is also high. The nitrogen content is medium. The organic matter is high. Available phosphorus is low. The ESP is low indicating no alkalinity hazard will occur.

These soils occur in southwestern part of Semen Gonder, Awi, Mirab Gojjam, Debub Wello, Oromiya, and North Western part of Semen Gonder, Eastern part of Semen Gonder, Wag Humra and Semen Shewa zones and cover an area of 592241.01 or about 3.76 percent of the Region.

Soil Mapping Unit 70

Soil mapping unit 70 comprises moderately well drained Dystric Leptosols on undulating valley floors. The soils have been formed from alluvium. Erosion in the mapping unit is slight.

The laboratory results indicate that the soil reaction is slightly acidic. The organic matter and total nitrogen are medium and low respectively. The electrical conductivity is medium and could increase if the water management is not proper. Sodium is medium; magnesium is high where as both potassium and calcium are very high indicating that the toxicity from sodium could easily be buffered. The CEC of the soils is very high while base saturation is high. The available phosphorus is medium.

These soils occur in Debub Gonder, Semen Wello and Semen Shewa and cover 10830.73 ha or about 0.07 percent of the Region.

Soil Mapping Unit 72

This soil mapping unit comprises somewhat excessively well drained Haplic Cambisols on rolling plateaus. These soils have been formed from ignimbrites. Erosion in the mapping unit is slight.

The laboratory results indicate that the soil reaction is moderately alkaline. The electrical conductivity is very low indicating low salinity hazard. The organic matter and total nitrogen are low. Exchangeable sodium and magnesium are medium where as both potassium and calcium are very high indicating that the toxicity from sodium could easily be buffered. The CEC of the soils is very high while base saturation is high. The available phosphorus is low.

These soils occur in Debub wello and Semen Shewa and cover 25696.13ha or about 0.16 percent of the Region.

Soil Mapping Unit 75

This mapping unit comprises moderately well drained Eutric Leptosols, Eutric Cambisols and Eutric Regosols on gorges, canyons, escarpments and hills. The soils have been formed from basalts, rhyolites, laterite, sandstones, Abbay beds and gabbros. Erosion is severe.

The soil chemical and physical analyses results show that the soil reaction is acidic; the electrical conductivity is low indicating no salinity hazard. The sodium is low, potassium is medium, and calcium and magnesium are very high indicating the parent material is high in bases. The CEC is very high. Base saturation is medium whereas the organic matter is very high contributing to a well developed structure and a good nutrients reserve. The nitrogen content is low, probably due to high microbial activity and monoculture. The soil content of the available phosphorus is very high probably will not respond to phosphorus fertilizer. The exchangeable sodium percentage is also low indicating the soils are free from alkalinity.

These soils occur in Misrak Gojjam, Mirab Gojjam, Awi, northwestern part of Semen Gonder, eastern part of Semen Gonder, Wag Humra, Debub Gonder, Semen Wello, and Semen Shewa and cover 394211.02 ha or about 2.50 percent of the Region.

Soil Mapping Unit 79

This mapping unit comprises excessive drained Eutric Leptosols on narrow plateaus. The soils have been formed from basic volcanic rocks. The soil erosion status is severe.

The soil chemical and physical analyses results show that the soil reaction is neutral; the electrical conductivity is low indicating no salinity hazard. The sodium and potassium are low whereas calcium and magnesium are medium. The CEC is medium while base saturation is high. Total nitrogen and organic matter are low whereas available phosphorus is very low. The exchangeable sodium percentage is low indicating that these soils are free from alkalinity.

These soils occur in northwestern part of Semen Gonder and eastern part of Semen Gonder and cover 3984.71ha or about 0.03 percent of the Region.

Soil Mapping Unit 81

This mapping unit comprises imperfectly drained Calcaric Fluvisols on almost flat plains. These soils have been formed from alluvium deposits. The soil erosion status is severe.

The soil chemical and physical analyses results show that the soil reaction is slightly alkaline; the electrical conductivity is low indicating no salinity hazard. The sodium and calcium are high whereas potassium and magnesium are very high medium respectively. CEC and base saturation are high. Total nitrogen content and organic matter are low while available phosphorus is high. The exchangeable sodium percentage is also low indicating the soils are free from alkalinity.

These soils occur in Debub Wello and Semen Shewa and cover 8630.02 ha or about 0.05 percent of the Region.

Soil Mapping Unit 82

This mapping unit comprises well drained Haplic Luvisols on low and medium gradient elongated ridges. These soils have been formed from basic volcanic and intrusive rocks. Erosion is severe.

The soil chemical and physical analyses results show that the soil reaction is strongly acidic; the electrical conductivity is very low indicating no salinity hazard. Exchangeable sodium is very low while potassium is very high. Exchangeable calcium and magnesium are medium and high respectively. CEC is high whereas base saturation is medium. Both Organic matter and nitrogen content and available phosphorous are low. The exchangeable sodium percentage is also low indicating the soils are free from alkalinity.

These soils occur in northwestern part of Semen Gonder, eastern part of Semen Gonder, Debub Gonder and Semen Wello, and cover 1086.74ha or about 0.01percent of the Region.

Soil Mapping Unit 83

This mapping unit consists of moderately well drained Calcic Solonetz on level to undulating plain. The soils have been derived from volcano lacustrine parent materials. Erosion is not common.

The soil analytical data indicates that the soil reaction is alkaline. The organic matter content is very low. The total nitrogen content is low. Available phosphorus is low. Exchangeable sodium is very high. Exchangeable magnesium is high. The content of exchangeable potassium and calcium are very high. The CEC is very high. The base saturation is also very high. The soils require to be reclaimed with the use of gypsum etc. the soils are difficult to manage and, therefore, require an elaborate management plan for a considerable length of time.

The soils occur in Debub Wello zone, Oromiya zone and Semen Shewa zone. The mapping unit covers 13839.60 ha or about 0.09 percent of the Region.

Soil Mapping Unit 84

Soil mapping unit 84 consists of excessively drained Eutric Leptosols and Eutric Cambisols on low and medium gradient elongated ridges. The soils have been formed from non-carbonate metasediments. Erosion is severe.

Soil laboratory determinations show that soil reaction is near neutral, sodium is low, potassium is low, calcium is high and magnesium is medium. The CEC is medium and base saturation is very high. The nitrogen content is low, organic matter is medium and available phosphorus is low. The ESP is medium. Application of macronutrients in a form of fertilizer is essential. Care should be taken to avert the alkalinity hazard that could be a reality because of soil mismanagement.

These soils occur in eastern part of Semen Gonder and Wag Humra zones and cover an area of 1926.23 ha or about 0.01 percent of the Region.

Soil Mapping Unit 85

This mapping unit consists of excessively drained Eutric Leptosols associated with Eutric Cambisols and Haplic Luvisols on low and medium gradient elongated ridges. The soils have been formed from meta carbonates basic volcanic and intrusive rocks. Erosion in the area is severe.

Results of the laboratory soil analysis indicate that the surface texture is silty clay. The soil reaction is on the slightly acidic side. Organic matter is low while total Nitrogen is medium. The exchangeable sodium is and potassium is medium. The exchangeable calcium and magnesium are very high. Available phosphorus is medium whereas both the CEC and the base saturation are very high. The nutrient status of these soils is good, had it not been for their shallow depth.

The soils occur in Metema and Chilga weredas, Semen Gonder zone and Wag Humra zone. The mapping unit covers 690196.16 ha or about 4.38 percent of the Region.

Soil Mapping Unit 86

This mapping unit consists of somewhat excessively drained Eutric Cambisols associated with Chromic Luvisols on low and medium gradient elongated ridges. These soils have been derived from meta volcanic rocks. Erosion in the area is moderate.

The soil analysis results indicate that the soil reaction is slightly acidic. The organic matter content is low while total nitrogen content is very low. The available phosphorus and potassium levels are low. Exchangeable sodium is very low while both calcium and magnesium are medium. CEC and base saturation are very high.. The overall nutrient level of the soils is poor.

The soils occur in northwestern part of Semen Gonder zone, Semen Gonder zone, Wag Humra zone, Debub Gonder zone and Semen Wello zone. The mapping unit covers 3165.83 ha or about 0.02 percent of the Region.

Soil Mapping Unit 88

This mapping unit consists of well drained Eutric Cambisols on low and medium gradient elongated ridges. The soils have been derived from acid to intermediate volcanic rocks. Erosion in the area is moderate.

The soil analysis results indicate that the texture is clay and the soil reaction is moderately alkaline. The organic matter content is medium. Total nitrogen content is also low. Available phosphorus level is medium while potassium is low. The exchangeable sodium is low whereas calcium and magnesium are high and medium respectively. CEC and base saturation are very high. The overall nutrient level of the soils is poor.

The soils occur in northwestern part of Semen Gonder zone, Semen Gonder zone, Wag Humra zone, Debub Gonder zone and Semen Wello zone. The mapping unit covers 9651.69 ha or about 0.06 percent of the Region.

Soil Mapping Unit 89

This mapping unit consists of excessively drained Eutric Leptosols on low and medium gradient elongated ridges. The soils have been formed from coarse grained acidic plutonic rocks. Erosion in the area is severe.

Results of the laboratory soil analysis indicate that the dominant texture is sandy loam. The soil reaction is on the acidic side. Organic matter is medium. Total Nitrogen is also medium. The exchangeable sodium is low. The exchangeable potassium is medium. The exchangeable calcium and magnesium are high. The available phosphorus is very high. Both the CEC and the base saturation are high. The nutrient status of these soils is good, had it not been for their shallow depth.

The soils occur in Metema, Sonja and Chilga weredas, Semen Gonder zone and Wag Humra zone. The mapping unit covers 1445.60 ha. or about 0.01 percent of the Region.

Soil Mapping Unit 90

This mapping unit consists of moderately well drained Eutric Cambisols and Eutric Leptosols on composite valleys. The soils have been derived from variable parent materials. Erosion in the area is moderate.

The soil analysis results indicate that the texture is clay and the soil reaction is acidic. The organic matter content is medium. Total nitrogen content is also medium. The available phosphorus level is very high. The exchangeable sodium is very low whereas the exchangeable potassium is low. Both calcium and magnesium are very high. The CEC is very high. The base saturation is medium. The overall nutrient level of the soils is good.

The soils occur in northwestern part of Semen Gonder zone, Semen Gonder zone, Wag Humra zone, Debub Gonder zone and Semen Wello zone. The mapping unit covers 286174.66 ha or about 1.82 percent of the Region.

Soil Mapping Unit 91

The mapping unit comprises poorly drained to waterlogged Eutric Gleysols on depressions. The soils have been derived from alluvium. Erosion is not observed in the area.

The laboratory results indicate that soil texture is clay. Soil reaction is acidic. The organic matter content is medium. Available phosphorus is low whereas total nitrogen is very low. Exchangeable sodium is medium. Exchangeable calcium is high. Both exchangeable potassium and magnesium are very high. CEC and base saturation are high. It is important to study the characteristics of waterlogged Gleysols before any attempt to drain them. Such soils could end up in acidic soils when the soil becomes oxidized after drainage.

These soils occur in Quara wereda, Alefa wereda, Metema wereda, Sanja wereda, Chilga wereda, Debub Gonder zone and Semen Wello zone. This mapping unit covers 14742.89 ha or about 0.09 percent of the Region.

Soil Mapping Unit 92

The mapping unit comprises moderately well Eutric Vertisols associated with Eutric Gleysols and Eutric Leptosols on low gradient plateaus. These soils have been derived from basic volcanic and intrusive rocks. Erosion is slight.

The laboratory results indicate that soil texture is clay. Soil reaction is moderately alkaline while electrical conductivity is low. The organic matter and total nitrogen content are medium whereas available phosphorus is very low. Exchangeable sodium is high while other cations are very high. CEC and base saturation are very high.

These soils occur in Semen Wello and Debub Wello zones and cover 115790.18 ha or about 0.73 percent of the Region.

Soil Mapping Unit 93

The mapping unit comprises imperfectly drained Eutric Vertisols associated with Eutric Cambisols on low gradient foot slopes. These soils have been derived from alluvium/ colluvium deposits. Erosion is slight.

The laboratory results indicate that soil texture is clay. Soil reaction is neutral. Electrical conductivity is very low. The organic matter and total nitrogen content are medium whereas available phosphorus is very low. Exchangeable sodium and potassium are high whereas exchangeable calcium and magnesium are very high. CEC is very high while base saturation are high.

These soils occur in Debub Wello, Semen Wello and Semen Shewa zones and cover 57823.86ha or about 0.37 percent of the Region.

Soil Mapping Unit 94

This mapping unit comprises well drained Vertic Cambisols and Haplic Luvisols in association with Eutric Leptosols on medium gradient foot slopes. These soils have been derived from colluvium. Erosion is slight.

The laboratory results indicate that soil texture is clay. Soil reaction is moderately alkaline. Electrical conductivity is very low. The organic matter and total nitrogen content are low whereas available phosphorus is very low. Exchangeable sodium and potassium are high whereas exchangeable calcium and magnesium are very high. CEC and base saturation are very high.

These soils occur in Debub Wello, Semen Wello, Oromiya, and Semen Shewa zones and cover 64233.13 ha or about 0.41 percent of the Region.

Soil Mapping Unit 95

The mapping unit comprises well drained Umbric Andosols in association with Umbric Leptosols on high ridges in the high land areas. These soils have been derived from volcanic rocks. Erosion is moderate in the area.

The laboratory results indicate that soil texture is silty loam. Soil reaction is moderately acidic. The organic matter content is medium and total nitrogen is high. Available phosphorus is low whereas exchangeable potassium is medium. Exchangeable sodium and calcium are high. CEC is high and base saturation is medium.

These soils occur in Semen Wello semen Gonder, East Gojjam and Semen Shewa and zones cover 13089.53 ha or about 0.08percent of the Region.

Soil Mapping Unit 96

The mapping unit comprises well drained Mollic Andosols in association with Mollic Leptosols and Lithic Leptosols high ridges in the high land areas. The soils have been derived from alluvium. Erosion is moderate in the area.

The laboratory results indicate that soil texture is loam. Soil reaction is moderately acidic. Organic matter and total nitrogen contents are very high. Available phosphorus is medium whereas exchangeable potassium low. Exchangeable is calcium medium while exchangeable sodium is high. Both and magnesium are very high. CEC is high whereas base saturation medium.

These soils occur in Debub Gonder, semen Shewa and Semen Wello zones cover 17379.62 ha or about 0.11percent of the Region.

Soil Mapping Unit 97

This soil mapping unit consists of well drained Haplic Acrisols in association with Haplic Alisols and Haplic Nitisols on plains and Plateaus. The soils have been formed from granites and undifferentiated lower complex. Erosion is slight to moderate.

Laboratory determination indicates that soil reaction in acidic, electrical conductivity is very low indicating no salinity problem is anticipated. Sodium is very low, potassium is very low, calcium is low, and

magnesium is medium. The CEC is medium and base saturation is low. The nitrogen content is low. The organic matter is medium. Available phosphorus is low.

These soils occur in south western part of Semen Gonder, Awi and Mirab Gojjam zones and covers an area of 25472.46 ha or about 0.16 percent of the Region.

Soil Mapping Unit 98

This soil mapping unit consists of well drained Haplic Acrisols in association with Haplic Alisols and Haplic Nitisols on high and low plateaus lowland plains hills valleys, canyons and ridges. These soils have been formed from alluvium colluvium volcanic and clastic rocks. Erosion is slight in this area.

Laboratory determination indicates that the surface soil texture is clay. Soil reaction is moderately acidic while electrical conductivity is low indicating no salinity problem is anticipated. Exchangeable sodium is medium and potassium is very high. Exchangeable calcium and magnesium are very high. The CEC is high and base saturation is very high. Nitrogen and organic matter content are very high while available phosphorus is high.

These soils occur in southwestern part of Semen Gonder, Awi, Mirab Gojjam and East Gojjam zones and cover an area of 17774.74ha or about 0.11 percent of the Region.

Soil Mapping Unit 99

This soil mapping unit consists of well drained vertic Cambisols in association with and Eutric Vertisols on low to moderate relief hills. The soils have been formed from basalts. Erosion is moderate.

The laboratory analysis results indicate that soil reaction is moderately acidic where by crop selection should consider the soil reaction as a major criterion. The electrical conductivity is low indicating that salinity is not a problem in the mapping unit. Sodium is low, potassium is medium, calcium is high and magnesium is high. The cation exchange capacity is very high and the base saturation is low. The nitrogen content is low. The organic matter is very high and probably it was in a form

fixed in microbes could be released once the decaying and mineralization process starts. The available phosphorus is very high indicating that there will not be response to phosphorus application. The ESP is very low indicating that the probability of alkalinity risk is remote.

These soils occur in southwestern part of Semen Gonder, Debub Wello, Oromiya and Semen Shewa Zones and cover an area 97025.41 or about 0.62 percent of the Region.

5. Description of major soils in the region

On the basis of the field soil studies and laboratory analytical results during the previous studies and the present study, major soil groups and soil units of the region have been identified and the finding re summarized in Table 5.1. The area coverage of each soil unit has been presented in Table 4.4

5.1. Vertisols

The soils of this category are deep to very deep, imperfectly drained soils formed on flat to almost flat topography. They have surface mulch and mostly well developed slickensides in the lower part of their horizons. They heavy clay throughout the profile and the proportion of clay fraction is mostly greater than 60%.

They are very hard to extremely hard when dry, and very sticky and plastic when wet, which is reflected in their poor work ability.

Table 5.1: Major Soils of the Amhara Region

Major soil groupings	Identified soil units	Mapping code
Vertisols	Eutric Vertisols	1,14,19,23,56,57,59,65,92,93
	Calcic Vertisols	62
	Dystric Vertisols	70
Nitisols	Haplic Nitisols	3,33,42
	Rhodic Nitisols	44,49
Luvisols	Eutric Luvisols	88
	Haplic Alisols	4,7,32,82
	Chromic Lvisols	8
Alisols	Haplic Acrisols	6,26
Acrisols	Haplic Acrisols	97,98

Major soil groupings	Identified soil units	Mapping code
Phaeozems	Luvic Phaeozems	50
Fluvisols	Eutric Fluvisols	5
	Calcaric Fluvisols	81
Gleysols	Eutric Gleysols	91
	Mollic Gleysols	45
Andosols	Vitric Andosols	55
	Mollic Andosols	66
	Umbric Andosols	95
Calcisols	Luvic Calcisols	16
Cambisols	Vertic Cambisols	18,99
	Humic Cambisols	72
	Calcaric Cambisols	9,12,31
	Eutric Cambisols	2,27,29,30,36,58,61,68,69,88, 89,90
Arenosols	Haplic Arenosols	29
Regosols	Eutric Regosols	24
Solonetz	Calcic Solonetz	83
Leptosols	Eutric Leptosols	25,35,37,41,51,53,75,79,84,85 ,89
	Rendezic Leptosols	28,63
	Umbric Leptosols	34,38
	Lithic Leptosols	40,43,46,47,48
	Dystric Leptosols	52
	Mollic Leptosols	67

They are commonly found in semen Gonder, Wag Humra, Awi, Mirab Gojjam, Misrak Gojjam, Semen wello, Debub Wello, Oromiya and Semen Shewa Zones. Vertisols of the region have been classified as Eutric Vertisols, Calcic Vertisols Dystric Vertisols. These soils are spread in the above mentioned zones and cover an area of 26738. 29 km^2 or about 18.83 percent of the region.

5.2. Nitisols

These soils have been developed in well-drained areas with good permeability, a favorable structure. They are found dominantly on flat to rolling topography. They are characterized by their very thick (greater than 150 cm) more or less uniform clay distribution. The soils are reddish in colour, derived from different parent materials.

Nitisols are mostly found in Awi, mirab Gojjam, Gera Midam keya Gebriel, Lalo Midir, Mama Midir Etc. they are classified as Haplic Nitisols and Rhodic Nitisols.

These soils cover an area of 1433. 76km2 or about 0.01% of the Region.

5.3. Luvisols

Luvisols are widely distributed in the region and are classified in the region and are classified as Eutric Luvisols, Haplic Luvisols and Chromic Luvisols. The soils are developed in well-drained areas at higher altitude. They are mainly developed in variable parent materials such as acid to intermediate volcanic rocks (Metema, Sanja and chillga Wereda) basalts, alkali trachytes and rhyolite (Awi and Mirab Gojam Zones) Aluminum,, Colluvium, basalt and Sandstone (Gonchana Sisona , Inese sar Midir).

The soils are generally deep, predominantly heavy clays their structure is moderately developed medium sub angular blocky. Consistence is hard (dry), friable to firm (moist) sticky and slightly plastic (wet).

The soils have good permeability. Their typical characteristic is that they are found in areas where climatic conditions permit clay movement. They are found commonly on flat and gently sloping topography.

Luvisols are widely distributed in the region and are classified as Eutric Luvisols, Haplic Luvisols, chromic Luvisols. These soils cover an area of 8277.61 km^2 or about 5.81% of the Region.

5.4. Alisols

These soils are well drained, deep, clay to clay loam. Erosion is slight to moderate. They occur commonly on hills, plains, valley and plateaus. They are formed from aluminum, colluvium, sandstones, basalt's and undifferentiated parent material.

The Alisols of the region have been classified as Haplic Alisols. They are mostly found in Misrak Gojam, Mirab Gojam, Awi, Semen Gonder and Wag Humra zones.

Alisols of the region cover an area of 7484. 62 km^2 or about 5.27% of the Region.

5.5. Acrisols

Acrisols are soils characterized by an agric B horizon with a base saturation of less than 50% in the major part between 25 and 100cm of the soil surface, cation exchange capacity of less than 24 cmol per kg clay. They are yellowish- reddish brown, well drained very deep fine textured acid soils and exhibit strongly weathered profiles that may be affected by aluminum toxicity and high phosphorous fixation.

They are commonly found in Misrak Gojam, Awi, Mirab Gojam Zones. Acrisols of the Region have Acrisols. They cover an area of 554. 49km^2 of about 0.395 of the area of Region.

5.6. Phaeozems

Phaeozems are soils having dark brown color commonly and are characterized by the presence of workable topsoil. Usually occurs on alluvial fan or undulating and derived from aluminum and colluvium.

These soils are deep, well drained, clay to sandy clay. They are friable and permeable.

They are mostly found in Debub Wello and Oromiya zones. Phaeozems of the region have been classified as Luvic Phaeozems. They cover an area of 90.55 km^2 of about 0.06 % of the Region.

5.7. Fluvisols

The Fluvisols in the Region are imperfectly drained, deep, clay with none to slight erosion hazard. That are mostly found on plains and depressions along main streams and are subject to annual flooding, consequently receiving fresh sediments from each flood. Their colur is variable differing from yellowish brown to dark reddish brown.

They are mostly found in Hulet Iju Inese, Bibugn, Guzamen Wereda and Semen Shewa Zone. Fluvisols of the region have been classified as Eutric Fluvisols and Calcaric Fluvisols. The soils cover an area of 3778. 13km^2 or about2.45% of the Region.

5.8. Gleysols

Gleysols are soils showing hydromorphic property within 50 cm of the surface. The soils in the Region are well drained to waterlogged, moderately deep to very deep, fine textured soils. The soils are commonly with groundwater influence. This can be explained by the presence of

reducing conditions, brought about by prolonged waterlogged conditions in the presence of high organic matter, resulting in the reduction of ferric compounds to ferrous compounds.

Gleysols are mostly found in the flat wet areas with up flux of moisture for most part of the year. They are commonly found Quara and Alefa weredas, Debub Wello zone, Oromiya zone, Metema wereda, Sanja wereda, Chilga wereda, Debub Gonder zone and Semen Wello zones. Gleysols of the Region are classified as Eutric Gleysols and Mollic Gleysols. These soils cover an area of 526.06 km^2 or about 0.36% of the Region.

5.9. Andosols

Andosols of the Region are deep to very deep, well drained, loam to clay textured and derived from pumice gravels and other volcanic rocks. They are commonly found on rolling, hilly, high ridges in the highlands.

They are mostly found in Misrak Gojam zone, Quara and Alefa woredas (Semen Gonder Zone), Debub Wello, Oromiya zones; Metema, Sanja and Chilga weredas (Semen Gonder Zone), Semen Gonder, Wag Humra, Debub Gonder, Semen Wello and Semen Shewa zones. Andosols of the Region are classified as Vitric Andosols, Mollic Andosols and Umbric Andosols. These soils cover an area of 903.30 km^2 or about 0.64% of the Region.

5.10. Calcisols

Calcisols are soils having calcic horizons within 100 cm of the surface. The soils are formed by the translocation of calcium carbonate from the surface horizon to an accumulation layer at some depth. The Calcisols of the Region are deep, well drained clay with moderate erosion. They are formed from volcanic rocks and basalts on plains and piedmonts.

They are mostly found in Debub Gonder, Semen Wello and Semen Shewa zones. Calcisols of the Region are classified as Luvic Calcisols. These soils cover an area of 1358.74 km^2 or about 0.96% of the Region.

5.11. Cambisols

Cambisols represent soils in which soil formation is characterized by a certain development of structure, or by colors indicating moderately pronounced alteration and development. The Cambisols of the Region are Shallow to very deep, excessively drained to well drained, clay loam to

sandy loam and formed from variable volcanic and sedimentary rocks on plains and rolling plateaus.

Cambisols are commonly found in almost all parts of the Region including Awi, Mirab Gojam, Misrak Gojam, Debub Gonder, Semen Gonder, Wag Humra, Debub Wello, Oromiya and Semen Shewa zones. The Cambisols of the Region are classified as Luvic Cambisols, Humic Cambisols, Calcaric Cambisols and Eutric Cambisols. These soils cover an area of 13244.82 km^2 or about 9.32% of the Region.

5.12. Arenosols

Arenosols are soils formed from course textured unconsolidated material. Arenosols in the Region are formed from coarse grained clastic rock and basaltic parent materials. They are mostly found in river gorges, canyons and plains.

They are mostly found in Semen Gonder, Wag Humra and Semen Shewa zones. Arenosols of the Region are classified as Haplic Arenosols. These soils cover an area of 789.04 km^2 or about 0.62% of the area of the Region.

5.13. Regosols

Regosols are developed on unconsolidated parent materials derived from different types of rocks. They usually consist of shallow, sandy clay loam and sandy loam textured soils with excessive drainage. Regosols are found on sloping topography. They Regosols resembled Leptosols and are usually associated with them. They differ from Leptosols by their soil depth and profile development.

The Regosols identified in the Region are shallow (10-50 cm deep), somewhat excessively drained, and fine to medium textured. They have been developed on ridges, gorges and Canyons. The soils have been derived from rhyolite, sandstone and basalts. The Regosols of the Region have been classified as Eutric Regosols. They cover an area of 1483.59 km^2 or about 1.04% of the Region.

Regosols are mostly found in Misrak Gojam, Mirab Gojam, Awi, Debub Wello, Oromiya zones, Metema, Sanja and Wag weredas, Semen Gonder and Wag Humra including Semen Shewa Zones.

5.14. Solonetz

Solonetz are soils having a nitric B-horizon within 100 cm of the surface. They are alkaline soils of Halomorphic Suborder. Solonetz soils have high exchangeable sodium percentage (ESP) and are very alkaline. Their soil reaction is greater than 8.5 in most of the soil horizons. They commonly occur on flat to almost flat topography.

In the Amhara Region, they are mostly found in Debub Wello, Oromiya and Semen Shewa zones.

The Solonetz identified in the Region are very deep, moderately well drained clay loam to silty loam and are highly calcareous. They have been developed on level to undulating plain. They are developed from volcanic rocks and lacustrine deposits.

Solonetz soils are not suitable for agricultural development. At a high pit, organic matter disperses, weakening aggregate cohesion and the soil passes to towards the black alkali stage. At this stage, the unstable Na-clay disperses and is moved into the lower horizon where it is flocculated by the higher salt concentration. The Bt horizon that forms is very poorly drained often with signs of glaying causing workability problems and water infiltration problems making agricultural activities very difficult.

Solonetz soils of the Region are classified as Calcic Solonetz. They cover an area of 138.40km^2 or about 0.10% of the Region.

5.1.5. Leptosols

Leptosols are very shallow soils limited in depth by continuous hard rock. They occur mainly steep side slopes; mountains and hills are prominent in the Region. The soils are generally young and are limited by their topsoil horizon or directly over an altered parent rocks from which they have developed.

Leptosols are the most widely spread soils in the Region and are shallow (2-60 cm), excessively drained, sandy loam to clay. They are commonly with common rockiness and stoniness. Erosion is moderate to severe. The soils have been developed from variable parent materials including basic volcanic rocks, intrusive rocks, alluvium colluvium deposits, coarse grained clastics, non carbonate metasediments, meta volcanic rocks, laterite, Abbay beds, sandstone, gabbros, etc.

Apart from offering limited grazing resources, they have little or no agricultural potential. In spite of their low agricultural potential, they are widely cultivated.

The major limitation of the soils is a shallow effective soil depth. The shallow depth does not allow sufficient moisture storage. This renders the soils being prone to drought. Because they dry up easily, they are very likely to be truncated and washed away during heavy rains. They, cannot also support sufficient vegetative growth to protect them from severe erosion. Crops do not perform well in these soils because of their ability not to conserve enough moisture and lack of space for root proliferation. The unfortunate situation in the Amhara Region is that large area is under these soils discouraging even the smallholder

agriculture. In most cases the plow reaches the underlying hard rock making land preparation difficult.

These soils occur in almost all the zones of the Region. Leptosols of the Region have been classified as Eutric Leptosols, Rendezic Leptosols, Umbric Leptosols, Lithic Leptosols and Mollic Leptosols.

Leptosols cover an area of 74222.38 km^2 or about 52.26% of the Region.

6. Soil and Land Management

This section provides some insight into soil and land management practices, which are principal tenets of good soil husbandry.

Knowledge of soils is clearly integral to improving the management and output from existing agricultural areas as well as developing new sites.

The objective of soil and land management is to establish a sustained use for the purpose at hand. Sustainable agricultural development comprises arresting land degradation, maintaining fertility, environmental conservation, controlling salinity, sodicity and other limitations to development. The soil has to be tended wisely and with care in order to make the best use of it.

6.1. Watershed Management

Land degradation due to deforestation, soil erosion, overgrazing, inappropriate cultivation practices and overpopulation is a major problem in the Region.

Areas that need urgent attention in soil conservation activities are interfluvial Ridges, upper Plateau, Hill Side Slopes, mountains, and Elongated Ridges. Water and wind are the main causes of erosion in the Region.

Traditional coping mechanisms include the construction of traditional drainage ditches, mulching, bunding, tree planting and check dam construction. The government effort is observed in many instances but the effectiveness is not far reaching.

Severe land degradation is observed in many parts of the highlands particularly in Debub Gonder, Semen Wello and Semen Shewa zones. Suggested solutions include: -

1. Closing off degraded lands for revegetation.
2. Moving people from steep slopes
3. Cultivating of flat land and foresting and grazing the steep slopes

Integrated watershed management is recommended in a piece-metal starting with micro-catchments of about 500 ha and expanding into the whole watershed.

6.2. Soil Fertility

There are several chemical elements required for plant growth, most are supplied from the soil and all of these are taken up in water soluble forms. The use of fertilizers is established as an important aspect of crop production and advice is required on the type of fertilizer to use, how much, when and how to apply them.

Nutrients are obtained from the soil in a soluble form. If the soil is dry for prolonged time, nutrient intake is inadequate to meet the plants needs and reduced growth may result.

In the soil of the Amhara Region, base saturation is very high >50%) in most soils rendering the soils relatively fertile except in a few soils such as some Cambisols, Luvisols, Leptosols and Andosols that the base saturation is low. Exchangeable calcium is mostly high to very high (>15me/100g soil) in most of the soils of the Region. Magnesium is medium to very high in most of the soils of the Region except for some Cambisols and Andosols where it is low and medium respectively. There will not be response to potassium fertilizer when the soil has exchangeable potassium above 0.4me/100g soil and a requirement for potassium fertilizer when the exchangeable potassium is below 0.2 me/100gm soil. Most of the soil of the Region will not respond to potassium fertilizer except in a few cases of Cambisols, Leptosols, Nitisols and Vertisols. Application of potassium fertilizer should therefore follow a result of a laboratory test of the soil.

Soil reaction is good for most soils except for some Nitisols and Leptosols where the soil pH is below 5.5. These soils may suffer from aluminum toxicity. The low PH may also induce nutrient uptake imbalance. Lime is required to raise the PH to an acceptable level of above 5.5. Available phosphorus is medium to very high in most soils and there will not be response to phosphorus fertilizer in most soils of the Region. The exception to this is sum Fluvisols, Cambisols, Leptosols, Nitisols, Vertisols, Gleysols and Andosols. There is a clear indication that vertisols and Leptosols require phosphorus fertilizers as far as the soils of the Region are concerned.

The level of total nitrogen is very low to medium in the soils of the Region. Although the availability of nitrogen depends on several aspects of the physical environment, the soils of the Region are relatively deficient in nitrogen. This is also closely related to low level of organic matter in most soils of the Region.

The recommendation is to increase the organic matter in the soils and it involves:

- Area closure of degraded lands
- A forestation of vulnerable areas
- Organic cycling including residue management and refraining from using animal dung for fuel source.

6.3. Flood Prevention and Drainage

Excess water in the soil can severely limit the use of land for agriculture. Poor drainage and seasonal flooding are common occurrences in some part of the Region.

During the rainy season, water from uplands accumulates on flat low lands with slowly permeable soils such as Vertisols and Gleysols. Other soils with finer texture or occurring on flat landscape such as Fluvisols and Cambisols have also been prone to flooding.

Plant root activity is reduced in heavy textured soils during wet periods because of excess moisture in the soil. The characteristic symptoms are wilting yellowing of leaves etc. Denitrification losses are serious in agricultural soils with seasonal water logging. In acidic soils, waterlogging leads to high levels of exchangeable manganese, which causes manganese toxicity to plants. Phosphorus is also adsorbed and becomes unavailable to plants in waterlogged condition.

Effective utilization of soils with imperfect and poor drainage requires the removal of excess moisture from the soil through internal or external drainage. Allowing wter percolation through the soil horizons encourages internal drainage. Impermeable clay, hardpans, indurates layers or bedrock at shallow depth affects soil drain ability.

Drainage problems can also occur where the ground water level is near the soil surface. This could also be followed by a salt accumulation on the surface. The water table should therefore remain below 120 cm for normal growth of crops.

In the Region Vertisols pose the most drainage problems. They are mostly imperfectly drained. Some Cambisols and Fluvisols also are imperfectly drained. Eutric Gleysols remain water logged for considerable part of the year. They cover an area of 48984.63 ha or about 0.33 percent of the area of the Region. The soils occur in the southwestern part of Semen Gonder, northwestern part of Semen Gonder, Debub Gonder and Semen Wello zones. The total area that requires drainage because of imperfect drainage or water logged condition adds up to 3008983.39 ha or about 20.58 percent of the total area of the Region.

6.4. Management of Saline and Sodic Soils

Some areas of the Region have been affected by salinity or sodicity. Only those areas with considerable spatial coverage have been considered at the present scale of mapping, which is 1:250,000, small patches cannot be mapped at this scale.

Soil salinity and sodicity can restrict the growth of natural vegetation or agricultural crops. Many of the valley bottoms in the Region are affected by some degree of salinity or sodicity. Soils not initially saline with deep water tables could become saline under irrigation or due to a change in land use. Where the soils are naturally well drained and the water table is deep below the soil surface, the annual flooding leaches out any accumulated salts. A saline soil becomes a saline sodic soil when the exchangeable sodium percentage (ESP) exceeds 15%.

Solonetz soils with high (ESP) occur covering considerable areas in Semen Shewa, Oromiya and Wello zones. These soils are characterized by the presence of a nitric B-horizon within 100cm depth from the surface. They are alkaline with a pH of 8.0. The organic matter is very low. The Solonetz of the Region have been classified as Calcic Solonetz and it covers an area of 13839.60 ha or about 0.09 percent of the Region.

It is recommended that applying calcium, as gypsum should reclaim the soils. It can be spread on the affected soils after determining the requirement of gypsum to reduce the exchangeable sodium percentage (ESP) to an acceptable level. Gypsum can also be dissolved in irrigation water.

6.5. Management of Vertisols

Vertisols are soils having 30 percent or more clay in all horizons to a depth of at least 50cm. They develop cracks, gilgai, and micro relief, slickensides or wedge shaped structure. Hence they are prone to deterioration of soil structure, soil compaction, erosion by water, water

logging etc. They are very hard to extremely hard when dry and very sticky and very plastic.

They are found in almost all parts of the Region and cover a total area of 26738.29km2 or about 18.83 percent of the area of the Region. They have high natural fertility, high water holding capacity and respond well to many of the crop requirements. Their drainage and workability imposes may problems to agricultural development and management.

The most critical aspect of Vertisols management is the use of the soils only at optimum moisture level. Land preparation, sowing harvesting etc should be panned in such a way that the on set of the rainy season should be avoided.

Proper crop selection (aggressive rooting system) and use of modern technologies developed fir improved management of Vertisols. Use of broad beds, furrows, and cumber beds is essential to dispose water from the rooting zone. The broad elevated bed and furrow system of preparing land in Vertisols dominated areas is a recommended approach. There should also be an elaborate drainage system to enhance a proper crop development.

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ANNEX – A

SOIL ANALYTICAL DATA

Physico Chemical Characteristics of Soils of the mapping units

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas.sa %	T.N %	O.C %	Av. P.Ol. PPm	ESP	CaCo 3
										Meq/100 gm Soil										
1	URe	G018	0-12	6.7	0.1	21	22	57	C	0.4	0.3	42.5	13.7	69.4	82	0.09	1.6	0.5	1	0.0
			12-31	6.9	0.0	23	22	55	C	0.5	0.3	46.2	12.8	69.6	86	0.08	0.8	0.1	1	0.0
			31-72	7.4	0.0	27	22	51	C	0.8	0.6	46.4	13.5	67.5	91	0.05	0.7	0.0	4	0.0
			72-125	8.1	0.0	25	26	49	C	2.3	0.7	39.1	13.3	64.3	86	0.04	0.6	0.0	0.0	0.0
			125-175	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	0.0
			175-200	8.3	0.0	23	26	51	C	3.6	0.5	41.1	15.1	71.6	84	0.04	0.4	0.0	5	0.0
2	Lpe	YF26	0-20	7.0	0.1	33	28	39	CL	0..5	0.7	26.0	8.1	33.8	104	0.07	0.8	1.4	1	3.8
19	VRe	YF37	0-36	8.0	0.2	25	28	46	C	0.8	0.8	75.4	6.6	74.0	113.0	0.06	1.1	0.8	1	6.9
			36-72	8.0	0.2	25	22	52	C	2.0	0.6	75.9	7.8	74.6	116.0	0.05	0.9	0.7	3	6.7
			72-105	8.0	0.2	21	24	54	C	4.0	0.6	76.9	9.5	75.4	121.0	0.00	0.0	0.5	5	7.4
			105-156	8.3	0.3	15	28	56	C	5.1	0.6	66.9	11.0	72.0	116.0	0.00	0.0	1.6	7	7.0
			156-186	8.4	0.5	17	28	54	C	4.7	0.8	54.9	10.3	77.4	91.0	0.00	0.0	0.6	6	9.5
22	ARb	A001	0-10	7.0	0.1	63	20	17	SL	0.7	1.5	12.0	1.9	13.4	110	0.14	1.5	25.0	5	2.5
23	VRe	YF015	0-10	8.1	0.1	69	22	9	SL	0.5	0.1	25.8	5.0	33.2	95	0.04	0.3	0.8	2	6.4
			10-40	8.2	0.1	75	18	7	SL	0.7	0.1	26.1	5.6	33.4	97	0.02	0.2	0.2	2	6.3
25	LPe	YF25	0-20	7.5	0.1	17	26	56	C	0.7	1.5	59.4	11.6	70.2	104	0.04	0.6	1.1	1	5.0
			20-47	7.6	0.1	15	34	51	C	1.0	1.2	58.4	11.3	67.4	107	0.04	0.6	0.8	1	5.0
			47-77	7.8	0.2	11	30	59	C	1.4	1.2	58.4	12.0	74.6	98	0.06	0.8	0.4	2	5.8
			77-106	8.2	0.3	17	30	53	C	0.2	1.1	59.4	12.1	67.0	109	0.00	0.0	0.9	0	6.8
37	LPe	YF05	0-15	6.2	0.0	46	34	20	L	0.2	0.4	12.9	3.2	27.4	61	0.09	0.7	5.0	1	1.9
			15-50	6.5	0.0	20	32	48	C	0.5	0.7	30.5	10.0	54.2	77	0.08	0.8	21.8	1	3.1
			50-70	6.3	0.1	16	26	58	C	1.0	0.8	30.7	10.2	61.8	69	0.10	1.0	10.1	2	3.1
37	LPe	YF19	0-14	6.1	0.2	21	40	38	CL	0.5	2.1	21.0	4.9	39.0	73.0	0.20	2.8	8.4	1	0.0
			14-55	6.1	0.1	21	28	50	C	0.4	1.1	18.0	5.4	41.8	60.0	0.07	0.6	2.0	1	0.0
57	VRe	YF10	0-16	6.8	0.0	38	26	36	CL	0.5	0.4	21.5	11.8	40.6	84	0.04	0.3	5.0	1	0.0
			16-45	7.8	0.0	30	30	40	C	0.6	0.4	24.0	13.1	45.2	84	0.03	0.2	5.4	1	0.0
			45-74	7.3	0.0	30	30	40	C	0.7	0.4	27.0	14.1	50.2	84	0.03	0.2	6.1	1	0.0
			74-105	8.0	0.1	40	28	32	CL	0.8	0.3	34.0	15.4	48.4	106	0.02	0.2	5.5	2	0.0
65	VRe	G004	0-15	5.7	0.1	23	48	29	CL	0.3	0.7	26.9	9.2	54.4	68	0.20	2.7	26.3	1	0.0
			15-35	5.4	0.0	13	30	57	C	0.3	0.5	27.3	8.8	55.4	67	0.10	1.9	14.8	1	0.0
			35-70	6.3	0.0	11	26	63	C	0.3	07	26.8	8.6	53.0	69	0.10	1.7	21.1	1	0.0
			70-110	5.7	0.0	11	26	63	C	0.4	08	31.4	9.6	56.4	75	0.10	1.7	26.4	1	0.0

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas.sa %	T.N %	O.C %	Av. P.Ol. PPm	ESP	CaCo 3
										Meq/100 gm Soil										
75	NTe	YF07	0-12	5.8	0.2	38	40	22	L	0.8	4.1	14.5	3.3	31.6	72	0.29	3.3	40.0	3	0.0
			12-42	6.4	0.0	38	36	26	L	0.5	2.0	14.5	3.6	29.6	69	0.13	1.1	25.0	2	0.0
			42-75	6.5	0.0	38	30	32	CL	0.4	1.5	17.0	4.9	32.6	73	0.11	1.1	31.9	1	0.0
			75-130	6.2	0.0	44	24	32	CL	0.3	0.8	18.5	5.4	35.4	71	0.08	0.7	35.9	1	0.0
			130-160	6.6	0.0	34	28	38	CL	0.2	0.5	22.0	6.2	35.9	81	0.08	1.0	41.2	1	0.0
48	LPe	YF28	0-25	7.0	0.1	29	36	35	CL	0.3	0.5	27.0	7.0	36	99	0.14	1.6	1.0	1	2.6
			25-60	6.8	0.1	31	34	35	CL	0.4	1.2	27.4	8.6	46	82	0.10	1.2	0.4	1	2.6
57	VRe	YF35	0-20	6.4	0.1	21	34	44	C	0.5	1.0	24.0	7.2	31.4	104	0.11	1.1	9.8	2	0.0
			20-45	5.9	0.1	23	26	50	C	0.5	0.7	27.0	8.1	46.4	78	0.07	0.8	2.2	1	0.0
65	VRe	G029	0-10	5.3	0.0	24	34	42	C	0.5	0.3	4.0	3.1	32.2	25	0.20	2.4	1.6	2	0.0
			10-27	5.3	0.0	24	32	44	C	0.3	0.2	6.0	3.1	31.8	30	1.20	2.1	0.2	1	0.0
			27-50	5.0	0.0	20	26	54	C	0.2	0.2	3.5	3.0	27.8	25	0.10	1.5	0.4	1	0.0
			50-83	5.8	0.0	16	16	58	C	0.3	0.3	4.0	3.0	28.3	27	0.00	0.0	0.0	1	0.0
			83-130	5.6	0.0	6	14	80	C	0.2	0.3	4.5	3.1	25.2	32	0.00	0.0	0.0	1	0.0
69	CMe	AK12	0-20	5.9	0.1	19	44	37	SicL	0.4	1.3	20.1	4.7	30.8	67	0.30	3.5	4.2	1	0.0
			20-60	6.7	0.0	11	26	63	C	0.5	0.7	27.0	6.6	46.6	75	0.10	0.8	4.0	1	0.0
			60-120	7.4	0.0	17	24	59	C	1.1	0.6	38.0	7.0	47.8	98	0.00	0.0	0.0	2	3.7
			120-145	7.6	0.0	11	28	61	C	1.2	0.6	31.8	6.8	47.8	85	0.00	0.0	0.0	3	4.1
			145-340	7.3	0.0	7	30	63	C	1.2	0.9	31.0	6.4	44.2	91	0.00	0.0	0.0	3	3.1
75	LPe	G005	0-15	6.5	0.0	35	34	31	CL	0.3	0.3	18.5	13.3	41.2	70	0.10	1.2	1.2	1	0.0
84	LPe		0-30	7.3	0.0	51	18	31	ScL	0.2	0.2	14.5	2.0	12.0	141	0.10	1.8	2.4	2	2.4

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Na	K	Ca	Mg	CEC Meq/ 100 gm Soil	Bas.sa %	T.N %	O.C weight	C/N	Av.P. Ol PPM	CaCo 3	Om
										Meq/100 gm Soil											
3	NTh	REC 030	0.29	0.3	4.4	0.1	6	18	76	0.1	1.5	8.4	2.1	22.8	53.1	0.14	1.42	10	9	0.0	2.4
			29-87	5.4	4.5	0.0	2	12	86	0.1	0.5	6.3	4.2	16.4	67.3	0.08	0.72	9	5	0.0	1.2
			87-200	5.5	4.7	0.0	1	11	88	0.1	0.3	5.3	5.3	18.3	59.5	0.96	0.56	7	4	0.0	1.0
3	NTh	REC 029	0-10	5.8	4.9	0.0	41	21	36	0.0	0.3	7.2	4.1	18	0.0	0.14	1.12	8	5	0.0	1.9
			10-100	6.1	5.3	0.0	29	20	51	0.2	0.2	8.4	3.8	23.6	53.2	0.06	0.56	9	4	0.0	1.0
			100-140	7.1	5.8	0.1	29	25	46	0.2	0.4	0.8	3.8	291.1	55.5	0.06	0.48	9	2	0.0	0.8
4	Lvh	REC 019	0-14	5.3	4.3	0.1	12	38	50	0.1	0.5	14.5	5.6	116.3	35.5	0.27	2.18	8	46	0.0	3.7
			14-55	5.4	4.6	0.1	14	30	57	0.1	0.4	16.8	6.7	39.8	60.2	0.07	0.66	9	64	0.0	1.1
			55-90	6.0	4.7	0.1	12	24	64	0.3	0.6	26.4	11.5	45.5	84.8	0.03	0.21	8	46	0.0	0.4
			90-135	6.5	5.1	0.1	13	23	64	0.3	0.6	26.2	10.6	65.7	89.5	0.02	0.16	8	65	0.0	0.3
			135-200	6.6	5.4	0.1	10	28	62	0.3	0.4	23.9	9.2	60.7	90.9	0.01	0.10	7	60	0.0	0.2
6	ALh	Rec 020	0-30	5.3	4.5	0.1	14	31	55	0.1	0.8	9.6	2.1	25	50.4	0.19	2.55	13.0	5	0.0	4.4
			30-120	5.3	4.5	0.0	7	20	73	0.2	0.2	10.7	2.1	42.5	31.2	0.15	1.19	6	6	0.0	2.1
			120-200	5.7	4.8	0.0	5	17	78	0.1	0.2	9.6	4.3	37.4	37.7	0.08	0.59	7	9	0.0	1.0
7	LvH	REC 017	0-20	5.4	4.7	0.0	28	26	46	0.1	0.8	10.7	5.4	29.8	56.6	0.29	3.33	11	80	0.0	5.7
			20-60	5.6	5.0	0.0	12	31	57	0.1	0.9	10.6	5.3	27.7	61.0	0.15	1.48	10	45	0.0	2.5
			60-110	6.2	5.7	0.0	16	17	67	0.0	1.9	12.0	4.7	21.4	87.0	0.11	1.00	9	75	0.0	1.7
			110-200	6.6	5.7	0.0	11	11	78	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0	0	0.0	0.0
8	LVX	REC 018	0-25	6.3	5.3	0.0	28	30	42	0.1	0.2	18.6	5.9	36.6		0.17	2.95		12	0.0	5.1
			25-100	5.3	4.5	0.0	16	17	67	0.1	0.1	14.0	5.4	38.2		0.08	0.60		2	0.0	0.6
			100-180	6.1	4.8	0.1	17	22	61	0.1	0.1	15.9	6.9	34.3		0.04	0.32		2	0.0	0.3
14	VRe	REC 035	0-25	5.4	4.5	0.2	5	30	65	0.1	1.0	26.1	10.2	47.4	79	0.01	0.10	7.0	14	0.0	0.2
			25-40	5.3	4.4	0.1	12	28	60	0.1	0.9	21.5	12.4	49.6	70.3	0.31	2.59	8.0	8	0.0	4.5
			40-85	5.7	4.6	0.1	14	19	67	0.2	0.6	28.8	14.9	50.6	88.1	0.24	2.08	9.0	3	0.0	3.6
			85-100	5.7	4.5	0.1	8	15	77	0.3	0.6	35.0	12.8	87.6	72.9	0.06	0.39	7.0	5	0.0	0.7
			150-200	5.7	4.7	0.1	3	19	78	0.2	0.4	28.9	12.7	48.3	87.3	0.02	0.14	7.0	6	0.0	0.2
14	VRe	REC 036	0-20	6.0	5.3	0.2	5	20	75	0.6	0.9	38.7	20.0	68.2	88.3	0.10	0.72	7	14	0.0	1.2
			20-80	0.2	6.3	0.1	3	15	82	1.5	0.9	49.5	20.1	71.4	10.1	0.13	1.12	9	3	0.0	1.9
			80-14	7.2	6.5	0.4	5	16	79	1.6	0.7	46.4	17.9	68.5	97.1	0.08	0.68	8	6	0.0	1.2
14	VRe	REC 037	0-13	5.6	4.0	0.0	34	20	46	0.3	0.6	2.6	3.1	47.6	53.7	0.52	7.38	14.0	5	0.0	12.7
			13-50	5.5	4.3	0.0	22	20	58	0.6	0.8	31.0	4.8	45.0	82.9	0.05	0.53	11.0	0	0.0	0.9
			50-77	7.0	5.1	0.0	14	28	58	0.9	0.8	38.2	5.1	46.4	96.9	0.04	0.28	8.0	0	0.0	0.5
			77-132	7.6	5.6	0.1	16	30	54	0.9	0.7	37.5	4.2	44.4	97.5	0.01	0.12	9.0	2	0.0	0.2
			132-175	7.3	6.0	0.1	16	26	58	0.9	0.7	42.9	3.8	45.0	10.7	0.01	0.12	17.0	3	0.0	0.2

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Na	K	Ca	Mg	CEC Meq/ 100 gm Soil	Bas.sa %	T.N %	O.C weight	C/N	Av.P.Ol PPM	CaCo3	Om
										Meq/100 gm Soil											
32	Lvh	REC 016	0-30	6.1	4.8	0.0	24	33	43	0.1	0.5	32.4	9.9	42.1	32.4	0.18	1.68	9	20	0.0	2.9
			30-95	5.9	4.5	0.0	12	26	62	0.1	0.4	19.3	6.4	37.8	19.3	0.15	1.40	9	17	0.0	2.4
			95-150	6.1	4.6	0.0	3	33	64	0.1	0.2	11.4	5.5	30.4	11.4	0.03	0.36	13	44	0.0	0.6
			150-200	6.2	4.6	0.0	10	20	70	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0
35	RGe	REC 010	0-15	6.4	5.4	0.1	28	27	45	0.8	0.4	37.7	9.8	47.0	10.4	0.07	0.50	7	5	0.0	0.9
			15-35	7.2	6.3	0.3	15	23	62	0.3	0.7	46.9	16.8	58.9	11	0.05	0.44	9	0	0.0	0.7
37	Lpe	REC 001	0-20	7.0	6.4	0.3	12	30	58	0.2	4.1	37.9	11.7	59.4	37.9	2.50	1.46	8	15	0.0	2.5
37	Lpe	REC 004	0-30	6.3	5.1	0.1				0.1	0.5	21.3	14.4	62.9	0.0	0.0	0.0	0.0	67	0.0	0.0
22	Arb	REC 007	0-70	7.9	7.5	0.2	79	13	8	0.0	0.3	12.2	1.2	12.8	10.7	0.15	1.06	7	9	0.0	1.8
22	Arb	REC 008	0.45	8.0	7.4	0.2	81	11	8	0.0	0.3	11.7	1.2	10.1	13.1	0.15	1.12	7	11	0.0	1.9
27	CMe	REC 012	0-20	6.0	5.1	0.2	41	26	33	0.2	0.5	21.3	12.2	41.6	82.3	0.07	0.70	10	37	0.0	1.2
			20-70	6.1	5.3	0.1	26	30	44	0.3	0.7	31.7	15.0	59.7	80.1	0.09	1.19	12	34	0.0	2.1
			70-150	6.4	5.9	0.1	24	26	50	0.6	08	29.9	14.1	57.6	78.7	0.07	0.62	9	0	0.0	1.1
28	LpK	REC 006	0-20	8.1	7.1	0.2	41	39	20	1.1	0.9	35.0	15.5	44.6	11.8	0.14	1.14	8	10	0.0	1.9
75	RGe	REC 011	0-25	5.7	4.4	0.1	9	54	37	0.3	0.3	21.4	17.1	68.1	21.4	0.63	5.28	8	35	0.0	9.1
99	CMV	REC 013	0-20	5.4	4.6	0.1	7	58	35	0.1	0.4	12.6	4.2	55.3	31.3	0.46	3.95	9	18	0.0	6.8
			20-70	5.0	4.3	0.1	9	41	50	0.1	0.3	10.5	4.2	29.3	51.6	0.18	1.28	7	34	0.0	2.2
			70-150	5.5	4.7	0.1	11	32	57	0.2	0.3	16.2	3.3	28.2	70.8	0.17	1.26	7	0	0.0	2.2

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas. sa %	T.N %	OM	Av.P.Ol PPm	AvK PPm	CaCo 3
											Meq/100 gm Soil										
9	CMC	YK 113	0-20	7.6	7	0.7	8	60	32	SiCL	0.94	6.59	30.2	0	78	49	0.08	2.21	6.71	6.71	
			20-45	6.8	6	0.5	14	69	17	SiL	1.02	6.41	22.3	5.6	37	95	0.11	2.07	0	0	
			45-90	7.6	6	0.6	12	82	6	SiL	0.83	7.63	30.4	0	41	94	0.11	2.48	0	0	
			90-150	8	7	0.6	11	82	17	Si	1.12	6.93	35.0	0	41	100	0.05	1.14	0	0	
16	CLI	YK 289	0-30	7	6	0.5	32	43	25	L	1.64	2.21	15.1	6.5	79	32	0.08	2.05	2.16		8.7
			30-78	8	7	0.7	32	16	52	C	3.20	2.64	21.8	0	69	40	0.05	1.31	0		10.3
			78-130	8	8	1.2	37	22	42	C	8.51	3.07	29.4	8.7	73	68	0.05	0.60	3.267		31.6
55	ANZ	YK 285	0-52	6.7	5.5	0.3	32	46	22	L	0.49	3.36	14.7	6.3	39	39	0.15	3.51	5.3		7.4
			52-90	7.3	6.3	0.4	36	41	23	L	0.65	4.21	24.4	0	48	61	0.16	2.34	0		8.5
			90-120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
			120-170	7.7	6.3	0.4	40	33	27	L	0.53	2.73	18.1	2.1	50	47	0.02	1.44	2.1		9.1
			170-182	7.3	6.1	0.4	27	49	24	L	0.59	2.46	15.0	5.4	48	49	0.05	0.66	3.2		8.6
			182-220	7.7	6.4	0.7	17	31	52	L	0.77	3.86	23.4	5.6	63	53	0.05	-	0		1.7
63	LPK	YK 305	0-25	6.9	5.6	0.3	32	25	43	C	3.24	10.4	16.0	4.3	48	71	0.15	3.5	2.1		6.9
			25-65	7.8	6.9	0.3	14	46	39	SiCL	3.56	8.2	17.0	5.3	43	79	0.07	1.3	3.2		62.3
			65-150	8.1	7.1	0.4	18	36	46	C	1.04	3.0	19.2	-	37	63	0.05	-	-		68.3
70	VRd	YK 299	0-23	6.7	5.1	0.6	4	40	66	C	0.64	4.9	22.0	5.6	103	-	0.08	2.1	6.6		13.3
			23-65	6.6	4.6	0.6	5	24	71	C	0.78	2.8	26.2	1.1	102	-	0.10	1.8	3.4		13.12
			65-125	7.9	6.3	0.6	7	30	63	C	0.87	2.2	39.3	2.3	96	-	004	0.9	0		21.4
			125-165	7.8	6.3	0.7	8	18	74	C	1.12	2.5	31.8	6.8	105	-	0.06	1.1	0		15.9

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas. sa %	T.N %	OC	C/N	Av.P.Olp pm	Av.K. ppm	ESP %	OM
											Meq/100 gm Soil												
45	GLm	B107	0-17	5.9			28	26	46	C	4.3	2.0	18.6	13.4	49.0	78	0.8	12.0	15	13		9	
			17-38	5.6			10	22	58	C	4.3	1.0	20.3	14.1	43.4	92	0.4	6.5	16	3		10	
			38-75	6.8			8	20	72	C	2.6	1.0	22.7	15.1	46.6	89	0.2	2.8	14	5		6	
			75-105	7.3			24	44	32	CL	-	-	-	-	-	-	0.2	1.9	11	-		-	
96	ANm	210d	0-20	5.1			54	34	13	L	1.7	0.5	9.8	4.2	34.2	47	0.9	9.2	10	8			
			20-65	4.8			32	40	28	L	0.4	0.5	10.7	5.7	29.2	59	0.4	6.8	16	10			
			65-100	4.7			34	32	34	CL	0.9	0.3	16.6	0.6	35.8	51	0.6	4.2	8	6			
50	PHl	B20a	0-10	6.4	5.4	0.09	27	42	31	L	0.9	2.0	24.0	6.4	18.0	-		1.9		8		3.2	
			10-35	6.3	5.3	0.05	29	42	29	L	0.4	1.5	24.0	7.2	29.6	100		1.3		6		2.3	
			35-85	6.8	5.4	0.06	29	50	21	L	0.4	0.5	-	-	19.6	-		0.4		6		0.8	
			85-130	7.2	5.7	0.06	43	40	17	L	0.9	0.3	-	-	19.2	-		0.2		8		0.4	
			130-170	7.3	5.9	0.07	49	28	23	L	0.9	0.5	21.6	8.0	31.6	98		0.8		4		1.4	
			170-190	7.5	5.9	0.07	67	18	15	SL	0.9	0.5	-		17.2			0.3		4		0.6	
24	RGe	175d	0-30	6.3			65	30	5	SL			28.8	2.4	11.6		0.04	0.5	12	5		0.9	
95	ANu	DK8	0-30	5.3						SiL							1.01		7	3.20	97		11.65
			30-55	5.6						L							0.74		8	1.60	58		1111.65.04

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas. sa %	T.N %	OM	Av.P. Ol ppm	ESP %
											Meq/100 gm Soil									
72	CMU	YK 309	0-9	8.2	6.8	0.3	66	19	15	SL	0.53	2.27	25.0	2.1	48	63	0.07	1.01		
			9-58	7.2	6.6	0.3	48	50	2	SL	0.73	1.91	24.5	-	54	50				
			58-104	8.2	6.6	0.2	31	55	4	SiL	1.74	0.28	18.1	4.3	50	49				
			104-150	7.8	6.3	0.4	46	40	14	L	2.77	2.45	17.0	1.1	48	48				
			150-180	7.8	6.3	0.4	-	-	-	-	3.53	2.49	1.7	2.2	65	15				
83	SNK	YK 153	0-20	7.9	8.0	0.6	24	74	2	SiL	6.51	9.1	38.1	-	50	100	0.35	4.43	10.7	
			20-62	9.8	8.9	1.7	32	32	36	CL	7.86	9.4	31.1	-	43	100	0.10	1.36	6.4	
			62-94	10.5	10.	2.5	30	16	54	C	7.77	10.4	21.3	1.1	47	100	-	-	2.1	
			94-130	10.2	9.8	1.2	-	-	-	-	6.84	3.8	25.6	2.1	15	87	0.04	1.03	13.4	
			130-155	10.1	9.8	0.6	32	70	8	SiL	-				30	100	0.04	1.44	2.1	
81	FLC	YK 505	0-21	7.9	6.6	0.8	2	50	48	C	0.88	3.51	16.9	2.1	34	69	0.10	1.45	17.9	10.0
			21-48	8.0	6.5	0.5	1	51	48	C	1.26	0.15	29.7	2.1	24	100	0.06	1.02	3.2	9.0
			48-74	7.9	6.4	1.0	2	58	40	C	4.23	1.67	26.0	6.5	73	53	0.09	1.42	17.3	9.2
			74-103	7.9	6.5	0.5	1	54	45	C	2.31	0.87	28.7	1.1	39	84	0.07	0.95	13.8	9.0
			103-150	7.9	6.6	0.4	2	74	24	SiL	2.38	0.49	27.1	2.1	68	47	0.02	-	7.3	7.8
			150-196	8.1	6.5	0.5	1	60	39	SiCL	1.72	0.87	27.5	5.3	39	91	0.14	1.02	10.6	8.9
			196-220	8.2	6.6	0.2	38	50	12	SiL	1.34	0.71	22.7	-	36	68	0.01	-	3.1	11.9
48	CMe	PBR-1	0-18	8.7		0.187	44	22	34	CL	0.5	1.11	23.5	10.85	34.8	104	0.158	2.24	6.42	
			18-40	8.9		0.154	46	38	16	Loam	0.42	1.06	25.49	10.26	35.2	106	0.124	1.1	2.24	
67	LPe	PBR-2	0-15	8.8		0.12	66	14	20	SL	0.14	1.36	19.61	1.72	26	88	0.12	1.1	2.28	
			15-30	7.5		0.11	72	22	6	SL	2.41	1.3	19.6	1.64	24.2	103	0.035	0.7	0.03	
61	CMk	PBR-3	0-6	8.3		0.174	38	36	26	Loam	1.02	1.34	22.7	7.24	46.0	70	0.312	4.7	1.94	
94	CMv	PHK-1	0-20	8.5		0.26	24	28	48	Clay	0.9	1.41	28.89	8.97	41.2	98	0.105	1.43	0.92	
			20-60	7.0		0.211	20	26	54	Clay	0.61	1.23	28.94	8.89	51.8	77	0.083	1.04	1.4	
18	ALh	PHK-2	0-23	6.8		0.037	32	38	30	CL	0.46	1.3	9.43	4.77	30.4	53	0.147	1.67	5.26	
			23-39/43	7.0		0.025	40	26	34	CL	0.5	1.64	9.43	5.76	28.4	61	0.104	1.22	4.2	
			39/43-93/100	7.2		0.026	24	36	40	Clay	0.54	1.62	12.47	7.24	21.87	36	0.032	0.38	12.76	
			93/100-113/153	6.6		0.07	26	36	38	CL	1.03	1.02	13.32	6.83	41.2	55	0.016	0.2	19.88	

Mapping unit	Soil unit	Field No.	Depth cm	PH H2O 1:2.5	PH KCL 1:2.5	EC ds/m	Sand %	Silt %	Clay %	Class	Na	K	Ca	Mg	CEC Meq/100	Bas. sa %	T.N %	OM	Av.P. OI ppm	ESP %
											Meq/100 gm Soil									
93	VRe	PHK-3	0-17	6.8		0.13	32	32	36	CL	1.22	1.07	24.9	11.83	53.2	73	0.192	3.99	3.5	
			17-40	6.9		0.061	28	26	46	Clay	1.22	1.07	29.29	13.66	59	77	0.15	2.63	Nill	
			40-50/65	7.4		0.054	24	26	50	CL	0.9	1.44	19.56	11.35	53.4	62	0.129	1.5	Nill	
1	VRe	ANR-4	0-30	8.8		0.318	26	40	34	Clay Loam	0.56	3.19	34.43	8.31	48.2	96	0.167	2.88	3.74	
			30-60	9.0		0.26	30	30	40	Clay	0.66	1.14	36.57	13.66	53.2	98	0.124	2.04	1.26	
			60-85	9.1		0.429	26	30	44	Clay	2.13	1.15	42.87	10.16	59.6	94	0.112	1.91	2.48	
1	VRe	ANR-5	0-30	7.8		0.189	32	34	34	CL	1.75	0.96	31.04	25.1	59.6	99	0.242	3.44	14.76	
92	VRe	ANR-8	0-15	8.8		0.242	34	34	32	CL	0.71	1.12	36.91	8.07	50.5	93	0.153	2.26	3.3	
			15-70	8.8		0.242	36	30	34	CL	0.88	1.11	38.32	10.95	51.92	99	0.143	2.43	1.2	
			70-95	8.9		0.35	32	22	46	Clay	1.06	1.06	39.97	14.9	53.92	106	0.106	2.12	0.86	
62	VRk	ANR-14	0-30	8.7		0.276	30	32	38	CL	0.55	1.26	40.56	9.3	60.32	86	0.172	3.11	5.56	
			30-80	8.9		0.279	28	26	46	Clay	1.65	1.32	41.07	10.99	60.4	91	0.119	2.2	3.02	

ANNEX - C

SOIL LEGEND
FOR EACH MAP SHEET

Esgo

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classificatio
7	Colluvium, Basalts, Clastics& Tsaliet Garo	5-30	50-100	Moderately well	Clay loam	Few	Common	Slight	Haplic Luvisols
8	Alluvium, Colluvium, Basalts & Sandstone	2-30	>150	Well to moderate	Clay	Few	Common	Moderate	Chromic Luvisols
14	Alluvium, Colluvium, Alkali Trachytes, Lacustrine deposits	0-10	100-150	Imperfectly drained	Clay	None	Few	Slight	Eutric Vertisols
19	Alluvium, colluvium(sandstone)	0-5	50-100	Imperfect drained	Clay	None	Few	Slight	Eutric Vertisols
24	Rhyolite, Sandstone&Basalts	10-30	0-50	Somewhat Exc. drained.	Clay to silty clay loam	Few	Common	Slight to Moderate	Eutric Regosols
26	Basalts, Sandstones & Granites	0-30	100-150	Well drained	Clayloam to sandy clay	few	common	Slight	Haplic Alisols
27	Basalts, Rhyolite, Alkali trachtes, clastic	2-60	50-150	Some what Excessively	Loam to clay	common	None	Slight to Moderate	Eutric Cambisols
28	Baslts, Limestone, Sandstone & Undifferentiated lower complex	10-60	0-50	Excessively Drained	Clay loam	common	many	Moderate to Severe	Rendezic Leptosols
37	Alluvium, colluvium, lacustrine deposits, basic volcanic	5-60	10-30	Some what Exc. Dr	Clay to clay loam	Common	Common to many	Moderate	Eutric Leptosols
42	Basalts, Syntecctonic granodiorites & diorites	0-20	>150	Well drained	Clay			Slight	Haplic Nitisols
57	Alluvium, Colluvium, Sandstone, Rhyolite	0-5	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols
59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-10	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisols
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	20-30	Somewhat Exc. drained	Clay	Common	Many	Severe	Eutric Leptosols (lithic & rudic phase)
96	Volcanic rock	15-30	50-100	Well Drained	Loam	Few	Common	None	Mollic Andosols

Left

Mapping Symbol	Geology	Slope %	Effective Soil Depth(cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly	Clay	None	Few	None to slight	Eutric Vertisols
3	Alluvium, Basalts, Clastics & sandstone	0-15	>150	Well drained	Sandy Clay to clay	None	Many	Slight	Haplic Nitisols
5	Alluvium, colluvium, Basants,Granites	0-5	>150	Imperfectly to moderately	Clay	None	None	Slight	Eutric Fluvisols
8	Alluvium, Colluvium, Basalts & Sandstone	2-30	>150	Well to moderate	Clay	none	Common	Moderate	Chromic Luvisols
37	Alluvium, Colluvium, lacustrine deposits, basic volcanic	5-60	10-30	Some what Exc. Dr	Clay loam	Common to m	Common to many	Moderate	Eutric Leptosols
57	Alluvium, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectvely drained	Clay	None	Few	Moderate	Eutric Vertisols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic Volcanic andintrusive	5-60	50-150	somewhat Exc. to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols (rudic phase)
91	Alluvium, colluvium, lacustrine deposits, basic volcanic	0-2	100-150	Poorly to waterlogged	Clay	None	None	None	Eutric GLeyosols
93	Alluvium/Colluvium	0-8	100-150	Imperfectly drained	Clay	None	None	None	Eutric Vertisols
94	Calluvium	8-30	100-150	Well drained	Clay	None	None	Moderate	Vertic Cambisols
95	Volcanic rock	15-30	50-100	Well drained	Silty loam	Common	Common	Moderate	Umbric Andosol
96	Volcanic rock	15-30	50-100	Moderately well d.	Loam	Few	Common	None	Mollic Andosols
97	Granites and undifferentiated lower complex	5-15	>150	Well Drained	Clay	Few	None	Slight	Haplic Acrisols
98	Alluvium, Colluvium, Volcanics, clastics	0-10	>150	Well drained	Clay	None	None	Slight	Haplic Acrisols
99	Basalts	0-30	30-150	Well drained	Silty clay	Few	Common	Moderate	Vertic cambisols (rudic phase)

Wgoi

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to mod. W. dr.	Clay	None	Few	None to slight	Eutric Vertisols
3	Alluvium, Basalts, Clastics and sandstone	0-15	>150	Well drained	Sandy Clay to clay	None	Many	Slight	Haplic Nitisols
4	Basalts	0-5	50-100	Moderately well drained	Clay	Common	Common	Moderate	Haplic Luvisols
5	Alluvium, colluvium, Basalts,Granites	0-5	>150	Imperfectly to mod. w	Clay	None	None	Slight to moderate	Eutric Fluvisol s
6	Alluvium, Colluvium, Basalts, Sandstones, Undifferentiated	0-30	100-150	Well drained	Clay to silty laom	None	None	Slight	Haplic Alisols
7	Colluvium, Basalts, Clastics &Tsaliet Garo.	5-30	50-100	Moderately well drained	Clay loam	Few	Common	Slight	Haplic Luvisols (rudic phase)
8	Alluvium, Colluvium, Basalts & Sandstone	2-30	>150	Well to moderate	Clay	none	Common	Moderate	Chromic Luvisols
14	Alluvium, colluvium, Alkali Trachytes, Lacustrine Deposites	0-10	100-150	Imperfectly to mod. W. dr.	Clay	None	None	Slight to moderate	Eutric Vertisols
24	Rhyolite,Sandstone & Basalts	10-30	10-50	Somewhat Exc.drained	Clay to silty clay loam	Few	few	Slight to moderate	Eutric Regosols
26	Basalts, Sandstones & Granites	0-30	100-150	Well drained	Sandy clay to clay	few	Common	Slight	Haplic Alisols
27	Basalts, Rhyolite,Alkali Trachytes, clastic	2-60	50-150	Excessively to somewhat Exc. drained	Loam to Clay	common	many	Moderate	Eutric Cambisols
32	Basalts, Alkali trachytes & Rhyolite	0-10	>150	Moderately well drained	Clay	None	Common	Slight	Haplic Luvisols
33	Volcanics, sandstones & undifferentiated lower complex	0-5	>150	Well drained	Clay	None	None	Slight	Haplic Nitisols
37	Alluvium, Colluvium, lacustrine, deposits, basic volcanic	5-60	10-50	Somewhat excessively drained	Clay to Clay loam	Common	Common to many	Moderate	Eutric Leptosols
42	Basalts, Syntecctonic granodiorites & diorites	0-20	>150	Well drained	Clay	Few	Few	Slight	Haplic Nitisols
43	Basalts	0-5	0-10	Excessively drained	Sandy loam	common	Abundant	Severe	Lithic Leptosols
44	Basalts	0-10	>150	Well drained	Clay	Few	None	Slight	Rhodic Nitisols
48	Basic Volcanic	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Lithic Leptosols
49	Basalts,laterate & undifferentiated lower complex granite	0-20	>150	Well drained	Clay	None	Few	Moderate	Rhodic Nitisols
52	Basalts	5-60	0-50	Somewhat Exc. drained.	Clay loam	Common	Many	Severe	Dystric Leptosols
57	Alluvium, Basic volcanic, colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Slight to Moderate	Vertisols
59	Basalts, Alkali Trachytes, Rhyolite & Sandstone	0-5	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic volcanic and intrusive	5-60	50-150	Somewhat Exc.to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols /rudic phase)
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	20-30	Somewhat excessively drained	Clay	Common	Many	Severe	Eutric Leptosols

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
97	Granites & undifferentiated lower complex	5-15	>150	Well drained	Clay	Few	None	Slight	Haplic Acrisols
98	Alluvium, colluvium, volcanic, clastics.	0-10	>150	Well drained	Clay	None	None	Slight	Haplic Acrisols

Swel

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to mod. W. dr.	Clay	None	Few	None to slight	Eutric Vertisols
14	Alluvium, Colluvium, Alkali Trachytes, Lacustrine deposits	0-10	100-150	Moderately well to imperfectly drained	Clay	None	Few	Slight to moderate	Eutric Vertisols
18	Basic Volcanic and intrusive rock	15-30	100-150	moderatly well dr.	Clay	None	Few	moderate	Vertic Cambisols
19	Alluvium, colluvium(sandstone)	0-5	50-100	Imperfectly drained	Clay	None	Few	Slight	Eutric Vertisols
24	Rhyolite, Sandstone &Basalts	10-30	0-30	Somewhat exc. Dr.	Clay to silty	Few	Common	Slight Moderate	Eutric Regosols
25	Basic Volcanic and Intrusive rock	2-30	0-30	Excessively drained	Clay	Many	Many	Severe	Eutric Leptosols
27	Basalts, Rhyolite, Alkali trachytes, clastic	2-60	50-150	somewhat Excessively to Excessively drained	Loam to clay	common	many	Moderate	Eutric Cambisols
28	Baslts, Limestone, Sandstone & Undifferentiated lower complex	10-60	0-50	Excessively drained	Loam to clay	common	many	Moderate to Severe	Rendezic Leptosol
35	Coarse grained acidplutoric rock, Basalts & Rhyolite	15-60	0-25	Excessively drained.	Sandy clayloam	Common	Many	Moderate to severe	Eutric Leptosols
37	Alluvium, colluvium, lacustrine deposits, basic volcanic	5-60	10-30	Some what exc. Dr.	Clay to Clay loam	Common to many	Common to many	Moderate	Eutric Leptosols
40	Organic rocks	8-60	0-25	Excessively drained	Sandy clay loam	Many	Many	Severe	Lithic Leptosols
45	Backswamp deposits	<1	100-150	poorly drained	Clay	Few	None	None	Mollic Gleysolsols
48	Basic Volcanic and intrusive rock	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Lithic Leptosols
50	Alluvium	0-1	>150	Well drained	Clay loam	none	few	slight	Luvic Phaeozems
57	Alluvium, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols
59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-5	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisols
62	Basalts	0-10	100-150	Imperfectly drained	Clay	None	Few	Slight to moderate	Calcic Vertisols
67	Basalts	30-60	0-30	Excessively drained	Clay loam	Common	Many	Severe	Mollic Leptosols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic Volcanic and intrusive	5-60	50-150	somewhat Exc. to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols /rudic phase)
83	Volcano lacustrine	0-2	>150	Moderately well drained	Silty loan	None	None	None	Calcic Solonetz
85	Mtacarbonates, basic volcanic & intrusive rock	8-30	0-25	Excessively drained	Silty clay	Common to many	Many to abundant	Severe	Eutric Leptosols
92	Basic Volcanic & intrusive	0-15	100-150	Moderately well drained	Clay	None	None	slight	Eutric Verisols
93	Alluvium/Colluvium	0-8	100-150	Imperfectly	Clay	None	None	slight	Eutric Vertisols
94	Clluvium	8-30	100-150	Well drained	Clay	None	None	slight	Vertic Cambisols
96	Volcanic rock	15-30	50-100	Well Drained	Loam	Few	Common	None	Mollic Andosols
99	Basalts	0-30	30-150	Well drained	Silty clay	Few	Common	Moderate	Vertic cambisols

Righ

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to moderatly drianed	Clay	None	Few	None to slight	Eutric Vertisols
2	Basic Volcanic and intrusive (basalt)	5-10	25-50	Well drained	Clay loam	Few	Many	Moderate	Eutric Cambisols
12	Basic volcanic and intrusive	0-8	50-100	moderatly drained	Clay	Few	Few	Moderate	Calcaric Cambisols
19	Alluvium, colluvium(sandstone)	0-5	50-100	Imperfectly drained	Clay	None	Few	Slight	Eutric Vertisols
23	Variable parent material	0-8	50-100	Imperfectly drained	Clay	None	Few	Slight	Eutric Vertisols
24	Rhyolite, Sandstone&Basalts	10-30	10-50	Somewhat Exc. Dr.	Clay to silty	Few	Common	Slight to Moderate	Eutric Regosols
25	Basic Volcanic and Intrusive rock	2-30	0-30	Excessively drained	Clay	Many	Many	Severe	Eutric Leptosols
34	Basic Volcanics and intrusive rocks	15-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Umbric Leptosols
36	Acid to intermediate volcanic	8-60	50-100	Moderately well drained	Clay	Few	Many	Severe	Eutric Cambisols
37	Alluvium, Colluvium, lacustrine deposits, basic volcanic	5-60	10-30	Somewhat Exce. drained	Clay to Clay loam	Common to many	Common to many	Moderate	Eutric Leptosols
38	Coarse grained acid plutonic rocks	15-60	0-25	Excessively	Sandy clay loam	Common	Many	Severe	Umbric leptosols
45	Backswamp deposits	<1	100-150	Very poorly drained	Clay	None	None	None	Mollic Gleysols
46	Variable parent material	15-60	0-25	Excessively drained	Clay loam	Many	Many	Severe	Lithic Leptosols
47	High gradient valleys	15-60	0-25	Excessively drained	Clay loam	Common to many	Abundant	Severe	Lithic Leptosols
48	Basic Volcanic and intrusive rock	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Eutric Leptosols
51	Non-carbonate metasediments	8-60	0-25	Excessively drained	Clay loam	Many	Many	Severe	Eutric Leptosols
52	Basalts	5-60	0-50	Somewhat Exce. Dr	Clay loam	Common	Many	Severe	Dystric Leptosols
56	Alluvium/Colluvium	5-15	>150	Imperfewctly drained	Clay	None	Common	Moderate	Eutric Vertisols
57	Alluvium, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols
59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-15	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisol
65	Basic Volcanic & Intrusive	2-60	100-150	Imperfectly drained	Clay	Few	Few	Moderate	Eutric Vertisols
68	Basic Volcanic & intrusive	8-15	25-50	Well Drained	Clay loam	Common	Many	Moderate	Eutric Cambisols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic Volcanic and intrusive	5-60	50-150	Effectively to somewhat Exce. Drained	Silty clay	Common	Many	Moderate	Eutric Cambisols /rudic phase)
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	50-100	Somewhat Excessively drained	Clay	Common	Many	Severe	Eutric Leptosols
79	Basic Volcanics & intrusive	2-60	0-25	Excessively drained	Sandy clay loam	Many	Many	Severe	Eutric Leptosols
82	Basic Volcanic & intrusive	8-15	50-100	Well drained	Clay	Common	Many	Slight	Haplic Luvisols
85	Mtacarbonates, basic volcanic & intrusive rock	8-30	0-25	Excessively drained	Silty clay	Common to many	Many to abundant	Severe	Eutric Leptosols
88	Acid to Intermediate Volcanic	8-15	25-50	Well drained	Clay	Common	Many	Slight	Eutric Cambisols
89	Coarse grained acidic plutonic	2-30	0-25	Excessively drained	Sandy loam	Abundant	Abundant	Severe	Eutric Leptosols
90	Variable parent material	2-30	50-100	Moderately well drained	Clay loam	Few	Common	Moderate	Eutric Cambisols
91	Alluvium	0-2	100-150	Poorly to Waterlogged	Clay	None	None	None	Eutric Glevsols
92	Basic Volcanic & intrusive	0-15	100-150	Moderately well drained	Clay	None	None	Slight	Eutric Vertisols
93	Alluvium/Colluvium	0-8	100-150	Imperfectly drained	Clay	None	None	None	Eutric Vertisols
94	Clluvium	8-30	100-150	Well drained	Clay	None	None	Moderate	Vertic Cambisols

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
95	Volcanic rock	15-30	50-100	Well drained	Silty loam	Common	Common	Moderate	Umbric Andosols
96	Volcanic rock	15-30	50-100	Well Drained	Loam	Few	Common	None	Mollic Andosols

Ngoe

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to Mod. W. Drained	Clay	None	Few	None to slight	Eutric Vertisols
3	Alluvium, Basalts, Clastics and sandstone	0-15	>150	Well drained Mod. W.D	Sandy Clay to Clay	None	Many	Slight	Haplic Nitisols
5	Alluvium, colluvium, Basalts,Grantes	0-5	>150	Imperfectly to	Clay	None	None	Slight	Eutric Fluvisols
6	Alluvium, Colluvium, Basalts, Sandstones, Undifferentiated	0-30	100-150	Well drained	Clay to silty loam	None	None	Slight	Haplic Alisols
8	Alluvium, Colluvium, Basalts & Sandstone	2-30	>150	Well to moderate	Clay	none	Common	Moderate	Chromic Luvisols
12	Basic volcanic and intrusive	0-8	50-100	Imperfectly Drained	Clay	Few	Few	Moderate	Calcaric Cambisols
19	Alluvium, colluvium(sandstone)	0-5	50-100	Imperfectly Drained	Clay	None	Few	Slight	Eutric Vertisols
22	Basalts, and coarse Graned clastics	5-60	50-100	Moderately well Drained	Clay loam	Few	Few	Moderate	Haplic Arenosols
23	Variable parent material	0-8	50-100	Imperfectly drained	Clay	Few	Few	Slight	Eutric Vertisols
24	Rhyolite,Sandstone & Basalts	10-30	10-50	Somewhat Exc. Drained	Clay to silty clay loam	Few	Common	Slight to moderate	Eutric Regosols
25	Basic Volcanic and Intrusive rock	2-30	0-30	Excessively	Clay	Many	Many	Severe	Eutric Leptosols
29	Organic Rocks	5-30	25-50	Somewhat Exc.	Sandy clay	None	Few	Severe	Eutric Cambisols
30	Coarse grained clastics	8-15	25-50	Somewhat Exc.	Sandy clay loam	None	Common	Severe	Eutric Cambisols
31	Non-carbonate metasediments	8-15	50-100	Well drained	Clay loam	None	Common	Severe	Calcaric Cambisols
34	Basic Volcanics and intrusive rocks	15-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Umbric Leptosols
36	Acid to intermediate volcanic	8-60	50-100	Moderately well dr.	Clay	Few	Many	Severe	Eutric Cambisols
37	Alluvium, Colluvium, lacustrine, deposits, basic volcanic	5-60	10-30	Somewhat Exce. Drained	Clay to Clay loam	Common	Common	Moderate	Eutric Leptosols
40	Organic rocks	8-60	0-25	Excessively Dr	Sandy clay loam	Many	Many	Severe	Lithic Leptosols
41	Coarse Grained clastics	15-60	0-25	Excessively Drained	Loamy sand	Many	Many	Severe	Eutric Leptosols
46	Variable parent material	15-60	0-25	Excessively drained	Clay loam	Comm	Abundant	Severe	LithicLeptosols
47	Variable parent material	15-60	0-25	Effectively drained	Sandy clay loam	Common	Abundant	Severe	Lithic Leptosols
48	Basic Volcanic & intreusive rock	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Lithic Leptosols
51	Non-carbonate metasediments	8-60	0-25	Excessively drained	Clay loam	Many	Many	Severe	Eutric Leptosols
53	Metavolcanics	8-60	0-25	Excessively drained	Sandy loam	Many	Abundant	Severe	Eutric Leptosols
57	Alluvium, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols
59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-5	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisols
61	Coarse grained clastics	8-15	50-100	Well drained	Sandy clay	Few	Few	Moderate	Eutric Cambisols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic volcanic and intrusive	5-60	50-150	Somewhat excessively to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols /rudic phase)
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	20-30	Somewhat excessively drained	Clay	Common	Many	Severe	Eutric Leptosols
84	Non-carbonate metasediments	2-30	0-25	Excessively drained	Sandy clay loam	Few	Abundant	Severe	Eutric Leptosols

85	Metacarbonates, basic volcanic & intrusive rock	8-30	0-25	Excessively drained	Silty clay	Common to many	Many to abundant	Severe	Eutric Leptosols
86	Metavolcanics	2-30	25-50	Somewhat Exc.	Sandy clay loam	Few	Common	Moderate	Eutric cambisol & Dystric Leptosols
88	Acid to intermediate volcanic	8-15	25-50	Well drained	Clay	Common	Many	Slight	Eutric Cambisols
89	Coarse grained acidic plutonic	2-30	0-25	Excessively drained	Sandy loam	Abundant	None	Severe	Eutric Leptosols
90	Variable parent material	2-30	50-100	Moderately well drained	Clay l	Few	Common	Moderate	Eutric Cambisols
95	Volcanic rock	15-30	50-100	Well drained	Slit loam	Common	Common	Moderate	Umbric Andosols

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Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to moderately well. Dr	Clay	None	Few	None to slight	Eutric Vertisols
2	Basic Volcanic and intrusive (basalt)	5-10	25-50	Well drained	Clay loam	Few	Many	Moderate	Eutric Cambisols
3	Alluvium, Basalts, Clastics and sandstone	0-15	>150	Well drained	Sandy Clay to clay	None	Many	Slight	Haplic Nitisols
4	Basalts	0-5	50-100	Moderately well Dr.	Clay	Common	Common	Moderate	Haplic Luvisols
5	Alluvium, colluvium, Basalts,Granites	0-5	>150	Imperfectly to moderate	Clay	None	None	Slight	Eutric Fluvisols
8	Alluvium, Colluvium, Basalts & Sandstone	2-30	>150	Well drained	Clay	none	Common	Moderate	Chromic Luvisols
14	Alluvium, Colluvium, Alkali Trachytes, Lacustrine deposits	0-10	100-150	Imperfectly drained	Clay	None	Few	Slight	Eutric Vertisols
16	Volcanics and basalts	5-10	50-100	Well drained	Clay	Few	Few	Moderate	Luvic Calcisols
18	Basic Volcanic and intrusive rocks	15-30	100-150	moderatly well	Clay	None	Few	moderate	Vertic Cambisols
23	Variable parent material	0-8	50-100	Imperfectly Dr.	Clay	Clay	Few	Slight	Eutric Vertisols
25	Basic Volcanic and Intrusive rocks	2-30	0-30	Excessively drained	Clay	Many	Many	Severe	Eutric Leptosols
34	Basic Volcanics and intrusive rocks	15-60	0-25	Excessively Dr.	Clay loam	Common	Many	Severe	Umbric Leptosols
35	Coarse grained acidplutoic rock, Basalts & Rhyolite	15-60	0-25	Excessively drained.	Sandy clay loam	Common	Many	Moderate to Severe	Eutric Leptosols (rudic phase)
36	Acid to intermediate volcanic	8-60	50-100	Moderately well	Clay	Few	Many	Severe	Eutric Cambisols
37	Alluvium, Colluvium, lacustrine, deposits, basic volcanic	5-60	10-30	Somewhat Exc. drained	Clay to Clay loam	Common to many	Common to many	Moderate	Eutric Leptosols
47	Variable parent material	15-60	0-25	Excessively drained	Sandy clay loam	Common to m	Abundant	Severe	Lithic Leptosols
48	Basic Volcanic	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Lithic Leptosols
57	Alluvium, Intrusive rock, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols
58	Coarse grained acidic plutonic	8-15	>150	Well Drained	Sandy loan	None	None	Moderate	Eutric Cambisols
59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-10	>150	Imperfectly Drained	Clay	Few	Common	Moderate	Eutric Vertisols
67	Basalts	30-60	0-30	Excessively drained	Clay loam	Common	Many	Severe	Mollic Leptosols
68	Basic Volcanic & intrusive	8-15	25-50	Well drained	Clay loam	Common	Many	Moderate	Eutric Cambisols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic volcanic and intrusive	5-60	50-150	Somewhat Exc. to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols /rudic phase)
70	Alluvium	2-5	>150	Moderately well drained	Clay	None	None	Slight	Dystric Vertisols
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	50-100	Moderately well drained	Clay	Common	Many	Severe	Eutric Leptosols

Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
85	Mtacarbonates, basic volcanic & intrusive rock	8-30	0-25	Excessively drained	Silty clay	Common to many	Many to abundant	Severe	Eutric Leptosols
90	Variable parent material	2-30	50-150	Moderately well drained	Clay	Few	Common	Moderate	Eutric Cambisols
91	Alluvium	0-2	100-150	Well drained	Clay	None	None	None	Eutric Glevsols
92	Basic Volcanic & intrusive	0-15	100-150	Moderately well drained	Clay	None	None	None	Eutric Vertisols
93	Alluvium/Colluvium	0-8	100-150	Imperfectly drained	Clay	None	None	None	Eutric Vertisols
94	Clluvium	8-30	100-150	Well drained	Clay	None	None	Moderate	Vertic Cambisols and Haplic Luvisols
95	Volcanic rock	15-30	50-100	Well drained	Slit loam	Common	Common	Moderate	Umbric Andosols

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Mapping Symbol	Geology	Slope %	Effective Soil Depth (cm)	Drainage	Surface Texture	Rockiness /Stoniness		Soil Erosion Status	Classification
1	Alluvium, Colluvium, Lacustrine Deposits, Laterite	0-8	100-150	Imperfectly to	Clay	None	Few	None to slight	Eutric Vertisols
4	Basalts	0-5	50-100	Moderately well D.	Clay	Common	Common	Moderate	Haplic Luvisols
5	Alluvium, colluvium, Basants,Grantes	0-5	>150	Imperfectly to Mod. W	Clay	None	None	Slight	Eutric Fluvisols
9	Basalts & Volcanics	10-15	100-150	Moderately well	Clay	None	Few	Moderate	Calcaric Cambisols
14	Alluvium, Colluvium, Alkall Trachytes, Lacustrine deposits	0-10	100-150	Imperfectly drained	Clay	None	Few	Slight to moderate	Eutric Vertisols
16	Volcanics and basalts	5-10	50-100	Well drained	Clay	Few	Few	Moderate	Luvic Calcisols
18	Basic Volcanic and intrusive rock	15-30	100-150	moderately well drained	Clay	None	Few	moderate	Vertic Cambisols
19	Alluvium, colluvium(sandstone)	0-5	50-100	Imperfectly	Clay	None	Few	Slight	Eutric Vertisols
22	Basalts, and coarse Graned clastics	5-60	50-100	Moderately well	Clay loam	Few	Few	Moderate	Haplic Arenosols
24	Rhyolite,Sandstone & Basalts	10-30	10-50	Somewhat excessively	Clay to silty clay loam	Few	Common	Slight to moderate	Eutric Regosols
27	Basalts, Rhyolite, Alkali trachtes, clastic	2-60	50-150	Excessively to some what Exc.	Loam to Clay	None	None	Slight to Moderate	Eutric Cambisols
28	Baslts, Limestone, Sandstone & Undifferentiated lower complex	10-60	0-50	Excessively	Loam to Clay	None	None	Moderate to Severe	Rendezic Leptosols
35	Coarse grained acidplutoric rock, Basalts & Rhyolite	15-60	0-25	Excessively drained	Sandy clay loam	Common	Many	Moderate to Severe	Eutric Leptosols (rudic phase)
36	Acid to intermediate volcanic	8-60	50-100	Moderately well	Clay	Few	Many	Severe	Eutric Cambisols
37	Alluvium, Colluvium, lacustrine, deposits, basic volcanic	5-60	10-30	Somewhat Exc. Dr.	Clay to Clay loam	Common to many	Common to many	Moderate	Eutric Leptosols
38	Coarse graned acid prutonic rocks	15-60	0-25	Excessively Dr.	Sandy clay loam	Common	Many	Severe	Umbric leptosols
40	Organic rocks	8-60	0-25	Excessively Dr.	Sandy clay	Many	Many	Severe	Lithic Leptosols
48	Basic Volcanic rocks and intrusive rock	8-60	0-25	Excessively drained	Clay loam	Common	Many	Severe	Lithic Leptosols
55	Pumice gravels	0-5	>150	Well drained	Loam	None	None	Moderate	Vitric Andosols
57	Alluvium, intrusive rock, Colluvium, Sandstone, Rhyolite	0-15	100-150	Imperfectly drained	Clay	None	Few	Moderate	Eutric Vertisols

59	Basalts, Alkali trachytes, Rhyolite & Sandstone	0-5	>150	Imperfectly drained	Clay	Few	Common	Moderate	Eutric Vertisols
63	Basalts	30-60	30-50	Somewhat Excessively drained	Clay	Common	Common	Severe	Rendezic Leptosols
67	Basalts	30-60	0-30	Excessively drained	Clay loam	Common	Many	Severe	Mollic Leptosols
69	Rhyolite, Basalts, Alluvium, Sandstone, Basic volcanic and intrusive	5-60	50-150	somewhat Excessively to Excessively drained	Silty clay	Common	Many	Moderate	Eutric Cambisols (rudicphase)
70	Alluvium	2-5	>150	Moderately well	Clay	None	None	Slight	Dystric Vertisols
72	Lgnimmbrites	5-10	>150	Somewhat Exc.	Sandy loam	None	None	Moderate	Humic cambisols
75	Basalts, Rhyolite, Laterite, Sandstone, Abbay beds, gabbros	2-60	20-30	Somewhat excessively drained	Clay	Common	Many	Severe	Eutric Leptosools
81	Alluvium	0-2	>150	Imperfectly	Clay	None	None	Sight	Calcaric Fluvisols
83	Volcani clacustrine	0-2	>150	Moderately well	Silty loan	None	None	None	Calcic Solonetz
85	Mtacarbonates, basic volcanic & intrusive rock	8-30	0-25	Excessively drained	Siltyclay	Common to many	Many to abundant	Severe	Eutric Leptosols
92	Basic Volcanic & intrusive	0-15	100-150	Moderately well drained	Clay	None	None	None	Eutric Vertisols
93	Alluvium/Colluvium	0-8	100-150	Imperfectly drained	Clay	None	None	None	Eutric Vertisols
94	Colluvium	8-30	100-150	Well drained	Clay	None	None	Moderate	Vertic Cambisols
96	Volcanic rock	15-30	50-100	Well Drained	Loam	Few	Common	None	Mollic Andosol
99	Basalts	0-30	30-150	Well drained	Silty clay	Few	Common	Moderate	Vertic Cambisol

ANNEX - D

SOIL PROFILE PIT DESCRIPTION

SOIL PROFILE DESCRIPTION

Profile No.: ANR 4 **Date**: 31/01/2005

Location: 400m East of Arabati Village

Zone: South Wello **Wereda**: Werebabo

Mapping unit No: 1 **Co-ordinates:** N11^0 29'30.6'' E 39^{0}57'46.2''

Elevation: 1167 mt

Topography: Flat **Landform** Valley bottom **Slope (%)** 1 %

Microtopography --

Slope Class

Land Use Harvested field of Sorghum

Land Cover Farm Land

Parent Material Sedimentary Rock

Surface Characteristics Wide Crack

Surface Coarse fragments -- **Erosion** None

Other Surface Characteristics -- **Drainage Class** Moderately Well

External Drainage x

Flooding None **Ground Water (cm)** > 120 cm

Human Influence Ploughing

Crops Sorghum, (Chickpea, Maize and Teff in belg season)

Soil Classification FAO Calcic Vertisols

Remarks Deep dark grayish brown Eutric vertisols

Profile No.: ANR4

Profile Description

Ap 0-30 cm. Very dark gray (10 YR3/1) dry; clay loam; strong medium angular blocky; sticky slightly plastic wet, friable moist, firm dry; many fine interstitial pores; many fine roots; strongly calcareous; gradual and smooth boundary.

A_1 30 – 60 cm. Very dark brown (10 YR2/2) dry; black (10YR2/1) moist; clay; strong coarse prismatic; very sticky plastic wet; friable moist; firm dry; common distinct slicken sides; many fine interstitial pores; many fine roots; strongly calcareous; gradual and smooth boundary.

A_2 60 – 85cm. Very dark brown (10 YR2/2) moist, clay; strong coarse prismatic; very sticky plastic wet, friable moist; many distinct slickensides; few fine calcium carbonate mineral nodules; many fine interstitial pores; strongly calcareous gradual and smooth boundary.

AC*5-125 +cm. Brown (10/YR4/3) moist, clay; strong coarse angular blocky; sticky plastic wet, friable moist; many fine pores; many fine roots; gradual and smooth boundary.

Remark: Fine CaCo3 powder below 60 cm.

SOIL PROFILE DESCRIPTION

Profile No: ANR5 **Date**: 1/2/2005

Location: about 200m south of Hara Elementary School or about 400 north east of Lake Haradibe

Zone: South Wello **Wereda**: Tehuledere

Mapping unit No: 1 **Co-ordinates:**

Elevation: 2160m

Topography: Flat **Landform** Plain **Slope (%)** 4%

Micro topography None

Slope Class

Land Use Cultivated Land (Wheat and Sorghum)

Land Cover Crop Land

Parent Material Basalt

Surface Characteristics None

Surface Coarse fragments None **Erosion** None

Other Surface Characteristics None **Drainage Class** Imperfectly (drained)

External Drainage

Flooding None **Ground Water (cm)** > 125 cm

Human Influence Ploughing & Irrigation

Crops Wheat, Sorghum, Carrot, Onion and Horse Bean

Soil Classification FAO Vertisols

Remarks Very deep Vertisols

Profile No.: ANR 5

Profile Description

Ap 0 - 30 cm. Black (10YR2/1) moist; clay loam; strong medium angular blocky; sticky plastic wet, friable moist; many fine interstitial pores; many fine roots; gradual and smooth boundary.

A_1 30 – 80 cm. Black (10YR2/1) moist; clay; strong medium angular blocky; very sticky very plastic wet; friable moist; firm dry; many fine interstitial pores; many fine roots; gradual and smooth boundary.

A_2 80 – 125 cm. Black (10 YR 2/1) moist; clay; strong medium angular blocky; very sticky very plastic wet, friable moist; many fine interstitial pores; gradual and smooth boundary.

Remarks: Much Manganese mottles below 15 cm. only surface soil is taken for fertility assessment.

SOIL PROFILE DESCRIPTION

Profile No.: ANR 8 **Date**: 4/2/2005

Location: 2 km East of Bora

Zone: Oromiya **Wereda**: Dawa Chefa

Mapping unit No: 92 **Co-ordinates:** N:$10^0$42'39.5'' E$40^0$04'54.5''

Elevation: 1407 mt

Topography: Plain **Landform** Rolling Plain **Slope (%)** 0-2

Micro topography None

Slope Class

Land Use Harvested field of chickpea

Land Cover Cultivated Land

Parent Material Basalt

Surface Characteristics Common stones and few boulders

Surface Coarse fragments Few gravels **Erosion** Moderate

Other Surface Characteristics None **Drainage Class** Mod well

External Drainage

Flooding None **Ground Water (cm)** > 120 cm

Human Influence Ploughing

Crops Sorghum, Chickpea and teff

Soil Classification FAO Eutric Vertisols

Remarks Deep grayish brown Eutric Vertisols; (rudic phase) associated with Eutric Regosols 20% Eutric Cambisols 10% and Leptosols10%.

Profile No.: ANR 8

Profile Description

Ap 0 - 15cm. Black (10YR2/1) moist; clay loam; strong coarse angular blocky; sticky plastic wet, friable moist; many fine interstitial pores; common fine roots; strongly calcareous; gradual and smooth boundary.

A_1 15 - 70cm. Black (10YR2/1) moist; clay loam; strong coarse angular blocky; very sticky very plastic wet, friable moist; many fine interstitial pores; common fine roots; strongly calcareous; gradual and smooth boundary.

A_2 70 – 95cm. Black (10YR2/1) moist; clay; strong coarse angular blocky; very sticky very plastic wet, friable moist; many fine interstitial pores; common fine roots; strongly calcareous; gradual and smooth boundary.

AC95 – 120 + cm.

Remarks: Common $CaCo_3$ nodules below 70 cm.

SOIL PROFILE DESCRIPTION

Profile No.: ANR 14 **Date**: 8/12/2005

Location: 200 m North of Abaye Atir town

Zone: N/Shewa **Wereda**: Kewot

Mapping unit No: 62 **Co-ordinates:** N $9^0$54'56.3'' E$40^0$00' 48.3''

Elevation: 1389 m

Topography: Flat **Landform** Plain **Slope (%)** 3%

Micro topography --

Slope Class

Land Use Harvested field of teff

Land Cover Cultivated land

Parent Material Basalt

Surface Characteristics Cracks

Surface Coarse fragments -- **Erosion** Slight

Other Surface Characteristics -- **Drainage Class** Moderately well

External Drainage

Flooding None **Ground Water (cm)** > 130 cm

Human Influence Ploughing

Crops Teff, Sorghum and Chickpea

Soil Classification FAO Eutric Vertisols

Remarks Deep dark grayish brown Vertisols

Profile No.: ANR 14

Profile Description

Ap 0-30 cm. Very dark gray (10YR3/1) dry, very dark brown (10YR2/2) moist; clay loam; strong coarse angular blocky; friable moist; hard dry; many fine interstitial pores; many fine roots; strongly calcareous; gradual and smooth boundary.

A_1 30 - 80 cm. Black (10YR2/1) moist; clay; strong coarse prismatic; friable moist; hard dry; many fine interstitial pores; common fine roots; common fine roots; common distinct slickensides; strongly calcareous; gradual and smooth boundary.

A_2 80 – 120 cm. Black (10YR 2/1) moist; clay; strong coarse prismatic; friable moist; hard dry; many fine interstitial pores; few fine roots; common distinct slickensides; strongly calcareous; clear and smooth boundary.

AC95-120+cm. Very dark brown (10YR2/2) moist; clay; strong coarse angular blocky; friable moist; hard dry; common fine interstitial pores; few distinct slickensides; strongly calcareous.

Remarks: Common CaCO3 nodules below 70 cm.

SOIL PROFILE DESCRIPTION

Profile No.: YF 05 **Date**: 01/01/96

Location: Sekota-Amdework 61.7 km; 40m NW

Zone: Wagehemra **Wereda**:

Mapping unit No: 37 **Co-ordinates:** 1375070N; 481674E

Elevation: 2280m

Topography: _____ **Landform** Plateau **Slope (%)**

Micro topography --

Slope Class Very gently sloping

Land Use Rain fed agriculture/extensive grazing on fallow and stubble land

Land Cover Cultivated land/annual crops

Parent Material (Weathered) rock derived from Basalt

Surface Characteristics --

Surface Coarse fragments Few medium/Coarse Gravel **Erosion**

Other Surface Characteristics -- **Drainage Class** Excessively drained

External Drainage Rapid

Flooding None **Ground Water (cm)** Not observed

Human Influence Ploughing or raised beds

Crops Wheat

Soil Classification FAO 1988, Leptosols

Remarks

- The whole soter unit is cultivated land
- 200m NW of the pit site there is vertisols with wide cracks and potholes

1 0-15 cm 7.5 YR 4/4 (moist) sandy clay loam; weak, fine, sub angular blocky structure; soft, very friable, slightly sticky, slightly plastic; few, medium/coarse gravel; few fine roots; common medium and coarse and few fine pores; non- calcareous; clear boundary.

2C1 15 – 50 cm / (dry);

3C2 50 – 70 cm / (dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF07 **Date**: 06/03/96

Location: Lalibela- Ayna 58m; approximate 2km NE of Ayna

Zone: North Wollo **Wereda**:

Mapping unit No: 75 **Co-ordinates:** 1345452 N, 484517E

Elevation: 2600m

Topography: _____ **Landform** Plateau **Slope (%)**

Micro topography --

Slope Class Gently sloping

Land Use Rain fed agriculture/Extensive grazing on fallow and stubble land

Land Cover Cultivated land/annual crops

Parent Material (weathered) rock derived from Basalt

Surface Characteristics --

Surface Coarse fragments Common stones & boulders **Erosion**

Other Surface Characteristics -- **Drainage Class** Imperfectly drained

External Drainage Well

Flooding Annually, < 1 day **Ground Water (cm)** --

Human Influence Ploughing or raised beds

Crops Horse bean and Wheat

Soil Classification FAO 1988, Nitisols

Remarks

- In the vicinity of the pit there is stone clearance to increase farm area
- Intensively cultivated with annual crops
- Very few trees within the farm land
- The soils in the soter unit vary in depth from very shallow to very deep
- No terracing

YF07

0-12 cm 7.5 YR3 /3 (moist) clay loam; no mottles; slightly hard, very friable to friable slightly sticky to sticky, slightly plastic to plastic; common, medium/coarse gravels and few, stones; many fine and medium roots; many fine and common medium pores non-calcareous; PH:4.0; clear boundary.

12-42 cm 7.5 YR3 /3.5 (moist) silty clay; no mottles; slightly hard, very friable, sticky plastic; patchy, faint, shiny faces; common, medium/coarse gravel and few stones; black, soft, iron-manganese nodules; common medium and many fine roots; common medium and many fine pores; non-calcareous; PH:5.0; clear boundary.

42-75 cm 7.5 YR3 /3 (moist) clay; no mottles; slightly hard, very friable, sticky, plastic, patchy, faint, clay cutans and broken, distinct, shiny faces; few, medium/coarse gravel and few, stones; common, black, soft, iron-manganese nodules; few medium and many fine roots; few medium and common fine pores; non-calcareous; PH:5.0; gradual boundary.

75-130 cm 7.5 YR3 /2.5 (moist) clay; no mottles; very firm, sticky, plastic; continuous, prominent, clay cutans; very few, stones and common, medium/coarse gravel; many, black soft, iron-manganese nodules; common fine roots; very few medium and common fine pores; non-calcareous; PH:5.0; gradual boundary.

130 – 160 cm 7.5 YR3 /2 (moist) clay; few, bluish-black mottles; very friable to friable, sticky, plastic; continuous, prominent, clay cutans; many, black, soft, iron manganese nodules; few fine roots; common fine and very few medium pores; non-calcareous.

6R 160-bedrock / (dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF10 **Date**: 07/03/96

Location: Lalibela- Sekota 28 km; 300 m NE of the road

Zone: North Wollo **Wereda**:

Mapping unit No: 57 **Co-ordinates:** 1342142 N, 495700E

Elevation: 2140m

Topography: _____ **Landform** Rolling Plain **Slope (%)** _____

Micro topography --

Slope Class Gently Sloping

Land Use Rain fed agriculture/extensive grazing on fallow & stubble land

Land Cover Cultivated land/annual crops

Parent Material (weathered) rock derived from Basalt

Surface Characteristics

Surface Coarse Fragments Common stones & bounders **Erosion**

Other Surface Characteristics Gullied **Drainage Class** Imperfectly Drained

External Drainage Well

Flooding _____ **Ground Water (cm)** Not observed

Human Influence Ploughing or raised beds

Crops Teff/Sorghum

Soil Classification FAO 1988, Vertisols

Remarks

- Cracks until 74 cm
- Some scattered shrubs & bushes and few trees in the cultivated land
- The site is intensively cultivated

YF 10

1	0 – 16 cm	10YR 3 /2 (moist) sandy clay; strong, medium, sub angular blocky structure; hard, firm, sticky, plastic; few, stones and common, medium/coarse gravel; many clay cutans; common medium roots; many fine and common medium pores; non-calcareous; PH:6.5; clear boundary.
2	16-45 cm	10YR 3 /2 (moist) sandy clay; strong, medium and coarse, angular blocky structures, hard, firm, sticky, plastic; broken, distinct, slicken sides and broken, distinct clay cutans; common, medium/coarse gravel and very few, stones; few, black, soft, iron-manganese nodules; many fine and few medium roots; common termite or ant channel and nests; many fine and common medium pores; non-calcareous; PH:6.0; clear boundary.
3	45-74 cm	10YR 3/2 (moist) clay; moderate, medium and coarse, angular blocky structure and moderate, medium and coarse, wedge shaped structure; firm, very sticky, very plastic continuous, prominent, slickensides and broken, distinct, clay cutans; few, fine/medium gravel; few, black, soft, iron-manganese nodules; common fine and very few medium.
4	74-106 cm	7.5 YR 3/2 (moist) sandy clay loam; moderate, fine and medium, angular blocky structure; firm, sticky, plastic; few, fine/medium gravel; common, black, soft, iron-manganese nodules; few fine roots; common fire and very few medium pores; non-calcareous; pH: 6.0; abrupt boundary.
5C	106 – 120 cm	/ (dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF 19 **Date**: 29/05/96

Location: Ebinat-Meiza, 11 km; 20m mw of the road

Zone: South Gonder **Wereda**:

Mapping unit No: 37 **Co-ordinates:** 1338773N, 405066E

Elevation: 2380m

Topography: _ **Landform** High gradient mountain **Slope (%)**

Micro topography --

Slope Class Moderately Steep

Land Use Rain fed agriculture/extensive grazing on fallow and stubble land

Land Cover Cultivated land/annual crops

Parent Material Colluvial deposits over (weathered) rock derived from basalt

Surface Characteristics --

Surface Coarse fragments Many stones, coarse gravel **Erosion**

Other Surface Characteristics -- **Drainage Class** Moderately well drained

External Drainage Well

Flooding -- **Ground Water (cm)** --

Human Influence Ploughing or raised beds

Crops --

Soil Classification FAO 1988, Cambisols

Remarks

- Intensively cultivated area
- Scattered shrubs at the side slope of few mountains
- Most of the side slopes are cultivated
- Few deep gulies at the side shapes of surrounding site.

YF 19

1 0-14 cm 10YR 3 / 2 (moist) clay loam; weak, fine and medium, sub angular blocky structure friable, slightly sticky, slightly plastic; common, stones and few, medium/ coarse gravel; common medium and many fine roots; many fine and common medium pores; non-calcareous; pH: 5.0; gradual boundary.

2 14-55 cm 7.5YR 3/3 (moist) sandy clay; moderate, fine and medium, angular blocky structure , friable, sticky, plastic; few, coarse gravel; few medium and common fine roots;fine and common medium pores; non-calcareous; pH:5.0; clear boundary.

3C 55 – 80 cm / (dry);

4R 80- bedrock / (dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF 25 **Date**: 03/06/96

Location: Ebinat-Arbatseguar, 87 km; 100 m Sw of the road

Zone: South Gondar **Wereda**:

Mapping unit No: 25 **Co-ordinates:** 1384626 N, 413076 E

Elevation: 1820 m

Topography: **Landform** Medium gradient hills **Slope (%)**

Micro topography --

Slope Class Gently sloping

Land Use Rain fed agriculture/extensive grazing on fallow and stubble land

Land Cover Cultivated land/annual crops

Parent Material (Weathered) rock derived from Basalt

Surface Characteristics Many stones

Surface Coarse fragments -- **Erosion**

Other Surface Characteristics -- **Drainage Class** Imperfectly drained

External Drainage Well

Flooding None **Ground Water (cm)** Not observed

Human Influence Ploughing or raised beds

Crops Sorghum/Teff

Soil Classification FAO 1988, vertisols

Remarks

- Scattered trees and shrubs on the farm land
- Site is intensively cultivated
- There are termite mounds
- Slightly soft rock strongly calcareous

1	0 - 20cm	10YR 2/1 (moist); clay loam; weak, fine and medium, sub angular blocky structure; friable, slightly sticky, slightly plastic; very few, medium gravel; many fine and many medium roots; many fine and medium and common coarse pores; non-calcareous; pH:6.5; clear boundary.
2	20 – 47 cm	2.5Y 2.5/1 (moist) clay; moderate, fine and medium, sub angular blocky structure; friable, slightly sticky, slightly plastic; broken, faint, slicken sides and continuous distinct, pressure faces; few, medium/coarse gravel; common medium and many fine roots, few termite or ant channels and nests; many fine and common medium pores, slightly calcareous; pH: 7.0; gradual boundary.
3	47-77 cm	2.5Y 2.5/1 (moist) clay; moderate, medium, angular blocky structure; friable, sticky, plastic; continuous, distinct, slicken sides and continuous, prominent, pressure faces; few, coarse gravel; few medium and common fine roots; few termite or ant channels and nests; common medium and many fine pores; slightly calcareous; pH:7.0; clear boundary.
4	77-106 cm	10YR 2 /1 (moist) clay; moderate, medium, angular blocky structure and moderate, medium, wedge shaped structure, very firm, very sticky, very plastic; continuous, prominent, slickensides and continuous, prominent, pressure faces; few, medium gravels; very few medium and common fine roots; many fine pores; slightly calcareous; clear boundary.
5B	106 – bedrock	/ (dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF 26 **Date**: 05/06/96

Location: Ebinat-Arbat Seguar, 57 km; 100m Se of the road

Zone: South Gondar **Wereda**:

Mapping unit No: 2 **Co-ordinates:** 1371385N, 400801E

Elevation: 1885 m

Topography: **Landform** Plan **Slope (%)**

Micro topography --

Slope Class Sloping

Land Use Rain fed agriculture/extensive grazing on shallow and stubble land

Land Cover Cultivated/annual crops

Parent Material Alluvial/colluvial deposits over (weathered) rock derived from Basalt

Surface Characteristics

Surface Coarse fragments Common stones & boulders **Erosion**

Other Surface Characteristics -- **Drainage Class** Excessively drained

External Drainage Rapid

Flooding None **Ground Water (cm)** Not observed

Human Influence Ploughing or raised beds

Crops Teff/ Sorghum

Soil Classification FAO (1988) Leptosols

Remarks

- There are few termite mounds
- Site is intensively cultivated
- Very few scattered trees and shrubs are on the side slope of the surrounding hills and ridges.

1 0-20 cm 10YR 2 / 2 (moist) silty clay loam; moderate, medium, sub angular blocky structure; hard, friable, slightly sticky, slightly plastic; few, medium/coarse gravel; common fine and few medium roots; many fine and many medium pores; non-calcareous; pH6.5; clear boundary.

2R 20-bedrock / (dry);

SOIL PROFILE DESCRIPTION

Profile No: G004 **Date**: 01/12/95

Location Gonder-Humera, 35.5km(near musebamb village):

Zone: North Gonder **Wereda**:

Mapping unit No: 65 **Co-ordinates:** 1421509N,322239E

Elevation: 1300m

Topography: _ **Landform** plain **Slope (%)**

Micro topography medium gilgai

Slope Class Gently sloping

Land Use Rain fed Agriculture

Land Cover cultivated land/ annual crops

Parent Material (weathered) rock derived from Basalt

Surface Characteristics

Surface Coarse fragments few stones **Erosion**

Other Surface Characteristics -- **Drainage Class** somewhat excessively drained

External Drainage

Flooding ____ **Ground Water (cm)**

Human Influence ploughing or raised beds

Crops

Soil Classification FAO 1988,Vertisols

Remarks At 110cm many rounded gravels encountered, so no deep auguring is done.

1 0-15cm 10YR4/2 (moist)clay loam; no mottles, fine and medium, sub angular blocky stricture; friable, sticky, plastic; no cutans; few, fine/ cores gravel; no nodules; common Finland few medium roots; few open large burrows; common fine and few coarse pores; PH:5.0;

15-35cm 10YR4/1 (moist) clay; few, yellowish brown mottles; moderate, fine and medium sub angular blocky structure; friable, sticky, plastic; moderate, fine and medium, sub angular blocky structure; friable, sticky, plastic; patch, prim in, pressure face and patchy, faint, clay curtains; few/coarse gravel; no nodules; common fine and few medium roots; few burrows; common fine and few medium pores; PH: 5.0; clear boundary.

35-70cm 10YR3/1 (moist) clay; few, yellowish brown mottles; moderately, medium and coarse crumb structure; friable, sticky, plastic; broken, distinct, pressure faces; very few fine/coarse gravel; no nodules; few fine roots; no biological activity common fine and few medium pores; pH: 5.0 gradual boundary.

70-110cm. 10YR2/1 (moist) clay; few, yellowish brown mottles; moderate, medium and coarse crumb structure; friable sticky, plastic; broken, distinct, pressure faces very few, fine/ coarse gravel; no nodules; few fine roots; no biological activity; common, fine and few medium pores; PH5.0; gradual boundary.

1100-120cm /(dry); dominant, stones;

SOIL PROFILE DESCRIPTION

Profile No:G005 **Date**:

Location:Gonder-Humera, 27.5km.150m N50E

Zone: **Wereda**:

Mapping unit No: 75 **Co-ordinates:** 1414639N,325151E

Elevation:

Topography: _ **Landform** high gradient hills . **Slope (%)**

Micro topography --

Slope Class steep

Land Use

Land Cover Rain fed agriculture/Extensive grazing on fallow & stubble land/ exploitation of natural forest and woodland.

Parent Material Colluvial deposit over (weathered) rock derived from Basalt.

Surface Characteristics Ridges

Surface Coarse fragments many fine/ coarse gravel stones & boulders. -- **Erosion**

Other Surface Characteristics -- **Drainage Class** Excessively drained

External Drainage Rapid

Flooding _____ **Ground Water (cm)**

Human Influence Ploughing or raised beds

Crops Sorghum/Teff

Soil Classification FAO 1988, Leptosols

Remarks:

- Very steep slop areas around the site are ploughed (about 40%of the whole hillside areas is ploughed) mini pit observation with sample

1 0-15 cm 7.5YR/3 (moist) sandy clay loam; weak, medium, sub angular blocky suture; slightly hard, friable, slightly sticky, plastic; common, fine/ coarse gravel common fine and medium roots; common fine and medium pores; non-calcareous; PH4.5; clear boundary.

2R 15-bedrock /(dry);

SOIL PROFILE DESCRIPTION

Profile No.: G018 **Date**: 17//12/95

Location: Shedy-Gonder,42.5m

Zone: Shedy-Gonder 42.5m (North Wollo) **Wereda**:

Mapping unit No: 1 **Co-ordinates:** 1395845N,248542E

Elevation: 1000M

Topography: **Landform** Plain **Slope (%)**

Micro topography medium gilgai

Slope Class Gently slopping

Land Use Expensive grazing on(semi) natural vegetation/ rain fed agriculture

Land Cover Wooded grassland

Parent Material (weathered) rock derived from basalt

Surface Characteristics: wide cracks + potholes

Surface Coarse fragments -- **Erosion**

Other Surface Characteristics -- **Drainage Class**

External Drainage Well

Flooding ____ **Ground Water (cm)** Not observed

Human Influence Vegetation disturbed

Crops Sorghum

Soil Classification FAO 1988, Vertisols

Remarks

0-12cm. 2.5YR3/2 (moist) clay; mottles; moderate, medium and, sub angular blocky structure; hard, firm, sticky, plastic; patchy, faint cutans; no rock fragments no nodules; many fine and very few medium roots; no biological activity; many fine common medium pores; non- calcareous; PH5.0; clear boundary.

12-31 2.5Y3/2 (moist) clay; few yellowish brown mottles; moderate, medium and coarse sub angular blocky structure; firm very sticky, plastic; broken, distinct clay cutans; no rock fragment; few black, both hard and, iron-manganese nodules and few, white, hard carbonate concretion; common fine and very few medium roots few burrows; many fine and common medium pores; non- calcareous; PH: 6.0; gradual boundary.

31-72cm. 2.5Y3/1.5(moist); few, yellowish brown mottles; strong, medium and coarse granular structure; firm very sticky very plastic; broken, distinct, pressure faces; no rock fragment; few, black, both hard and soft, iron- manganese nodules and none whit hard, Carbonate concretions; very few coarse and common fine roots; few termite or ant cannels and nets; many fine and few medium pores; slightly calcareous; gradual boundary.

72-125cm. 2.5Y3/2 (moist) clay; no mottles; strong, medium and coarse, wedge shaped structure;, firm, very sticky, very plastic; continuous, prominent, pressure faces; no rock fragment; few, black, soft, iron- manganese nodules and common, white hard carbonate concretion; very few coarse and few fine roots; no biological activity; many fine and very few medium pores; slightly calcareous; PH7.5; clean boundary.

125-175cm. 2.5Y3/3(moist) clay strong, medium and coarse, wedge shaped structure; firm, very sticky, very plastic; continuous, prominent, slicken sides; no rock fragment; few black, soft, iron-manganese nodules and common ‘ white soft carbonate concretions very few fine roots; many fine and few medium pores; slightly calcareous.

175-250cm. 7.5YR/6 (moist);

SOIL PROFILE DESCRIPTION

Profile No.: YF015 **Date**: 27/12/95

Location: Sekota-ziquala 48km;50m left of the road

Zone: Wagehemera **Wereda**:

Mapping unit No: 23 **Co-ordinates:** 14073117N, 483856E

Elevation: 16000m

Topography: _ **Landform** **Slope (%)**

Micro topography --

Slope Class Gently sloping

Land Use Exposed rock

Land Cover Exposed rocky **Parent Material** Alluvial/colluvial deposits over (weathered) rock

Surface Characteristics

Surface Coarse fragments common stones -- **Erosion**

Other Surface Characteristics -- **Drainage Class** Excessively drained

External Drainage Rapid

Flooding -- **Ground Water (cm)** Not observed

Human Influence --

Crops --

Soil Classification FAO 1988, Cambisols

Remarks

-Mini pits
-Surface full of gravels and stones
-Few carbonates in the second horizons

1	0-10cm.	10YR4/4	(moist) sandy clay loam; common, medium/coarse gravel; non- calcareous
2	10-40cm.	10YR3/5	(moist) sandy loam; abundant, medium/coarse gravel; strongly calcareous
3	40-bedrock	/	(dry);

SOIL PROFILE DESCRIPTION

Profile No.: YF37 **Date**: 18/06/96

Location: Ebinat-Arbaya, 54km; NE of the road

Zone: **Wereda**:

Mapping unit No: 19 **Co-ordinates:** 1370301N,382509N

Elevation: 1756m

Topography: -- **Landform** Plain **Slope (%)**

Micro topography --

Slope Class Very gently sloping

Land Use Rainfed agriculture/Extensive grazing on fallow & stubble land

Land Cover Cultivated land/ annual crops

Parent Material Alluvial/colluvial deposits derived from basalt

Surface Characteristics

Surface Coarse fragments Common stones medium/coarse gravel **Erosion**

Other Surface Characteristics -- **Drainage Class** Imperfectly Drained

External Drainage Slow

Flooding -- **Ground Water (cm)** --

Human influence: Ploughing or raised beds

Crops Sorghum/Teff

Soil Classification FAO 1988, Vertisols

Remarks

- Site is intensively cultivated
- There are open shrub vegetations on the side of the surrounding medium gradient hills
- Very deep vertisols on flat to undulating plain

0 – 36 cm 10YR 2.5/1 (moist) clay; weak, fine and medium, sub angular blocky structures, friable, sticky, plastic; few, fine gravel and very few, coarse gravel; few, white, hard, carbonate concretions; common fine and medium roots; many fine and common coarse pores; strongly calcareous; pH: 8.0; clear boundary.

36-72cm. 10YR2/1(moist) silt clay; strong medium, angular blocky structure; very firm, sticky very plastic; patchy, faint clay cutans and broken, distinct pressure faces very few coarse gravel; common and few, fine gravel; common white, hard, carbonate concretion; few fine roots; many fine and few coarse pres; moderately calcareous PH 7.5; clear boundary.

72-105cm 10YR2.5/1 (moist) clay; moderately, medium sub angular blocky structure; firm, sticky; plastic; continuous, distinct, sicken sides; very few, coarse gravel; common white, hard, carbonate concretion; very few fine roots; common fine and few coarse pores; moderately calcareous; PH: 7.5; gradual boundary.

105-156cm. 10YR2/2 (moist) silty clay; moderate, medium, angular blocky structure and moderate, medium wedge shaped structure; firm sticky very plastic; continues distinct, slicken sides; very few coarse gravel; common whit, hard carbonate concretion; many fine and few coals pores; moderately calcareous; PH: 7.5;gradual boundary.

156-186cm. 10YR2/1 (moist) clay; moderate, medium angular blocky structure and moderate medium, wedge shaped structure; firm very sticky, very plastic; continues, distinct, slicken sides; very few course gravel and few, fine gravel; many white hard carbonate concatenation; fine and coarse; moderately calcareous.

136-bedrock /(dry)

Date 16-02-02

Field No.: Dk8

Mapping unit No: 95

Project: Debark Agro forestry based fuel wood plantation

Location: About 1.5 k meter south Chenek camp

Elevation: 3460 meter about sea level

Coordinates: N13^0 15’ 09’’E38^0 11’ 03’’

Author(s): Gebeyehu Belay

Soil Classification: Umbric Andosol **PHASE:** none

Physiographic Position: Middle slope

Land Use/Cover: Grass land

Slope Gradient: 22%

Moisture Condition: Dry throughout

Drainage Class: Well drained

Ground Water Depth: > 55 cm

Parent Material: Basalt

Erosion Status: Slight sheet erosion at site and surrounding

Climate: Cold to very cold moist

Rock Outcrops: Few

Surface Stoniness: Few boulders

Profile Description

Ap	0-30cm	Very dark gray (7.5YR3/1) dry, black (7.5YR 2.5/1) moist, silty loam; weak fine crumb structure; soft (dry), friable (moist), slightly sticky & non plastic (wet); many fine interstitial pores; common fine roots; gradual and smooth boundary.
A	30-55cm	Dark brown (7.5YR3/2) dry, very dark gray (7.5YR 3/1) moist, silty clay loam; moderate sub angular structure; soft (dry), friable (moist), slightly sticky & non plastic (wet); common fine interstitial pores; few fine roots; clear & smooth boundary.

SOIL PROFILE DESCRIPTION

Profile No.: BPR3 **Date**:21/01/05

Location: 4kms north of mafud news Kebele

Zone: North Shewa **Woreda: Berehet**

Mapping unit No: 61 **Co-ordinates:** N 09^0 $15^{'}$ $43.3^{''}$ E 39^0 $42^{'}$ $44.4^{''}$

Elevation: 1510m

Topography: Steep side slopes **Landform** Rugged terrain **Slope (%)** 52%

Micro topography Irregular Surface

Slope Class: Steel

Land Use Rough grazing with very small paches of farm fields

Land Cover Tree (torny bushes, weeyba and Acacia)

Parent Material Symptom of limestone inter calcated with volcanic Ashes

Surface Characteristics Long ridges of house

Surface Coarse fragments Big boulders **Erosion** Extremely serves

Other Surface Characteristics Rocks **Drainage Class** Well drained to excessive

External Drainage Well drained

Flooding None **Ground Water (cm)** Not observed

Human Influence Little (such as beekeeping& cultivation)

Crops Sorghum teff on few patches

Soil Classification FAO Calcaric Cambisols

Remarks Not suitable for cultivation of crops

Profile No: BPR3

Profile Description

A1 0-60 CM. Dark yellowish brown 910YR/4) moist; Sandy Clay; moderate fine sub angular blocky structure; friable moist; slightly plastic wet; common medium pores; many fine common medium roots; clear and wavy

C 60+cm. Many rock fragments

Remark: This area can not be used food agriculture

SOIL PROFILE DESCRIPTION

Profile No.: PHK1 **Date**: 22/01/2005

Location: Some 5 kms south of Shola Gebeya

Zone: North Shewa **Woreda**: Hagermariam-Kesm

Mapping unit No: 94 **Co-ordinates:** N09^0 11'' 49.4'' E39^0 24' 41.3''

Elevation: 2660m asl

Topography: Middle Valley Side **Landform** Stream Valley **Slope (%)** 9%

Micro topography Sink holes and heaving

Slope Class Sloppy

Land Use Cultivated

Land Cover Annual crops

Parent Material Colluvium of volcanic Ash and Basalt

Surface Characteristics Uneven surface

Surface Coarse fragments Few stones **Erosion** Slight

Other Surface Characteristics **Drainage Class** Moderate

External Drainage Well drained

Flooding None **Ground Water (cm)** Not observed

Human Influence Cultivation and cutting

Crops Wheat, Chick Pea, Horse Bean Barely

Soil Classification FAO Vertic Cambisols

Remarks Soil with common vertic properties

Profile No.: PHK 1

Profile Description

Ap 0-20 cm. Very dark brown (7.5YR2.5/3) moist; clay strong coarse sub angular blocky; sticky plastic wet, friable moist ; many fine interstitial pores; common fine roots; strongly calcareous gradual and smooth boundary.

A1 20-60+CM. Very dark brown (7.5YR2.5/3) moist; clay strong coarse prismatic; very sticky very plastic, wet very firm moist; extremely hard dry; few large pores; few fine and common roots; slightly calcareous.

Remark: Cracks 2cm wide and between cracks 5-35cm.

SOIL PROFILE DESCRIPTION

Profile No.:PHK2 **Date**: 23/01/05

Location: 4Km east of Mutamayes Medhanealem

Zone: North Showa **Woreda** Hageremariam-Kesem

Mapping unit No: 18 **Co-ordinates**; N $09^0$15' 54'' E 39^0 29' 44''

Elevation: 3050masl

Topography: Dissected valley **Landform** Steep sided valley

Slope (%) 34%

Micro topography Terraces and furrows **Slope Class** Steep

Land Use Cultivated/rough grazing

Land Cover Annually crops

Parent Material Colluvium from volcanic ash

Surface Characteristics Uneven surface

Surface Coarse fragments Common stonnes **Erosion** Severe

Other Surface Characteristics Terrace bunds **Drainage Class** Well drained

External Drainage Well drained

Flooding None **Ground Water (cm)** Not observed

Human Influence Terrace construction

Crops Barely, Lentils & Wheat

Soil Classification FAO Haplic Alisols

Remarks This is a very steep sided valley, where narrow width terraces have been constructed all over the valley sides. The terraces themselves are up to 12% steep.

Profile No.: PHK 2

Profile Description

Ap 0-23cm. Light yellowish brown (10YR6/4) dry; very light grayish brown (10YR3.5/3) moist; sandy clay loam. Moderate medium sub angular blocky; hard, slightly sticky slightly plastic wet, friable moist; common medium pores; many fine roots; few gravel clear and wavy boundary.

A1 23-39/43cm. Dark brown (10YR3/3) moist; sandy clay; strong coarse angular blocky; spicy plastic wet; friable moist; many fain interstitial and few medium pores; many fine roots; few medium gravel; common manganese nodules; clear and wavy boundary.

A2 39/43/100cm. Very dark brown (7.5YR2.5/3) moist; clay; weak fine annular blocky; very sticky very plastic wet friable moist; common medium pores; very fine roots; common manganese nodules; common highly weathered coarse gravel; clear and wavy boundary.

AC 93/100-113cm. Dark yellowish brown (10YR3/4) moist; clay; moderate medium angular blocky; very sticky very plastic wet, friable moist; many fine and common pores; few Iron and manganese nodules; common highly weathered coarse gravel.

SOIL PROFILE DESCRIPTION

Profile No.:PHK3 **Date**: 24/01/05

Location: 14 km North of Shola Gebeya

Zone: North Shewa **Woreda**: Hageremariam - Kesem

Mapping unit No: 93 **Co-ordinates**; 09^0 17' 37'' E 39^0 27' 21.8''

Elevation: 1820m asl

Topography: Terraced valley sided **Landform** Rolling **Slope (%)** 12%

Micro topography: Gilgai & contour terracing

Slope Class Slopping

Land Use Cultivated

Land Cover Annually crops

Parent Material Residual material derived from ignimbrite and deposited as colluviums

Surface Characteristics Drainage arteries

Surface Coarse fragments Bolloders and rock fragments **Erosion** Moderate sheet

Other Surface Characteristics -- **Drainage Class-**

External Drainage Some Wheat excessively drained

Flooding None **Ground Water (cm)** Not observed

Human Influence Cultivation and terracing

Crops Barely, wheat, lentils and cheek pea

Soil Classification FAO Eutric vertisols

Remarks Gilgai & wide cracks

Profile No. PHK 3

Ap 0-17 cm. Black (10YR2/1) Dry, Very dark brown (10YR2/2) moist; clay moderate medium sub angular blocky; firm moist hard; many fine interstitial; many fine and medium roots; few medium gravels; clear and smooth boundary.

A1 17-40 cm. Black (10YR2/1) moist; clay; moderate coarse sub angular blocky structure; friable moist; very sticky very plastic wet; common medium pores; common fine and medium roots; few medium gravels; clear and smooth boundary.

AC 40-50/65+CM. Very dark brown (10YR3/3) moist; clay moderate fine angular blocky; friable moist; very sticky very plastic wet; few medium pores; few faint Manganese nodules; medium few coarse gravels; few distinct silken sides; strongly calcareous.

C50/65-143cm. Highly Weathered coarse gravel.

Remark: Many fine cracks 1cm width7cm between cracks

SOIL PRFILE DESCRIPTION

Profile No R101 **Date** 11/07/2000

Location Kachin Weha valley Rain, about 11 km North West of Woldiya along the Woldya – Gonder Road

Zone North wollo **Wereda** Gubalafato

Mapping unit No: **Co-ordinates** N1312800 E558600

Elevation1750m

Topography -- **Landform** valley plain very slightly dissected **Slope(%)** 1-2%

Micro topography --

Slop class Almost flat

Land Use Irrigated cropland

Land Cover Sorghum crop

Parent Materials Alluvial

Surface Characteristics ---

Surface Coarse fragments -- **Erosion** --

Other Surface Characteristics -- **Drainage Class** Moderately well

External Drainage --

Flooding -- **Ground Water (cm**) More than 4m

Human Influence --

Crops Sorghum

Soil Classification FAO Eutric Fluvisols

Remark

Profile No: R101

Ap 0-45 cm. Very dark grayish brown (10YR3/2, some what moist) clay, weak sub angular blocky, common fine and medium pores, many fine roots, soft when moist, very sticky and very plastic when wet, no mottling, nodules or concretions.

Sample R101/1

IIAB 445-75cm. Very dark grayish brow (10YR3/2, some what moist) court sandy lame; very weak angular blocky; common and medium pores; very few fine roots; soft when moist, very slightly sticky and non plastic when wet, no mottling, nodules or concretion.

IIB 75-90cm. Dark brown (10YR3/3, some what moist) sandy loam to sandy clay loam, very weak angular blocky, few very faint clay skins, common fine pores, no roots, soft when moist, slightly sticky and very plastic when wet, no mottling, nodules or concretions.

Sample R1011/3

IIIB 90-95cm. Dark brown (10YR3/3, some what moist) very gravelly sandy loam, structures, very few pores, no roots, loose moist, very sticky and non-plastic when wet, no mottling, nodules or concretions

No sample taken

IVB 95-120cm. Dark brown (10YR3/2, moist) clay loam weak angular blocky, pressure skins; common fine pros, no roots, firm when moist, sticky and plastic when wet, no mottling, nodules or concretion.

No sample taken

IVBCB 120-190+cm. Very dark brown (10YR2/2, moist) clay, angular blocky to prismatic, no pores roots, clear slickensides, firm when moist, very sticky and very plastic when wet, no mottling, nodules or concretion.

No sample taken

SOIL PROFILE DESCRIPTION

Profile No R 102 **Date** 11/07/2000

Location 2Km south west of Weldiya town along the road from the Agricultural Department

Zone North Wollo **Wereda** Guba Lafto

Mapping unit No: **Co-ordinates** N 1305400 E 563000

Elevation 1850m

Topography **Land form** Valley plain **slop (%)** 1-2%

Micro topography

Slop class Almost flat

Land Use Cultivated

Land Cover Annual crops

Parent Material Alluvial

Surface Characteristic

Surface Coarse Fragments **Erosion**

Other Surface Characteristics **Drainage Class** Moderately well

External Drainage

Flooding **Ground Water (cm)** More than 6m

Human In flues

Crops

Soil Classification FAO Buried Eutric vertisols

Remark

Profile No: R102

Ap 0-30 cm. Very dark grayish brown (10YR3/2, somewhat moist) clay, weak sub angular blocky, common and medium pores, common fine roots, soft when moist, very sticky and very plastic when wet, no mottling, nodules or concretion, few fine to coarse rock fragments.

Sample R 102/1

IIC 30-60cm Dark brown (7.5YR3/3, somewhat moist) fine gravelly sandy clay loam; very weak angular blocky; few fine pores; few fine roots; slightly sticky and plastic when wet, inn lower part of horizon common medium CaCO3 mottling, no concretions, abundant fine and medium rock fragment.

Sample 102/2

IIB1 60-100cm. Very dark grayish brown (10YR3/2,some what moist) clay, prismatic with increasing sicken side with depth, no pores, very few fine roots, when moist, very sticky and very plastic when wet, few fine and medium CaCO3 mottles, no concretions

Sample R102/3

IIB2 100-200cm. Black (10YR2/1, moist) clay, strongly prismatic with clear large sicken side, no popes, no roots, firm when moist, very sticky and plastic when wet, very few and fine and medium CaCO3mottles, no concretion.

No sample taken

SOIL PROFILE DESCRIPTION

Profile No: R103 **Date**: 13/07/2000

Location: Near Tukalesh Nursery

Zone: North Wollo **Woreda**

Mapping unit No: 1 **Co-ordinates**; N 1343800 E 552500

Elevation: 1880 m

Topography: **Landform** Medium gradient valley **Slope (%)** 10%

Micro topography:

Slope Class:

Land Use Cultivated

Land Cover Annually crops

Parent Material Alluvium/Colluvium **Surface Characteristics**

Surface Coarse fragments **Erosion**

Other Surface Characteristics **Drainage Class** Moderately Well

External Drainage

Flooding **Ground Water (cm)**

Human Influence

Crops Teff, Barely, Wheat & Sorghum

Soil Classification FAO Burried Haplic Luvisols

Remark

Profile No.: R 103

Profile Description

Ap 0-25cm. Very dark grayish brown (10YR3/2, moist) sandy clay loam, weak angular blocky, common fine to coarse pores, many fine and medium roots, soft wheat moist, slightly and slightly plastic when wet, no mottling, nodules or concretions.
Sample R103/1

$A_1$25-65cm. Dark grayish brown (10YR4/2, dry) sandy clay loam; weak angular blocky; common fine and medium pores; common fine and medium roots; slightly hard when dry, slightly sticky and slightly plastic when wet, no mottling, nodules or concretion.
Sample R103/2

IIB 65-125cm. Dark grayish brown (10YR4/2, dry) sandy clay loam to clay loam, including thin lenses of coarse sandy loam, moderate angular blocky, few faint clay skins, common fine pores, few fine and medium roots, slightly hard when dry, sticky and slightly plastic when wet, no mottling, nodules or concretion.
Sample R103/3

IIBt1 125-165cm Dark grayish brown (10YR/2,dry) clay loam, moderate angular blocky, common fine thin clay skin, fine to medium pores, very few fine roots, hard when, sticky and plastic when wet, abundant fine and medium rust brown mottling along root channels, in the top 5cm of the horizon many fine Ca CO_3 concretion.
No sample taken

IIBt1 165-195cm. As previous horizon but no line concertino and mottles deceasing downward from common to few
No sample taken

SOIL PROFILE DESCRIPTION

Profile No: R104 **Date**: 13/07/2000

Location: Along the road from Kobo just before crossing

Zone: North Wollo **Woreda** Kobo

Mapping unit No: **Co-ordinates**; N1345200 E581200

Elevation: 1910m

Topography: **Landform** Foot slopes Low gradiant **Slope (%)** 4%

Micro topography;

Slope Class Undulating

Land Use Cultivated

Land Cover Annuall crops

Parent Material Colluvim/alluvial **Surface Characteristics**

Surface Coarse fragments **Erosion**

Other Surface Characteristics **Drainage Class** Well drained

External Drainage

Flooding **Ground Water (cm)**

Human Influence

Crops Sorghum

Soil Classification FAO Vertic Fluvisols

Remark

Profile No: R104

Profile Description

Ap 0-20cm. Drake brown (10YR3/3, dry) clay, strong angular blocky, common fine and very fine pores, many fine to medium roots, very hard when dry, slightly sticky and plastic when wet, no mottling, nodules or concretion.

Sample R104/1

AB 20-75CM. Dark brown (7.5YR3/2, dry) clay; weak angular; common fine and medium pressure skins; few fine pores; few fine; roots; very hard when dry, sticky and very plastic when wet, common medium CaCO3 concretion

Sampler R 104 /2

IIBC 75-110cm. Dark yellowish brown (10YR3/4, some what moist) gravelly clay, very weak angular blocky, few fine pores, few fine roots, firm when moist, sticky and non plastic when wet common fine to coarse CaCO3 mottles conception, abundant fine gravel, I top of 5cm many small stones.

No sample taken

IIBC 110-190cm. Dark yellowish brown (10YR3/4, moist) clay, moderate angular blocky, many clear medium pressure, very few pores, no roots, when moist, very sticky and very plastic when wet, very few fine and medium(0.5-3cm) rock fragments, no mottles or concretion.

Sample R104/3

SOIL PROFILE DESCRIPTION

Profile No.: PBR 1 **Date**: 19/01/05

Location: Sibu Kebele

Zone: North Shewa **Woreda** Berehet

Mapping unit No: 48 **Co-ordinates**; N 9^{0} 08^{1} 58.4^{4} 39^{0} 31^{1} 46.4^{11}

Elevation: 2150 m **Topography**: Rugged mountainous **Landform** Mountain **Slope (%)** 36%

Micro topography: Terraced

Slope Class Steep

Land Use Cultivated

Land Cover Annually crops

Parent Material Colluvim derived from basalt

Surface Characteristics Erosion remnants & terraces

Surface Coarse fragments Common Stones **Erosion** Highly eroded

Other Surface Characteristics **Drainage Class** Moderately well

External Drainage Well drained

Flooding None **Ground Water (cm)** Not observed

Human Influence Cultivation

Crops Sorghum, Enset & Millet

Soil Classification FAO Eutric Cambisols

Remarks There are common surface stones

Profile No: PBR1

Ap 0-18cm. Light brown (7.5YR/3.5) dry, dark brown (7.5YR3/3) moist; silt clay; moderately medium sub angular blocky; slightly sticky slightly plastic wet; friable moist slightly hard dry; common medium pores; many fine and medium roots; calcareous; few faint iron and Manganese nodules; clear and smooth boundary.

AC 18-40cm. Dark brown (7.5YR3/3) moist; sandy clay; strongly medium angular blocky; slightly firm moist; slightly sticky non-plastic wet; common medium pores; few faint Iron and Manganese nodules; strongly calcareous

Remark: Dissected valley side slopes.

SOIL PROFILE DESCRIPTION

Profile No.: PBR-2 **Date**: 19/01/05

Location: About 6 kms-North of Kosti School **Zone**: North Showa **Woreda** Berehet

Mapping unit No: 67 **Co-ordinates**; N $9^0$05' 09.3'' E 39^0 34' 04.3

Elevation: 1770m

Topography: Extremely rugged mountainous **Landform** Mountain **Slope (%)** 54%

Micro topography Uneven surface with ridges & Shallows

Slope Class Steep

Land Use Rough grazing

Land Cover Bushes & trees (Acacia, cactus, etc**)**

Parent Material Basalt **Surface Characteristics** Stones

Surface Coarse fragments Stones **Erosion** Sever gully

Other Surface Characteristics _____ **Drainage Class** Excessive

External Drainage Well drained

Flooding None **Ground Water (cm)** Not observed

Human Influence

Crops Not cultivated

Soil Classification FAO Eutric Leptosols

Remarks Cultivation not possible because of shallow depth and severe erosion

Profile No: PBR2

Profile Description

A1 0-15cm. Light yellowish brown (10YR6/4) dry; dark yellowish brown (10YR3/4) silt; moderately fine sub angular blocky structure; loose dry, friable moist, non-sticky non-plastic wet; common medium pores; common medium and roots; slightly calcareous; gradual and smooth boundary.

A215-30cm. Light yellowish brown (10YR6/40);dry brown (10YR3/3);silt loam; weak fine granule structure; non sticky non plastic; friable moist; common pores; few fine roots; highly calcareous.

Mapping Unit: 45

Profile No.: B107

Date of description: 10/04/84

Location: 4km NNW or Jemate, 0.8 km w of main road.
10^0 38' 30'' N: 39^0 54' 20'' E on map sheet 37-7-10 Were Ilu(1;250 000)

Photo no: 1431

Soil classification: MOLLIC GLEYSOL, SODIC PHASE (FAO) –Gm 1
FLUVAQUENTIC HAPLAQUOLL (USDA)

Physiographic position Marshy bottomlands in Borkena plain

Slope: 0%

Elevation: 1400m asl

Vegetation/land use: Cyprus alopecurides marsh vegetation; grazing during the dry season only in years with exceptional low rainfall.

Climate: Dry sub humid warm tropical

Parent materials: Clayey outwash basin and back swamp deposits very

Drainage: Very poorly drained; flooded for most of the year

Moisture condition: Wet throughout

Rock outcrop: None

Evidence of erosion: None

Profile description:

Ah1 0-17cm; very dark brown (10YR2/2) clay; common fine distinct mottles; structure less to weak sub angular blocky, platy structure occurs in the top; friable (most); many very fine to medium roots; smooth and clear on;

Ah2 17-37cm; Dark brown (7.5R3/2) clay; common to many medium distinct mottles (7.5YR4/5); structure less; friable (moist) slightly sticky (wet); few medium pores; many fine to coarse roots; smooth and clear on;

BG 38.75cm; (very) dark (grayish) brown (10YR3/2.5) clay; many medium prominent mottles (5YR4/6); weak coarse sub angular blocky; slightly (wet); shiny ped surfaces (cutans?); common medium root channel; common fine to medium roots; smooth and gradual.

Cg 75-105cm; very dark gray (10YR3/1); common fine prominent mottles (5YR4/6); weak coarse sub angular blocky; slightly sticky (wet); shiny ped surfaces (cutans?); common medium root channel; few fine root.

Mapping Unit: 50

Profile No.: $B20_{a.}$

Date of description: 09/06/83

Location: 3.5 km WSW of Milamile, 3 km W of the main road.
10^0 46' 10'' N; 39^0 48' 20'' on mapsheet NC 37-7-4 Were Ilu (1;250,000)

Photo no: 2429

Soil classification: LUVIC PHAEOZEM (FAO)-H1-1 UDIC ARGILUSTOLL (USDA)

Physiographic position: Stable (not receiving new material) alluvial fan

Slope: 0-1%

Elevation: 1445m asl

Vegetation/ land use: Cultivation of teff, Sorghum and Maize

Climate: Dry sub humid warm tropical

Parent materials: Silly sheet flood deposits

Drainage: Well drained

Moisture condition: Moist throughout

Rock outcrop: None

Evidence of erosion: None

Profile description:

Ap1 0-10cm; very dark grayish brown (10YR3/2) clay loam; strong coarse sub angular blocky; very firm (moist), sticky and plastic (wet); many very fine to medium pores; clear and smooth on:

Ap2 10-35cm; very dark grayish brown (10YR3/2) clay; moderate coarse sub angular blocky; firm (moist), sticky and plastic (wet); many fine to medium pores; many fine roots; clear and smooth on;

Bt1 35-85 cm; Dark brown (7.5YR3/20) moderate coarse sub angular l blocky; firm (moist), sticky and plastic (wet); broken moderately thick clay cutans; many fine and medium pores; few very fine and fine roots gradual and wavy on

Bt2 85-130cm; Dark brown (7.5R3/2) loam; weak coarse angular blocky; friable (moist), slightly sticky and slightly (wet); patchy thin clay cutans; many fine medium pores few very fine and fine roots; clear and smooth on:

BC 130-170cm; very dark grayish brown (10YR3/2) loan; few faint mottles; moderate medium angular blocky; friable (moist) slightly sticky and slightly plastic (wet); common fine and medium pores; few very fine and fine roots; clear and smooth on:

Cg 170-190 cm +; Dark brown (10YR3/3) sandy loam; few fine distinct mottles; weak medium subangular blocky; loose, non sticky and non plastic (wet); common fine pores; few fine roots.

Mapping Unit: 96

Profile No.: 210d

Date of description 16/12/83

Location 18km Ne of Rabel, 1 km N of junction Del Mikael road; along the road 10^{03} 39' 40'' N;39^{0} 42' 55'' E on mapsheet NC 37-7-9 Were IIu (1:250 000)

Photo no: 2387

Soil classification: MOLLIC or HUMIC ANDOSOL (FAO)STONY PHASE-Tm 1 TYPIC EUTRANDEPT or HYDRIC DYSTRADEPT (USDA)

Physiographic position High ridge in the highlands

Slope: 40%

Elevation: 3330m asl

Vegetation/ land use: Dwarf shrub grassland (Festuca abyssinica, Lobelia sp)

Climate: Humid cool tropical

Parent materials Colluvial deposit derived from volcanic rock (Probably mainly airboat tuffaceous deposits)

Drainage: Well drained

Moisture condition: Moist throughout

Rock outcrop: Fairly rocky.

Evidence of erosion: None

Profile description;

Ah 0-20cm; Black (10YR2/1) moist and very dark grayish brown (10YR3/2) dry, loam; weak fine and medium crumb; loose (dry), friable (moist), slightly sticky and non plastic (wet); many pores; few gravel; many fine to medium roots; diffuse and smooth on:

AB 20-65cm; Black (10YR2/1) moist and very dark brown (10YR2/2) dry, clay loam to loam; weak coarse sub angular blocky; soft (dry), friable (moist), slightly sticky, non plastic and thixotropic (wet); many pores; few gravel; many very fine and fine roots; diffuse and smooth on:

B 65-100CM+; Black (10YR2/1) clay loam; weak coarse singular blocky; slightly hard (dry), many pores; few gravel; many very fine and fine roots.

Remark: The soils of mapping unit B5-3 are classified as Mollic Andosols (instead of Humic Andosols) as laboratory resulted indicate, that base saturation of the epipedon is usually 50-60%

Mapping Unit: 24

Profile No.: 175d

Date of description: 09/12/93

Location: 2 km ENE of Degage along the rode
$10^0$48' 40'' N 39^0 41' 30''E on map sheet NC 37-7-3 Were Ilu (1:250 000)

Photo no: 2350

Soil classification: EUTRIC REGOSOL, LITHIC PHASE (FAO)- Re LITHIC USTORTHENT (USDA)

Physiographic position Steep mountain slope

Slope: 30%

Elevation: 2500m asl

Vegetation/ land use Shrub & grassland

Climate Moist sub humid cool tropical

Parent materials Slop deposit derived from porphyritic basalt.

Drainage: Excessively drained

Moisture condition: Dry

Rock outcrop: Rocky

Evidence outcrop Severe sheet erosion

Profile description;

A 0-30cm. Dark brown (10YR3//3) moist and light yellowish brown (10YR6/4) dry, sandy loam; weak medium sub angular blocky; soft to slightly hard (dry), very friable(moist), non sticky and non plastic (wet); many pose; common gravel; common fine to medium roots; smooth and clear on

C 30-100cm +; slightly weathered rock

SOIL PROFILE DESCRIPTION **Profile**: REC030 **Mapping Unit**: 3 **Status**:

Sheet/Grid: NC37-1/1137 A4 **Coord**: N 11-36-38 E037-00-49

Location: 60m from Bahir Dar to Hamusit

Survey Area: Bahir Dar **Elevation**: 1900 m

Author(s): Solomon Mengistu **Date**: 07/05/96

Classification FAO: Haplic Nitisols (1988)
ST:

Soil Climate:

Topography: 15-30% hilly **Land Form**: Upland alluvial

Element/Pos.: Middle Slope **Slope**: 2-5%

Micro Top: Termite mounds

Land Use: Rainfed arable cultivation- **Crops**: Maize **Human Infl**: Ploughing

Vegetation: Semi-deciduous forest **Grass cover**:

Species:

Parent Materials: Alluvial deposit

Eff. Soil Depth: > 150cm

Rock Outcrops: Nil

Surface Stones: Few coarse gravel

Erosion: Slight rill erosion **Sealing/Crusting**: Nil

Drainage: Permeability: mod. Wel drain.; external drainage: Moderate

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0 – 29, slightly moist 29 – 87, moist 87 – 200 cm

Remarks: Some shinning ped faces below 87cm with increasing fine textured clay materials.

Samples: A: 0 – 29 B: 29 – 87 C: 87 – 200

0 - 29 cm 5YR 4/6 (dry) and 5YR 3/4 (moist); clay; moderate fine angular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), non plastic (wet), many fine-medium pores, common fine roots; non calcareous; gradual smooth boundary.

29 - 87 cm 5YR 4/4 (moist); clay; moderate fine and medium angular blocky structure; friable (moist), sticky (wet), slightly plastic (wet), common medium-coarse pores, few fine roots; non calcareous; gradual smooth boundary.

87-200 cm 2.5YR 3/6 (moist); clay; weak fine and medium sub prismatic structure; very friable (moist), sticky (wet), plastic (wet), many fine and very fine pores, very few fine roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC029 **Mapping Unit**: 3 **Status**:

Sheet/Grid: NC36-8/ **Coord**: N 10-49-53 E 035-51-51

Location:

Survey Area: Bulen (Wembera) **Elevation**: 1110 m

Author(s): Solomon Mengistu **Date**: 03-08-96

Classification FAO: Haplic Nitisols (1988)
ST:
Soil Climate:

Topography: 15-30% hilly **Land Form**: Valley

Element/Pos.: Bottom (flat) **Slope**: 2-5%

Micro Top: Termite mounds

Land Use: Animal husbandry **Human Infl**: Vegetation disturbed

Vegetation: Evergreen woodland **Grass cover**:

Species:

Parent Materials: Alluvial deposit

Eff. Soil Depth: 100-150cm

Rock Outcrops: Nil

Surface Stones: Few stones

Erosion: Slight sheet erosion **Sealing/Crusting**: Nil

Drainage: ; Permeability: well drained; external drainage: slow

Water table: Not available

Flooding: Nil

Moist Condition: Dry 0-10, slightly moist 10-100, moist 100-140cm

Remarks: Below 140cm the profile is cemented by silica

Samples: A: 0-10 B: 10-100 C: 100-140

0- 10 cm 5YR 3/3 (dry) and 5YR 3/2 (moist); clay loam; weak medium sub angular blocky structure; slightly hard (dry), very friable (moist), slightly sticky (wet), non plastic (wet), non plastic (wet), common fine-medium pores, common fine- medium roots; non calcareous; clear smooth boundary.

10 – 100 cm 5YR 4/6 (moist); clay; moderate fine and medium angular blocky structure; friable (moist), sticky (wet), plastic (wet), common medium pores, few faint clay on pedfaces; few fine roots; non calcareous; gradual wavy boundary.

100 – 140 cm 5YR 4/4 (moist); clay; weak medium granular structure; very friable (moist), slightly sticky (wet), non plastic (wet), few very fine pores, many medium rounded hard and soft manganiferous nodules; very few very fine roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC019 **Mapping Unit**: 4 **Status**:

Sheet/Grid: NC3711/ **Coord**: N 09-39-17 E 039-38-25

Location: 65m N of the road from Debre Birhan to Ankober & Mitak Amanuel junction

Survey Area: Baso **Elevation**: 3130m

Author(s): Solomon Dagnachew **Date**: 31/10/96

Classification FAO: Haplic Luvisols (1988)
ST:
Soil Climate:

Topography: 2-5% gen. undulating **Land Form**: Upland alluvial

Element/Pos.: Middle slope **Slope**: 2-5%

Micro Top: No microrelief

Land Use: Rainfed arable cultivation - Crops: Barley **Human Infl**: Ploughing

Vegetation: No vegetation **Grass cover**:

Species:

Parent Material: In situ weathered

Eff. Soil Depth: > 150cm

Rock Outcrops: Nil -

Surface Stones: Nil

Erosion: Moderate sheet erosion **Sealing/Crusting**: Nil

Surface cracks: Fine (< 1cm)

Drainage: ; permeability; mod. Well drain.; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: Dry 0-14, slightly moist 14-55, moist 55-200 cm

Remarks: Yellowish brown on the surface but the third profile has a dark brown color

Samples: A: 0-14 B: 14-55 C: 55-90 D: 90-135 E: 135-200

0-14 cm 10YR 5/4 (dry) and 7.5YR 3.5/3 (moist); clay; weak to moderate fine and medium subangular blocky structure; hard (dry), friable (moist), very sticky (wet), very plastic (wet), common fine pores, many fine-medium roots; non calcareous; clear smooth boundary.

14-55 cm 7.5YR 3/2 (moist); common fine distinct mottles; clay; weak to moderate fine and medium subangular blocky structure; friable to firm (moist), very sticky (wet), very plastic (wet), many fine-medium pores, common distinct clay; common fine roots; non calcareous; clear smooth boundary.

55-90 cm 10YR 4.5/2 (moist); v. few faint mottles; clay; moderate coarse sub prismatic structure; firm (moist), very sticky (wet), very plastic (wet), common fine pores, many distinct clay-sesquioxides cutans on pedfaces; few fine rounded soft manganiferous nodules; very few fine roots; non calcareous; gradual smooth boundary.

90-135 cm 7.5YR 4/3 (moist); clay; weak medium sub prismatic structure; friable (moist), very sticky (wet), very plastic (wet), common fine pores, abundant distinct clay on pedfaces; few fine rounded soft manganiferous nodules; non calcareous; gradual smooth boundary.

135-200 cm 7.5YR 3.5/3 (moist); clay; very weak fine sub prismatic structure; very friable (moist), very sticky (wet), very plastic (wet), common fine pores, abundant distinct clay on pedfaces; few fine rounded soft manganiferous nodules; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC020 **Mapping Unit**: 6 Status:

Sheet/Grid: NC37-5/ **Coord**: N 10-16-49 E037-18-17

Location:

Survey Area: Amanuel **Elevation**: 2200 m

Author(s): Solomon Mengistu **Date**: 05/08/96

Classification FAO: Haplic Alisols (1988)
ST:
Soil Climate:

Topography: 2-5% gen. undulating **Land Form**: Plateau

Element/Pos.: Middle slope **Slope**: 2-5%

Micro Top:

Land Use: Rainfed arable cultivation **Crops**: Wheat **Human Infl**: Ploughing

Vegetation: Semi-deciduous woodland **Grass Cover**:

Species:

Parent Materials: Alluvial deposit

Eff. Soil Depth: > 150 cm

Rock Outcrops: Nil

Surface Stones: Nil

Erosion: Moderate sheet erosion and moderate rill erosion **Sealing/Crusting**: Nil

Surface Cracks: Medium(1-2cm) **Crack distance**: V close (< 0.2m)

Drainage: ; Permeability: well drained; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: 0 – 200 cm

Remarks:

Samples: A: 0-30 B: 30 – 120 C: 120 - 200

0-30 cm 5YR4/4 (dry) and 5YR 3/3 (moist); clay; moderate medium subangular blocky structure; hard (dry), friable (moist), sticky (wet), plastic (wet), common medium pores, common fine-medium roots; non calcareous; gradual smooth boundary.

30-120 cm 2.5YR ¾ (moist); clay; moderate medium subangular blocky structure; friable (moist), sticky (wet), plastic (wet) few fine pores, few fine roots; non calcareous; clear wavy boundary.

120 – 200 cm 2.5YR 3/6 (moist); clay; weak fine prismatic structure; very friable (moist), very sticky (wet), very plastic (wet), many very fine pores, few faint clay on pedfaces; very few fine rounded hard and soft manganiferous nodules; very few very fine roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC017 **Mapping Unit**: 7 **Status**:

Sheet/Grid: NC37-1/1136D4 **Coord**: N11-02-45 E 036-52-55

Location: 1.4km SW from Gatera Beta Egziabher

Survey Area: Addis Kidame **Elevation**: 2580 m

Author(s): Fidadu Kassa **Date**: 09/01/97

Classification FAO: Haplic Luvisols (1988)
ST:
Soil Climate:

Topography: 2-5% gen. undulating **Land Form**: Upland alluvial

Element/Pos.: Middle slope **Slope**: 2-5%

Micro Top: No microrelief

Land Use: Rainfed arable cultivation - **Crops**: tea, barley **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: in situ weathered

Eff. Soil Depth: > 150cm

Rock Outcrops: Nil -

Surface Stones: Nil

Erosion: Moderate sheet erosion **Sealing/Crusting**: Nil

Surface cracks: Wide (2-5 cm) **Crack distance**: Wide (2-5m)

Drainage: ; Permeability: mod. Well drain.; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0 -20, slightly moist 20-60, moist 60-200 cm

Remarks: Animal burrows

Samples: A: 0-20 B: 20-60 C: 60-110 D: 110-200

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0 – 20 cm 10YR5/3 (dry) and 10YR 3/2 (moist); clay; strong medium and coarse subangular blocky structure; hard (dry), friable (moist), sticky (wet), plastic (wet), common fine and very fine pores, common fine-medium roots; non calcareous; clear wavy boundary.

20 – 60 cm 7.5YR 4/3 (moist); clay; moderate fine and medium subangular blocky structure; friable (moist), sticky (wet), plastic (wet), few fine and very fine pores, very few faint clay no specific location very few fine irregular soft manganiferous soft segregation; few fine roots; non calcareous; clear wavy boundary.

60-110 cm 7.5YR 4/4 (moist); clay; weak fine subangular blocky structure; friable (moist), sticky (wet), plastic (wet), very few very fine pores, few faint clay no specific locations; common medium irregular soft manganiferous soft segregation; non calcareous; gradual wavy boundary.

110-200 cm 7.5 YR 4/6 (moist); clay; weak fine subangular blocky structure; friable (moist), sticky (wet), plastic (wet), very few very fine pores, few distinct clay no specific locations; many coarse irregular soft manganiferous soft segregation; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC018 **Mapping Unit**: 8 **Status**:

Sheet/Grid: NC36-4/ **Coord**: N 11-20-12 E035-44-22

Location:

Survey Area: Dangur **Elevation**: 840 m

Author(s): Solomon Mengistu **Date**: 02/08/97

Classification FAO: Chromic Luvisols (1988)
ST:

Soil Climate:

Topography: 15-30% hilly **Land Form**: Valley

Element/Pos.: Bottom (flat) **Slope**: 2-5%

Micro Top: Termite mounds

Land Use: Animal husbandry - **Crops**: Sorghum **Human Infl**: Vegetation disturbed

Vegetation: Evergreen woodland **Grass Cover**:

Species:

Parent Materials: Alluvial deposit over organic deposits

Eff. Soil Depth: > 150cm

Rock Outcrops: Nil

Surface Stones: Nil

Erosion: Slight sheet erosion **Sealing/Crusting**: Nil

Surface cracks: Fine (< 1cm) **Crack distance**: Wide (2-5m)

Drainage: ; Permeability: mod. well drain.; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0 – 25, slightly moist 25-100, moist 100 – 180 cm

Remarks: Below 180cm it is impossible to dig because of partially weathered gravels

Samples: A: 0-25 B: 25-100 C: 100-180

0-25 cm 7.5YR 3/2 (dry) and 7.5YR 2.5/2 (moist); clay; hard (dry), friable (moist), non sticky (wet), non plastic (wet), common fine pores, few fine roots; non calcareous; clear smooth boundary.

25 – 100 cm	2.5 YR 3/5 (moist); clay; moderate medium granular structure; firm (moist), slightly sticky (wet), slightly plastic (wet), common medium pores, very few medium rounded hard and soft manganiferous nodules; very few very fine roots; non calcareous; gradual wavy boundary.
100 – 180 cm	5 YR ¾ (moist); clay; strong medium subangular blocky structure; firm (moist), sticky (wet), slightly plastic (wet), few fine pores, few fine enlongated hard and soft manganiferous nodules; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC035 **Mapping Unit**: 14 **Status**:

Sheet/Grid: NC3711/ **Coord**: N 09-41-03 E 039-33-06

Location: 400m N of Ankober road & 500m E of the main road from Debre Birhan to Debre Sina

Survey Area: Debre Birhan **Elevation**: 2790

Author(s): Solomon dagnachew **Date**: 01-11/96

Classification FAO: Eutric Vertisols (1988)
ST:
Soil Climate:

Topography: 0.5-2% almost flat **Land Form**: Plain

Element/Pos.: Lower slope **Slope**: 0-2%

Micro Top: No microrelief

Land Use: Animal husbandry **Human Infl**: Vegetation disturbed

Vegetation: No vegetation **Grass Cover**:

Species:

Parent Materials: Alluvial deposit over colluvium

Eff. Soil Depth: > 150 cm

Rock Outcrops: Nil

Surface Stones: Nil

Erosion: Nil **Sealing/Crusting**: Nil

Drainage: ; Permeability: imper. Drained; external drainage: ponded

Watertable: Not available

Flooding: Nil

Moist Cond: Slightly most 0-25, moist 25-200cm

Remarks: The area is a modern ranch (sheep grazing land) since the establishment of the Debre Birhan wool factory.

Samples: A: 0-25 B: 25-40 C: 40-85 D: 150-200

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0 – 25 cm 10YR 3/2 (moist); common fine distinct mottles; clay; weak to moderate fine and medium subangular blocky structure; friable (moist), sticky (wet), plastic (wet), many fine and very fine pores, many fine and very fine roots; non calcareous; clear smooth boundary.

25-40 cm 10YR 3/1.5 (moist); few fine distinct mottles; clay; weak to moderate medium angular blocky and weak to moderate medium subangular blocky structure; firm (moist), very sticky (wet), very plastic (wet), few fine pores, very few faint slickensides on pedfaces; very few fine rounded hard and soft manganiferous nodules; many fine roots; non calcareous; clear smooth boundary.

40-85 cm	10YR 3.5/1 (moist); V. few faint mottles; clay; moderate medium angular blocky and moderate medium subangular blocky structure; firm (moist), very sticky (wet), very plastic (wet), few fine pores, common prominent slickensides on pedfaces; few fine rounded hard and soft manganiferous nodules; few fine roots; non calcareous; clear smooth boundary.
85-150 cm	10YR 4/2 (moist); common fine distinct mottles; clay; moderate medium subangular blocky structure; firm (moist), very sticky (wet), very plastic (wet), very plastic (wet), few fine pores, common prominent slickensides on pedfaces; common fine rounded hard and soft manganiferous nodules; few fine roots; non calcareous; abrupt smooth boundary.
150-200 cm	10YR 6/6 (moist); clay; moderate fine and medium subangular blocky structure; firm (moist), very sticky (wet), very plastic (wet), common fine pores, few fine rounded soft manganiferous nodules; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC036 **Mapping Unit**: 14 **Status**:

Sheet/Grid: NC37-3/

Location: 8.7 km north of Ajibar..

Survey Area: Tenta **Elevation**: 2980 m

Author(s): Dawit Abebe **Date**: 21/02/96

Classification FAO: Eutric Vertisols (1988)
ST:
Soil Climate:

Topography: 5-10% undulating **Land Form**: Valley

Element/Pos.: Lower slope **Slope**: 5-10%

Micro Top: No vegetation

Land Use: Rainfed arable cultivation -**Crops**: Barely, Wheat **Human Infl**: Plouging

Vegetation: No vegetation **Grass Cover**:

Species:

Parent Materials: In situ weathered

Eff. Soil Depth: 100-150 cm

Rock Outcrops: nil -

Surface Stones: Few stones

Erosion: Slight rill erosion and slight sheet erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: imper. Drained; external drainage: slow

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0-20, slightly moist 20-80, moist 80-140 cm

Remarks:

Samples: A: 0-20 B: 20-80 C: 80-140

0-20 cm 10YR 4/2 (dry) and 10YR 3/3 (moist); clay; strong fine and medium angular blocky structure; hard (dry), very firm (moist), sticky (wet), plastic (wet), common fine pores, very few very fine rounded hard and soft manganiferous nodules; common fine-medium roots; non calcareous; clear smooth boundary.

20-80 cm 10YR 2/1 (moist); clay; strong fine and medium angular blocky structure; very firm (moist), very sticky (wet), very plastic (wet), few very fine pores, many distinct partly intersecting slickenside very few fine

rounded hard and soft manganiferous nodules; very few fine and very fien roots; non calcareous; clear wavy boundary.

80-140 cm 10YR 3/1 (moist), clay; moderate fine and medium angular blocky structure; friable (moist), very sticky (wet), very plastic (wet), common fine-medium pores, few distinct partly intersecting slick very few very fine rounded hard and soft manganiferous nodules; very fien roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC037 **Mapping Unit**: 14 **Status**:

Sheet/Grid: NC3711/

Location: 15m west of Chacha river ..

Survey Area: Chacha **Elevation**: 2800 m

Author(s): Alemayehu Tafesse **Date**: 26/10/95

Classification FAO: Eutric Vertisols (1988)
ST:
Soil Climate:

Topography: 2-5% gen. undulating **Land Form**: Plain

Element/Pos.: Bottom (flat) **Slope**: 2-5%

Micro Top: Animal tracks

Land Use: Rainfed arable cultivation - **Crops**: Barley, Wheat **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: Alluvial deposit over colluvium

Eff. Soil Depth: > 150 cm

Rock Outcrops: Few 20-50m apart,

Surface Stones: Few stones

Erosion: Slight sheet erosion **Sealing/Crusting**: Nil

Drainage: ; Permeability: moderate; external drainage: slow **Crack distance**:

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0-13, slightly moist 13-50, moist 50-175cm

Remarks:

Samples: A: 0-13 B: 13-50 C: 5-77 D: 77-132 E: 132-175

0-13 cm 10YR 4/2 (dry) and 10YR 2/2 (moist); clay; moderate fine and medium subangular blocky and moderate fine and medium angular blocky structure; hard (dry), friable to firm (moist), slightly sticky (wet), slightly plastic (wet), many medium pores, many very fine roots; clear smooth boundary.

13-50 cm 10YR 3/1 (moist); clay; strong coarse prismatic structure; extremely hard (dry), extremely firm (moist) very sticky (wet), very plastic (wet), few fine pores, common distinct clay on pedfaces; few very fne rounded hard and soft manganiferous nodules; few medium roots; clear wavy boundary.

50-77 cm 10YR 4/2 (moist); clay; moderate medium and coarse subangular blocky and moderate medium and coarse angular blocky structure; friable to firm (moist), very sticky (wet), very plastic (wet, few fine pores, many distinct intersecting slickensides on pedfaces; few medium rounded hard and soft manganiferous nodules; very few fine roots; diffuse smooth boundary.

77-132 cm 10YR 4/2 (moist); clay; moderate medium subangular blocky and moderate medium angular blocky structure; friable (moist), very sticky (wet), very plastic (wet), very few fine pores, common distinct clay on pedfaces; few rounded soft manganiferous nodules; diffuse smooth boundary.

132-175 cm 10YR 4/2 (moist); clay; moderate medium subangular blocky and moderate medium angular blocky structure; firm (moist), very sticky (wet), very plastic (wet), common distinct intersecting slickenside on pedfaces; few medium rounded soft manganiferous nodules;

SOIL PROFILE DESCRIPTION **Profile**: REC008 **Mapping Unit**: 22 **Status**:

Sheet/Grid: NC37-6/

Location: 14km NW of Alem Ketema

Survey Area: Laybet **Elevation**: 1590 m

Author(s): Dawit Abebe **Date**: 20/09/97

Classification FAO: Haplic Arenosols (1988)
ST:
Soil Climate:

Topography: 15-30% hill **Land Form**: Hill

Element/Pos.: Middle slope **Slope**: 15-30%

Micro Top: No microrelief

Land Use: None **Human Infl**: Clearing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: In situ weathered over colluvium

Eff. Soil Depth: 25-50cm

Rock Outcrops: Nil

Surface Stones: Abundant

Erosion: Slight rill erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: mod. Well drain.; external drainage: rapid

Watertable: Not available

Flooding: Annually

Moist Cond: dry 0-45 cm

Remarks: Below 45 cm th profile is covered with tones and gravels together with weathered materials

Samples: A: 0-45

0- 45 cm 10YR 4.5/4 (dry) and 10YR 4/3 (moist); loamy sand; weak fine & very fien subangular blocky structure; soft (dry), very friable (moist), non sticky (wet), slightly plastic (wet), common very fine pores, many fine-medium roots; non calcareous; clear wavy boundary.

SOIL PROFILE DESCRIPTION **Profile**: REC007 **Mapping Unit**: 22 **Status**:

Sheet/Grid: NC37-6/

Location: 26m NW from Alem Ketema.

Survey Area: Meda **Elevation**: 1880 m

Author(s): Dawit Abebe **Date**: / /

Classification FAO: Haplic Arenosols (1988)
ST:
Soil Climate:

Topography: 10-15% rolling **Land Form**: Plateau

Element/Pos.: Middle slope **Slope**: 10-15

Micro Top:

Land Use: Rainfed arable cultivation - **Crops**: Sorghum **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: in situ weathered

Eff. Soil Depth: 50-100 cm

Rock Outcrops: Nil

Surface Stones: Abundant

Erosion: Moderate sheet erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: mod. Well drain. ; external drainage: rapid

Watertable: Not available

Flooding: Annually

Moist Cond: Dry 0 – 70 cm

Remarks: Below 70 cm the horizon is covered with stones, gravels and mixed weathered material

Samples: A: 0 – 70

0-70 cm 10YR 4/4 (dry) and 10YR 4/3 (moist); loamy sand; weak fine and medium subangular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), slightly plastic (wet), few very fine pores, very few coarse roots; non calcareous; clear wavy boundary.

SOIL PROFILE DESCRIPTION **Profile**: REC012 **Mapping Unit**: 27 **Status**:

Sheet/Grid: NC37-3/

Location: 5 km north of Mesha

Survey Area: Tenta **Elevation**: 2940 m

Author(s): Dawit Abebe **Date**: 21/02/97

Classification FAO: Eutric Cambisols (1988)
ST:
Soil Climate:

Topography: 5-10% undulating **Land Form**: Valley

Element/Pos.: Lower slope **Slope**: 5-10%

Micro Top: No microrelief

Land Use: Rainfed arable cultivation - **Crops**: Barley, wheat **Human Infl**: Ploughing

Vegetation: **Grass Cover**:

Species:

Parent Materials: In situ weathered

Eff. Soil Depth: > 150 cm

Rock Outcrops: Few – 20-50m apart,

Surface Stones: Few medium gravel

Erosion: Slight gully erosion **Sealing/Crusting**: Nil

Surface Cracks: Medium (1-2cm) **Crack distance**: Moderaate (0.5-2)

Drainage: ; permeability: mod. Well drain. ; external drainage: slow

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0-20, slightly moist 20-70, moist 70-150 cm

Remarks:

Samples: A: 0-20 B: 20-70 C: 70-150

0-20 cm 7.5YR 4/2 (dry) and 7.5YR 3/2 (moist); clayloam; weak fine and medium angular blocky structure; hard (dry), friable (moist), slightly sticky (wet), slightly plastic (wet), common fin-medium pores, many fine and very fine roots; non calcareous; abrupt wavy boundary.

20-70 cm 7.5YR 3/2 (moist); common medium distinct mottles; clay; moderate medium and coarse angular blocky and moderate medium and coarse subangular blocky structure; sticky (wet), plastic (wet), common fine-medium

pores, few fine rounded hard and soft manganiferous nodules; many fine and very fine roots; non calcareous; abrupt wavy boundary.

70-150 cm 7.5YR 3/2 (moist); few medium distinct mottles; clay; moderate fine and medium angular blocky structure; sticky (wet), plastic (wet), few fine pores, few fine irregular hard and soft manganiferous nodules; very few very fine roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC006 **Mapping Unit**: 28 **Status**:

Sheet/Grid: NC3710/

Location: About 10K south of Yejube

Survey Area: Yejube **Elevation**: 1600 m

Author(s): Eshetu Demisse **Date**: 16/08/97

Classification FAO: Rendzic Leptosols (1988)
ST:
Soil Climate:

Topography: 10-15% rolling **Landform**: Valley

Element/Pos.: Lower slope **Slope**: 10-15

Micro Top:

Land Use: Rainfed arable cultivation -**Crops**: Maize & sorghum **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: Colluvium

Eff. Soil Depth: 0-25cm

Rock Outcrops: Nil

Surface Stones: Many stones

Erosion: Sever sheet erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: well drained; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0- 20 cm

Remarks: Stopped by stones after 20cm.

Samples: A: 0-20

0- 20 cm 10 YR 4/3 (dry) and 10YR 3/3 (moist); loam; slightly hard (dry), non sticky (wet), non plastic (wet), strongly calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC016 **Mapping Unit**: 32 **Status**:

Sheet/Grid: NC37-2/

Location: 1 Km SW Ofmentol deffer

Survey Area: Jaro-Gedo **Elevation**: 2880 m

Author(s): Endale Werkeyle **Date**: 01/02/97

Classification FAO: Haplic Luvisols (1988)
ST:

Soil Climate:

Topography: 5-10% undulating **Land Form**: Upland alluvial

Element/Pos.: Middle slope **Slope**: 5-10%

Micro Top: No micro relief

Land Use: Rainfed arable cultivation - **Crops**: barley, wheat **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: Colluvium

Eff. Soil Depth: > 150 cm

Rock Outcrops: Nil

Surface Stones: Nil

Erosion: Moderate sheet and rill erosion **Sealing/Crusting**: Nil

Surface Cracks: Fine (< 1 cm) **Crack distance**: Very close (< 0.2 m)

Drainage: ; Permeability: well drained; external drainage: moderate

Water table: Not available

Flooding: Nil

Moist Cond: Slightly most 0-30, moist 30 – 200cm

Remarks: There are Regosols near the site

Samples: A: 0-30 B: 30-95 C: 95-150 D: 150-200

0 – 30 cm 7.5YR 4/3 (moist); clay; moderate medium sub angular blocky structure; friable (moist), slightly sticky (wet), slightly plastic (wet), common fine-medium pores, common fine-medium roots; non calcareous; clear smooth boundary.

30-95 cm 7.5YR 3/3 (moist); clay; moderate medium sub angular blocky structure; friable to firm (moist), sticky (wet), plastic (wet), common fine medium pores, very few faint clay; common fine roots; non calcareous; clear smooth boundary.

95-150 cm 7.5YR 3/6 (moist); clay; moderate to strong medium sub angular blocky structure; firm (moist), sticky (wet), plastic (wet), common fine-medium pores, very few faint clay; common fine roots; non calcareous; clear smooth boundary.

150- 200 cm 7.5YR 2.5/2 (moist); clay; moderate to strong medium and coarse sub angular and angular blocky structure; firm (moist), sticky (wet), plastic (wet), few fine pores, common distinct clay; few fine rounded hard manganiferous nodules; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC010 **Mapping Unit**: 35 **Status**:

Sheet/Grid: NC37-3/1139C2

Location: 600m east of Kundi School

Survey Area: Kuta Ber **Elevation**: 2380 m

Author(s): Shimeles Damene **Date**: 27/10/96

Classification FAO: Eutric Regosols (1988)
ST:
Soil Climate:

Topography: 15-30% hilly **Land Form**: Mountain

Element/Pos.: Lower slope **Slope**: 15-30%

Micro Top: Terracettes

Land Use: Rainfed arable cultivation - **Crops**: Sorghum **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: Colluvium over in situ weathered – derived from basic igneous/metamorphic

Eff. Soil Depth: 50-100 cm

Rock Outcrops: few 20-50m apart,

Surface Stones: Abundant medium gravel

Erosion: Slight sheet erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: mod. Well drain.; external drainage: rapid

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0-15, moist 15-55 cm

Remarks: Below the second horizon the profile is full of colluvated conglorometric material

Samples: A: 0-15 B: 15-55

0 – 15 cm 10YR 3/4 (dry) and 10YR 3/3 (moist); clay; moderate medium and coarse angular blocky structure; hard (dry), friable (moist), sticky (wet), plastic (wet), many fine and very fine pores, very few medium rounded hard carbonates concretions; few fine and very fine roots; non calcareous; gradual smooth boundary.

15 – 55 cm 10YR 3/2 (moist); clay; strong medium prismatic structure; friable (moist), sticky (wet), plastic (wet), few fine and very fine pores, few distinct slickensides on pedfaces; common medium rounded hard carbonates concretions; very few very fine roots; strongly calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC001 **Mapping Unit**: 37 **Status**:

Sheet/Grid: NC37-3/1139C2 **Coord**: N 11-20-31 E 039-25-33

Location: 600m West of Meswelu School

Survey Area: Kuta Ber **Elevation**: 2880 m

Author(s): Solomon Mengistu **Date**: 27/10/96

Classification FAO: Eutric Leptosols (1988)
ST:
Soil Climate:

Topography: > 30% steeply Dissected **Land Form**: Mountain

Element/Pos.: Crest **Slope**: > 60%

Micro Top: Terracettes

Land Use: Annual field cropping- **Crops**: Barley, tea **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: In situ weathered over colluvium

Eff. Soil Depth: 25-50 cm

Rock Outcrops: Abundant - < 2 m apart,

Surface Stones: Abundant medium gravel

Erosion: Slight sheet erosion **Sealing/Crusting**: Nil

Drainage: ; Permeability: mod. Well drain.; external drainage: rapid

Watertable: Not available

Flooding: Nil

Moist Cond: Slightly moist 0-20, moist 20 – 50 cm

Remarks: The site is on the top of the mountain having a number of natural terraces

Samples: A: 0 – 20

0 – 20 cm 10YR 3/1 (moist); v. few v. few faint mottles; clay; strong medium subangular blocky structure; firm (moist), sticky (wet), plastic (wet), common medium pores, common fine and very fine roots; non calcareous; clear smooth boundary.

20 – 50 cm clay; firm (moist), sticky (wet), plastic (wet), few fine pores, very few very fine rounded soft manganiferous; very few fine and very fine roots; non calcareous;

SOIL PROFILE DESCRIPTION **Profile**: REC004 **Mapping Unit**: 37 **Status**:

Sheet/Grid: ND3714/

Location: 3.5km SW of Addis Zemen town

Survey Area: Libo-Kemkem **Elevation**: 1920 m

Author(s): Getachew Kebede **Date**: 25/02/97

Classification FAO: Eutric Leptosols (1988)
ST:
Soil Climate:

Topography: 15-30% hilly **Land Form**: Hill

Element/Pos.: Lower slope **Slope**: 10-15

Micro Top:

Land Use: Rainfed arable cultivation **Human Infl**: Ploughing

Vegetation: Evergreen shrub **Grass Cover**:

Species:

Parent Materials: Coluvium

Eff. Soil Depth: 25-50cm

Rock Outcrops: Common -

Surface Stones: Many stones

Erosion: Sever sheet erosion **Sealing/Crusting**: Nil

Drainage: ; Permeability: well drained; external drainage: rapid

Watertable: Not available

Flooding: Nil

Moist Cond: Dry 0-30 cm

Remarks: The surrounding area (lower slope) are vertisols.

Samples: A: 0 – 30

0- 30 cm 10YR 4/3 (dry) and 10YR 3.5/3 (moist); clay; weak fine and medium subangular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), slightly plastic (we), few fine pores, few fine-medium roots; non calcareous; clear smooth boundary**.**

SOIL PROFILE DESCRIPTION **Profile**: REC011 **Mapping Unit**:75 **Status**:

Sheet/Grid: NC37-2/ **Coord**: N 11-35-26 E 038- 55-18

Location: 5 km south of Kone town

Survey Area: Meret **Elevation**: 3070 m

Author(s): Eshetu Demisse **Date**: 06/02/97

Classification FAO: Eutric Regosols (1988)
ST:
Soil Climate:

Topography: 5-10% undulating **Land Form**: Upland alluvial

Element/Pos.: Middle slope **Slope**: 5-10%

Micro Top: No microrelief

Land Use: Rainfed arable cultivation - **Crops**: Wheat **Human Infl**: Ploughing

Vegetation: Scattered trees/shrubs **Grass Cover**:

Species:

Parent Materials: Colluvium

Eff. Soil Depth: 0-25cm

Rock Outcrops: Few 2-5 m apart

Surface Stones: Common coarse gravel

Erosion: Moderate sheet erosion **Sealing/Crusting**: Nil

Drainage: ; permeability: well drained; external drainage: moderate

Watertable: Not available

Flooding: Nil

Moist Cond: Moist 0 – 25 cm

Remarks: There are some Luvisols nearby

Samples: A: 0 - 25

0- 25 cm 7.5YR 4/3 (moist); silt clayloam; weak fine subangular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), slightly plastic (wet), common fine-medium pores, few fine roots; non calcareous; abrupt smooth bundary.

SOIL PROFILE DESCRIPTION **Profile**: REC013 **Mapping Unit**: 99 **Status**:

Sheet/Grid: NC37-7/

Location: 2.5 km West of Kere Gimba school

Survey Area: Tenta **Elevation**: 3320 m

Author(s): Alemayehu Tafesse **Date**: 14/11/96

Classification FAO: Vertic Cambisols (1988)
ST:
Soil Climate:

Topography: 2-5% gen. undulating **Land Form**: Plain

Element/Pos.: Lower slope **Slope**: 2-5%

Micro Top: Animal burrows

Land Use: Animal husbandry - **Crops**: Barley **Human Infl**: Ploughing

Vegetation: Grassland **Grass Cover**:

Species:

Parent Materials: Alluvial deposit over colluvium

Eff. Soil Depth: > 150 cm

Rock Outcrops: Few 5-20m apart,

Surface Stones: Few stones

Erosion: Slight sheet erosion and slight rill erosion **Sealing/Crusting**: Nil

Surface Cracks: Fine **Crack distance**: Moderate (0.5-2)

Drainage: ; external drainage: slow

Watertable: Not available

Flooding: Nil

Moist Cond: dry 0-20, slightly moist 20-70, moist 70 – 150 cm

Remarks: Stopped by stones below 150 cm.

Samples: A: 0 – 20 B: 20 – 70 C: 70 – 150

0- 20 cm 10YR 4/3 (dry) and 10YR 3/3 (moist); silty clayloam; weak to moderate fine and medium subangular blocky structure; soft (dry), very friable (moist), slightly sticky (wet), slightly plastic (wet), many fine-medium pores, many medium-coarse roots; non calcareous; gradual smooth bundary.

20 – 70 cm 10YR 3.5/3 (moist); v. few fine faint mottles; silty clay; weak fine and medium subangular blocky and weak fine and medium granular structure; very friable (moist), sticky (wet), plastic (wet), many medium-

coarse pores, few medium rounded soft manganiferous nodules; few fine-medium roots; non calcareous; gradual smooth boundary.

70 – 150 cm 10YR ¾ (moist); few fine faint mottles; clay; weak medium subangular blocky structure; friable to firm (moist), sticky (wet), plastic (wet), few medium pores, very few faint clay on pedfaces; common medium rounded soft manganiferous nodules; non calcareous;

This soil unit is dominant in the Gimbi plain. It is young with weakly developed structures and vertic prope rties.

SOIL PROFILE DESCRIPTION **Profile**: MK 14 **Mapping unit No:** **Status**: CSc Pol:

Classification FAO: 1988: Cambisol **Phase**:
FAO 1974: **Date**: 11/12/95

Location: Agbe-Abiadi Km 4.8; 2 km west of the road

Coordinates: 1496995 N, 502900 E

Elevation: 1680 m **Agro Clim. Zone**: WD1

Land Form: Plain

Regional Slope: Flat to Undulating

Slope Class: Very gently sloping **Slope length**: 400m

Slope Form: Uniform **Position**: Middle

Local surf. form: **Height**: 1.5m

Coverage: 5%

Parent material: Alluvial deposits over (weathered) rock derived from sandstone

Eff. Soil Depth: Very deep **Depth to bedrock**: 2.00m

Rock Outcrops: None

Surf. Coarse fragm: Common stone

Sealing: None **Cracks**: None

Drainage Class: Somewhat excessively drained **External Drainage**: Rapid

Water Table: Not observed **Flooding**: None

Human Influence:

Land Cover: Cultivated land/annual crops **Crops**: Teff

Land Use: Rainfed agriculture/Extensive grazing on fallow and stubble land

Fertilizers:

Remarks:
- At 200 cm depth rounded boulders and sandstone
- Many scattered termite mounds
- Many scattered bushes at the surrounding site
- Wide river bank, deposition on left bank of the river

1 0-15 cm 10YR3 /3 (moist) Loamy sand; non-calcareous;

2 15-60cm 7.5YR2.5 /3 (moist) sandy loam; non-calcareous;

3 60-145 cm 7.5YR3 /2 (moist) sandy loam; few, stones; non-calcareous;

4 145-200 cm 7.5YR3 /2 (moist) sandy clay loam; non-calcareous;

SOIL PROFILE DESCRIPTION **Profile**: AX38 **Mapping unit No:** **Status**: PSc

Classification FAO: 1988: Cambisols **Phase**:
FAO 1974: **Date**: 22/10/96

Location: Adi Abun – Adigrat, 5km; 1 km East of the main road

Coordinates: 1570629 N, 491044 E

Elevation: 1950 m **Agro Clim. Zone**: WD1

Land Form: Rolling plain

Regional Slope: Rolling

Slope Class: Strongly sloping **Slope length**: 2000m

Slope Form: Irregular **Position**: Middle

Local surf. form: **Height**:

Coverage: **Dissection**: Dissected

Parent material: Alluvial/colluvial deposits over (weathered) rock derived from Slate/Phyllite

Eff. Soil Depth: Very deep **Depth to bedrock**: 1.60m

Rock Outcrops: Few

Surf. Coarse fragm: Few fine/coarse gravel

Sealing: None **Cracks**: Fine

Drainage Class: Moderately well drained **External Drainage**: Well

Water Table: Not observed **Flooding**: None

Human Influence: Plouging or raised beds

Land Cover: Cultivated land/annual crops **Crops**: Teff/Sorghum

Land Use: Painfed agriculture

Fertilizers:

Remarks: The area is extensively cultivated.

1AP	0-25 cm	10YR 4 /4 (moist) sandy clay loam; no mottles; weak, fine and medium, Sub Angular blocky structure; slightly hard, friable, slightly sticky, non plastic, no fine/coarse gravel and few, stones; non-cemented and non-compacted; no fine and common medium roots; few termite of ant channels and nests; common and medium pores; non-calcareous; pH:5.0; clear boundary.
2	25-55 cm	10YR4 /4 (moist) sandy loam; no mottles; weak, medium, subanglar blocky structure; slightly hard, very friable, non sticky, non plastic; no cutans; many fine/coarse gravel and common, stones; non-cemented and non-compacted; common fine and common medium roots;

		common termite or ant channels and few fine and few medium coarse pores; non-calcareous; pH:5.0; clear boundary.
3	55-115 cm	10YR4 /6 (moist) silty clay loam; common, yellowish brown mottles; moderate sub angular blocky structure; slightly hard, friable, sticky, slightly no cutans; common, fine/coarse gravel and few, stones; non-cemented and non compacted nodules; few fine roots; common termite or ant channels and nests; common many fine pores; non-calcareous; pH: 5.0; clear boundary.
4	115-160 cm	10YR 3 /4 (moist) loamy sand; few, yellowish brown mottles; moderate, sub angular blocky structure; slightly hard, friable, non sticky, non plastic cutans; few, fine/coarse gravel and few, stones; non-cemented and non nodules; very few fine roots; common termite or ant channels and nests; common medium and few coarse pores; non-calcareous; pH:5.0.

Profile Number: YK 113

Mapping unit: 9

Date: 16/01/89

Slope: 1%

Location: 4km NW of Kusaye Village

Elevation: 1720 masl

Soil Series Name: Haro Arba Series

Variant/Phase:

SOIL CLASSIFICATION

FAO: Calcaric Cambisols

USDA: Fluventic Ustropepts

Land Form: Nearly Flat Plain

Physiography: Middle part of plain

Parent Material: Volcano-Lacusirine

Rockiness/Stoniness

Vegetation/land use: Cultivation of teff, maize and sufflower

Drainage: Well drained

Erosion: Slight sheet at surrounding

Flooding/Ponding:

Ap 0-20 cm dark grayish brown (10 YR 4/2, dry) very dark grayish brown to dark brown (10 YR 3/2.5, moist); silt clay loam; strong coarse subangular blocky; very hard (dry), friable (moist), slightly sticky and slightly plastic (wet); slightly calcareous; many fine pores; common fien roots; clear and smoth boundary.

A1 20-45cm very dark grayish brown to very dark brown (10 YR 2.5/2, moist); silt loam; moderate fine to medium subangular blocky; friable (moist); slightly sticky and slightly plastic (wet); moderately calcareous; common fine pores; few fine roots; gradual and smooth boundary.

Ak 45-90 cm black (10YR 2/1, moist); silt loam; moderate fine to medium subangular blocky; friable (moist), sticky and plastic (wet); strongly calcareous; few fine to medium pores; very few fine roots; abrupt and smooth boundary.

Bk 90-150 cm dark brown (10 YR 3/3, moist); silt; moderate medium subangular blocky; friable (moist), sticky and plastic (wet); highly calcareous many fine to medium pores; very few fine roots.

Profile Number: YK289

Mapping unit: 16

Date: 07/03/89

Slope: 1-2%

Location: Wegere Village

Elevation: 1460 masl

Soil Series Name: Welenchiti Series

Variant/Phase: Sodic Phase

SOIL CLASSIFICATION

FAO: Luvic Calcisols

USDA: Ultic Haplustalfs

Land Form: Nearly Level Rift Valley Plain

Physiography: Level Plain

Parent Material: (Alluvium) Tuffs and Ignimbrites

Rockiness/Stoniness:

Vegetation/land use: Cultivation of teff, wheat and sorghum

Drainage: Well drained

Erosion:

Flooding/Ponding:

PROFILE DESCRIPTION:

Ap 0-30 cm. Very dark grayish brown (10YR 3/2, dry) very dark grayish brown to very dark brown (10 YR 2.5/2, moist); loam; strong coarse angular blocky and strong medium subangular blocky; hard (dry), friable (moist), sticky and plastic 9wet); few fine pores; common fine roots; clear and smooth boundary.

AB(N) 30 – 78 cm. Very dark grayish brown to dark brown (10YR 3/2.5, moist); clay; strong coarse prismatic and columnar; hard (dry), friable (moist), sticky and plastic (wet); slightly calcareous; few fine pores; few fine roots; clar and smooth boundary.

Btk (N) 78 – 130 cm. Dark yellowish brown (10YR ¼, moist); clay; moderate medium

Profile Number: YK 285

Mapping unit: 55

Date: 04/02/89

Slope: 1-2%

Location:

Elevation: 1700 masl

Soil Series Name: Nazret Series

Variant/Phase: Moderately deep ashy over cindery variant

SOIL CLASSIFICATION

FAO: Vitric Andosols

USDA: Mollic Vitrandepts

Land Form: Nearly Level Rift Valley Plain

Physiography: Nearly Level Plain

Parent Material: Pumice Gravels

Rockiness/Stoniness:

Vegetation/land use: Cultivation of teff, wheat, maize and acacia tree

Drainage: Well drained

Erosion:Moderate Gullying at site, slight gullying surrounding

FLOODING/PONDING:

PROFILE DESCRIPTION:

Ap 0 – 10 cm Brown (10YR 5/3, dry) dark brown (10 YR 3/3, moist); loam; moderate medium crumb and subangular blocky; slightly hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many medium pores; many fine to medium roots; gradual and smooth boundary.

A11 10 – 52 cm. Brown to dark brown (10 YR 4/3, dry), dark brown (10YR 3/3, moist); loam; moderate medium crumb and subangular blocky; slightly hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many medium to coarse pores; many fine to medium roots; gradual; and smooth boundary.

Ab 52-90 cm. Grayish brown to dark grayish (10YR 4.5/3, dry), dark brown (10 YR 3/3, moist), loam; moderate medium to coarse subangular blocky; slightly hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many medium to coarse pores; many fine to medium roots; gradual and smooth boundary.

Ab 52-90 cm Grayish brown to dark grayish (10 YR 4.5/3, dry), dark brown (10YR 3/3, moist), loam; moderate medium to coarse subangular blocky; slightly hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many medium to coarse pores; many fine to medium roots; gradual and smooth boundary.

C 90 – 120 cm. Pumice layer

2AB 120-170 cm. Dark grayish brown (10 YR 4/2, dry), black (10 YR 2/1, moist); loam; moderate medium angular blocky; hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many fine to medium pores; common fine roots; clear and smooth boundary.

"E" 170-182 cm. Grayish brown to dark grayish brown (10YR 4.5/2, dry), very dark grayish brown (10YR 3/2, moist); fine sandy clay loam; moderate medium to coarse subangular blocky; hard (dry), friable (moist), slightly sticky and slightly plastic (wet); many fine to medium pores; few fine roots; gradual and smooth boundary.

3AB 182-220 cm. Very dark grayish brown (10YR 3/2, moist); clay; moderate medium prismatic and columnar; hard (dry), friable (moist), sticky and plastic (wet); slightly calcareous; few fine pores; few fine roots.

Profile Number: YK 315

Mapping unit: 63

Date: 22/02/89

Slope: 32%

Location: 1.3 km. South of Nazret Radio Tower

Elevation: 1820 masl

Soil Series Name: Kechema Series

Variant/Phase: Rudic Phase

SOIL CLASSIFICATION

FAO: Rendzic Leptosols

USDA: Typic Rendolls

Land Form: Rocky, Steep Side Slopes

Physiography: Middle part of steep ridge

Parent Material: Basalt

Rockiness/Stoniness:

Vegetation/Land Use: Bush and grass land

Drainage: Somewhat excessively drained

Erosion: Strong sheet and gully both at site and surrounding

Flooding/Ponding:

PROFILE DESCRIPTION:

Ap 0-25 cm. Dark reddish brown (5YR 3/2, dry and moist); clay; moderate fine subangular blocky; hard (dry), friable (moist), slightly sticky and slightly plastic (wet); moderately calcareous; common fine and slightly sticky and slightly plastic (wet); moderately calcareous; common fine pores; few fine roots; gradual and smooth boundary.

ABk 25-65 cm. Yellowish red (5 YR 5/6) dry and (5 YR 4/6) moist; silty clay loam; moderate fine crumb slightly hard (dry); friable (moist), slightly sticky and slightly plastic (wet); strongly calcareous; common few fine and very fire pores; very few fine roots; gradual and smooth boundary.

Ck 65-150 cm. Reddish brown to yellowish red (75 YR 4/5, dry yellowish red (7.5 YR 4/4) moist; friable (moist), slightly gravelly clay; sticky and slightly plastic (wet); highly calcareous; many fine to medium pores.

Profile Number: YK 299

Mapping unit: 70

Date: 09/03/89

Slope: 2-3%

Location: + 1.5 Km East of Arerti Village

Elevation: 1760 masl

Soil Series Name: Wedecha Series

Variant/Phase: Dystric Variant

SOIL CLASSIFICATION

FAO: Dystric Vertisols

USDA: Udic Chromusterts

Land Form: Undulating Rift Valey; Valley Floor

Physiography: Middle part of slope

Parent Material: Alluvium

Rockiness/Stoniness:

Vegetation/land use: Intensively cultivated to Teff, Wheat, Barely and Sorghum

Drainage: Moderately well to well drained

Erosion:

Flooding/Ponding:

PROFILE DESCRIPTION:

A1 – 23-65 cm. Very dark grayish brown (10 YR 3/2) moist; clay; moderate medium to coarse columnen and angular blocky; friable (moist), sticky and plastic (wet); moderately developed slickensides; few fine pores; many fine roots; gradual and smooth boundary

ABk – 65-125 cm. Dark brown (10 YR 3/3) moist; clay; moderate medium to coars subangular blocky and crumb; friable (moist); sticky and plastic (wet); strongly calcareous; thin and patchy cutans; few fine pores; few fine roots; gradual and wavy boundary.

AB2 – 125-165+ c. Very dark grayish brown (10 YR 3/2) moist; clay; moderate medium angular blocky; friable (moist), sticky and plastic (wet); moderately developed slickensides; strongly calcareous; few fine pores; few fine roots.

Profile Number: YK 309

Mapping unit: 72

Date: 18/02/89

Slope: 9%

Location: 5.9 km East of Tede School

Elevation: 1950 masl

Soil Series Name: Senqo Gebeya Series

Variant/Phase: Dystric Variant

SOIL CLASSIFICATION

FAO:Humic Cambisols

USDA: Ustic Dystropepts

Land Form: Rolling

Physiography: Ridge Foot Slope

Parent Material: Ignimbrites

Rockiness/Stoniness:

Vegetation/land use: Eucalyptus Plantation

Drainage: Somewhat excessively drained

Erosion: Moderate Gully both at site and surrounding

Flooding/Ponding:

PROFILE DESCRIPTION:

A1 0-9 cm. Yellowish brown (10 YR 5/4, dry), dark yellowish brown (7.5 YR 4/4, moist); sandy silt loam; moderate coarse platy; hard (dry) firm (moist), slightly sticky and slightly plastic (wet); moderately calcareous; many fien pores; many fien roots, abrupt and smooth boundary.

2AB 9-58 cm. Strong brown (7.5 YR 5/6, dry), dark brown (7.5 YR 4/4, moist); sandy loam; weak coarse subangular blocky; extremely hard (dry), slightly firm (moist), slightly sticky and slightly plastic (wet) slightly calcareous with pseudo-myceium; many fine pores; common fine roots; diffuse boundary.

B1 58-104 cm. Brown (7.5 YR 5/4, dry) dark brown (7.5 YR 4/4, moist); silt loam; weak to moderate coarse subangular blocky; extremely hard (dry), firm (moist), few fine roots; clear and smooth boundary.

BC1 04-150 cm. Strong brown (7.5 YR 4/6, dry), reddish brown (5 YR 4/4, moist); weak medium to coarse angular blocky; extremely hard (dry), firm (moist), slightly sticky and slightly plastic (wet); many manganese nodules; many fine pores; diffuse boundary.

BC2 150-180+cm. Yellowish brown (10YR 5/4, dry) dark yellowish brown (10 YR 4/4, moist); loam; weak medium to coarse angular blocky and subangular blocky; extremely hard (dry), firm (moist), slightly sticky and slightly plastic (wet); many fine pores.

Profile Number: YK 505

Mapping unit: 81

Date: 17/03/89

Slope: 1-2%

Location: Doho RRC Settlement

Elevation:

Soil Series Name: Kesem Series

Variant/Phase: Inundic Aquic Variant Phase

SOIL CLASSIFICATION

FAO:Calcaric Fluvisols

USDA: Aquic Tropofluvents

Land Form: Almost flat plain

Physiography: Middle part of plain

Parent Material: Aluvium

Rockiness/Stoniness:

Vegetation/land use: Intensive Cultivation of Cotton

Drainage: Imperfectly drained

Erosion:

Flooding/Ponding: Flash Floods

PROFILE DESCRIPTION:

Ap 0-21 cm. Very dark grayish brown (10 YR 2.5/2, moist); clay; moderate medium crumb and angular blocky; friable (moist), sticky and plastic (wet); moderately calcareous; many medium and fine pores; common fine and many very fine roots; clear and wavy boundary.

Acg 21-48 cm. Dark grayish brown (10 YR 4/2, dry), very dark gayish brown (10YR 3.5/3, moist); clay; moderate medium crumb and subangular blocky; friable (moist), sticky and plastic (wet); moderately calcareous; few coarse distinct mottles; many fine and medium pores; common fine and many very fine roots; clear and wavy boundary.

2ACg 48-74 cm. Pale brown (10 YR 6/3, dry) dark brown (10 YR 3/3, moist); clay; moderate medium platy and subangular blocky; friable (moist), slightly sticky and slightly plastic (wet); moderately calcareous; few fine distinct motles; many fine and medium pores many very fine roots; clear and smooth boundary.

3AC 74-103 cm. Brown (10YR 5/3, dry), dark brown (10 YR 4/3 moist) clay; moderate medium columnar and plastic (wet); moderately calcareous; many fine and medium pores; common very fine roots; clear and smooth boundary.

C1 103 – 150 cm. Yellowish brown to dark yellowish brown (10 YR 4.5/4, moist); silt loam; moderate medium crumb and platy; very friable (moist); slightly sticky and slightly plastic (wet); strongly calcareous; many fine and medium pores; clear and smooth boundary.

C2 150 – 196 cm. Dark brown (10 YR 3/3, moist); silty clay loam; moderate medium subangular blocky and crumb; very friable (moist), slightly sticky slightly plastic (wet); moderately calcareous; many fine and medium pores; clear and smooth boundary.

C3 196 – 220+ cm. Dark brown (10 YR 3/3, moist); silt loam; 34 weak medium crumb; very friable (moist), non-sticky and non-plastic (wet); slightly calcareous; many fine and medium pores.

Profile Number: YK 153 **Mapping unit**: 83

Date: 25/01/89 **Slope**: 1%

Location: About 0.5 km west of Kusaye Village **Elevation**: 1680 masl

Soil Series Name: Kusaye Series

Variant/Phase: Very high Calcareous Phase

SOIL CLASSIFICATION

FAO: Calcic Solonetzs **USDA**: Mollic Natrustalfs

Land Form: Nearly level to undulating **Physiography**: Middle slope

Parent Material: Volcano-lacustrine **Rockiness/Stoniness**:

Vegetation/land use: Scattered trees, grass and cultivation of teff and maize

Drainage: moderately well drained **Erosion**: Moderate Gully at site and slight gully at surrounding

Flooding/Ponding:

PROFILE DESCRIPTION:

AP 0-20 cm. light brownish gray (10 YR 6/2, dry) very dark grayish brown (10 YR 3/2, moist); silt loam; moderate fine to medium crumb; slightly hard (dry), friable (moist), slightly sticky and slightly plastic (wet); moderately calcareous; many medium to coarse pores; common fine roots; clear and smooth boundary.

ABk 20-62 light brownish grey (2.5 YR 6/2, dry) dark grayish brown (2.5 YR 4/2, moist); clay loam; friable (moist), slightly sticky and slightly plastic (wet); strongly calcareous; many fine to medium pores.

Bt(n)k 62-94 cm light gray (10 YR 7/2, dry) light brownish gray (10 YR 6/2, moist); clay; moderate medium subangular blocky; friable (moist), slightly sticky and slightly plastic (wet); strongly calcareous; common fine pores; few fine roots; clear and irregular boundary.

Btnk 94-130 cm light brownish grey (10 YR 6/2, dry), grayish brown (10 YR 5/2, moist); clay; strong coarse subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); strongly calcareous; few fine pores; very few fine roots; gradual and smooth boundary.

Ck 130-155 cm light gray to gray (5 YR 6/1, dry) light brownish grey (2.5 6/2, moist); silt loam; strongly calcareous.