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ASSISTANCE TO SETTLEMENT

ETHIOPIA

LAND USE PLANNING AND SOIL AND WATER CONSERVATION DEVELOPMENT PLANNING OF HAREWA



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ASSISTANCE TO SETTLEMENT

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Land Use Planning and Soil and Water Conservation Development Planning Of the Harawa

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The Provisional Military Government

of

Socialist Ethiopia

Relief and Rehabilitation Commission United Nations Development Programme Food and Agriculture Organization of The United Nations

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This technical report is one of a series of reports prepared during the course of the FAO/UNDP project (ETH/O2/O12) preparing the Assistance to Settlement Project Phase IV. The conclusions and recommendation give in the report are these considered appropriate at the time of its preparation.

The designations employed and the presentation of the material in this working paper do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. FAD. Assistance to Settlement Project, Ethiopia Land Use Planning and Soil and Water Conservation Development Plans for Harawa. by S.K. Choi. Addis Ababa, 1986. 94 p., 5 tables, 3 figures, supplement including 4 map sheets. AG; DP ETH/82/012, Field Document 1.

ABSTRACT

This report describes the result of detailed survey of Land Use Planning and Soil and Water Conservation of Harawa Settlement Project 20,000 har in Northern Bale Administrative Region). The Land Resources map, present Land use/cover, slope and Erosion classes map and Land suitability classification map at one scale of 1:50,000 and Soil and Water Conservation Development plan at a scale of 1:20,000 (consisting of 6 map sheets and 1 legend sheet) accompanies the report.

The natural resource data and development plan information presented here is based on data collected during field work and the analysis of soil samples and reference of the Technical report 1, 2, 3, 10. Assistance to Land Use Planning Project (ETH/78/003). Aerial Photointerpretation played an important role in locating land resource boundaries and basic studies.

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MAP 4. Development plan map

1. INTRODUCTION

1.1 General

This document with its relevant maps is one of a series of documents prepared during the course of the FAO/UNDP Assistance to Settlement Project ETH/82/012 while pre paring Land Use Planning and Soil and Water Conservation Development Planning and Implementation for three large-scale settlement. Namely; Tedele/Harolo, Harawa and Asosa of the Relief and Rehabilitation Commission (RRC) of Ethiopia.

This document has been presented with the aim of transforming and promoting the selected settlement into sustainable self-reliant through the development of Land suitability classification and Soil and Water Conservation plan based on the FAO methodology for land use planning and soil and water conservation.

With respect to the planning excercise the fundamental requirement and an essential component has been the compilation of a comprehensive land resources of each selected settlement site (please , refer the location map of Harawa settlement site which is presented in figure 1 of this document).

1.2 Methods and Results

In preparing this document on the development plan of Harawa large scale settlement, the methodology for the study of land-use planning and land suitability classification is based on the FAO "Framework for Land Evaluation (FAO 1976) and the Land Evaluation in Rainfed Agriculture (FAO 1983). In addition, the study attained a much broader framework by following the "Soil Conservation and Management in developing countries (FAO 1977) and watershed development with special reference to soil and water conservation (FAO 1979). The land resources basis for land evaluation is treated by consisting a series of thematic maps into Land Resources Map at a scale of 1:50 000 which provides information in an integrated approach on Agro-Climatology, Geomorphology and soils. Thus, the land resources map played an important role in the land resources inventory ranging from providing the necessary data assemblege to integration of data resources for carrying out a land suitability evaluation.

The soil and water conservation development plan prepared at a map scale of 1:20 000 is dealt with especially from the physical and social point of view by recognising the needs and priorities of the settlers and underlining the most suited development options for the settlements.

2. Background Data

2.1 General description

2.1.1 Location

The project area, Harawa covers 20,000 ha with a population of 18,857 persons.

The settlement area is located in the northern part of CINIR town some 17 kms apart and about 500 kms south-east of Addis Ababa in Wabe Awraja, Bale Administrative Region.

2.1.2 PHYSIOGRAPHY

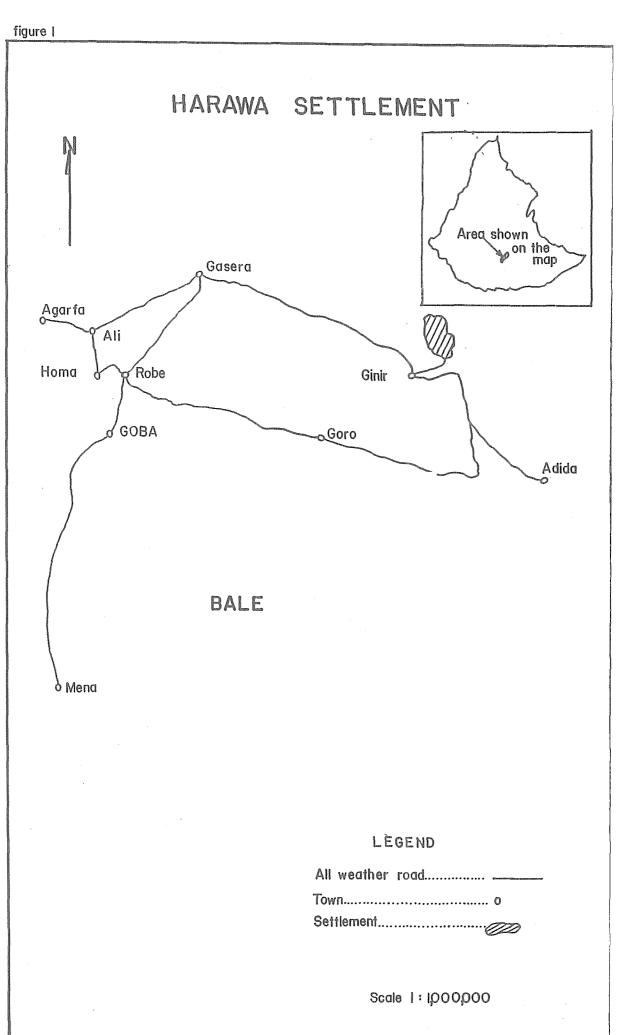
The general landscape of the area consists of an undulating sideslopes and piedmont zones which have been strongly influenced by colluvial processes but there are distinct residual characteristics and high mountainous relief hills whose altitudes increase from 1600 to 2000 meters above sea level.

The plateau of the area is dissected by numerous rivers which are broad and dry valleys flowing through the area.

It is a paramount importance to consider the prevailing situation of water resources development in the project area, i.e. surface water is very limited and the disappointing results of development efforts in underground water were below satisfactory level. Few wells along Elbuso River bed have been drilled.

The underlying geological strata consists of tertiory basalts and tuffs; the soil parent material is shallow colluvium underlain by tertiory basalts and tuffs.

The soils of the project area are dominantly classified as Pellic Vertisols on the undulating sideslopes, piedmont plains and lava plateaux.



The plateau terraces, gentle sideslopes and moderate sideslopes consist of entric mitosols where as steep sideslops and very steep sideslope areas are covered by chronic luvisols at shallower depth.

2.1.3. Climate

The main climatic factor affecting rain-fed agriculture in Harawa is Rainfall and its variation. Other climatic elements hardly vary throughout the area except in the high mountians. According to the climatic data (Refer table 1.) the climate is favourable for rainfed agriculture; as it is characterized by a length of growing period (LGP) of 61 to 150 days. The average annual rainfall is moderate (600-1044 mm). per annum but is not very erratic. The rainfall distribution is basically bi-modal; the main rains are from March to June and the small rains from October to November

The lowest mean monthly temperature varies between 7° C in January to 15° C in July while the highest mean monthly temperature vary between 28° C in February and September to 25° C in March.

2.1.4 Vegetation and Land-Use

Cropping patterns in Harawa and Melka Oda are related to differences in altitude, i.e. differences in temperature and rainfall. Generally, most of the land in thearea of survey which is suitable or only moderate to marginally suitable for cropping is under cultivation. At intermediate altitude (woina dega) there is a wider variety of crops including wheat, teff, sorghum, maize as main crops and sun-flower as secondary crop.

The vegetation on the plateau consists of open woodland savannah with scattered acacia and broad-leaved trees. The steeper areas on the periphery have thicker vegetation consisting mainly of acacia thickets.

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CLIMATIC DATA

Table 1

2.2 Development in the Area

The physical landscape of the area indicates that there is predominance of a flat plain with a slope of between 0-12% in which the present situation has led to carryout large-scale mechanized agricultural settlement.

Accessibility is relatively good to tap basic social and administrative services from the nearest town (17 kms) at Ginir which is also the Awraja capital.

The present number of settlement units in the project area includes two units of Malka Oda and eight units of Harawa following the RRC unit standard settlement pattern which are planned clusters of settlement sites of approximately 500 families each with their own social services and farming blocks.

The present health conditions and implications remains far from satisfactory especially tuberculosis and diarrhaea affects many people in most settlement sites. Malaria is not endemic in the area.

The total heads of families for the ten units is 4,754 The distribution by No. of settlers and land in Harawa settlement project is presented in Table 2.

TABLE 2

Distribution of Settlers and Land HARAWA SETTLEMENT PROJECT

Unit	No. of families Head	Crop	aland	No. of Cropland	Total Ha
1	500	451	1110	1003	2113
2	500	483	888	1126	2014
3	492	438	767	1869	2636
4	490	382	595	1571	2166
5	496	43 6	963	1115	2079
6	491	353	1136	613	1749
7	498	392	856	678	1534
8	483	381	631	550	1181
9	393	306	802	1019	2127
10	411	260	325	1684	2009
Total	4754	3882	8073	11229	19608

* 1986 lst cultivated land

** Total cropland

The way in which the Harawa Settlement scheme is implemented has been made to differ from the RRC Settlement model which is governed by the size of settlement holding of 1250 hectares per unit of 500 family heads. The limitedland suitable for cultivation has led to changes in sizes of the planned holding but still to maintain the same number of settlers which reminds us to make full utilization of available suitable land for crop production and the marginal land desirable to be managed for forestry and grazing. The arable land head of population is 1 ha. and the arable land per family is 4 ha.

2.3 Land Survey

During the field survey an area of some 20 000 ha was surveyed at semi-detailed level by dividing into nine landscape units based on differences in land form, soils, hydrographic pattern, slope, relief and vegetation density. Such survey was shown on maps at scale of 1:50 000 based on an aerial photo mosaic and topographic maps at a scale of 1:50 000. In the survey each unit is evaluated for its current and potential landuse suitability.

3. Land-Use Study

3.1 Methods of Study

3.1.1 Aerial photo interpretation

The method of aerial photo interpretation was used as follows: The photography was flown in January 1972 at approximately 1: 50 000 scale. The API was done with Topcon Mirror Stereoscope with 3 × binocular eyepiece. After scanning the general area and examining stereopairs, an API legend was prepared using data from the field study stage of the survey. The legend was reworked into soils oriented legend. See appendix 1.

The principal points of the aerial photography were marked on the existing mosaic. To identify the same points transparent drafting paper was placed over the mosaic and the principal points were transferred. The flight lines were drawn by joining the points in the flight line. The aerial photos with their delineations were placed under the transparency with flight lines in perfect coincidence and the lines and symbols transferred. Some mosaics were more distorted than others and adjustments had to be made during the transferred to the alternate Acrial Photos not previously marked, so that only information in the centre of aerial photo was used, thus reducing the adjustments in positioning. The scale of the map was calculated from identifiable point on the 1:50 000 scale and an average figure was taken.

3.1.2 Area measurement

Planimeter was used for measuring individual mapping units by adjusting for the appropriate scale. When measuring large areas, the methodology used was to treat area below 15 ha. to the nearest ha and larger areas are rounded of to the nearest mapping units was checked against the whole unit area by considering sinuous riverine forest as the difference between the sum of all other areas and the overall area within the unit boundary and hence includes errors.

According to table 2, nearly 19,608 ha was measured by planimeter. This is roughly 98% of the total area surveyed (20,000 ha).

3.2. Soil Survey and Soil Sampling

Soil survey has been conducted in the study area during 1985. The study was carried out through 40 auger descriptions taken to a depth of 120 cm. The augerings were made with a screw type auger. Land and soil characteristics were recorded on a standard form for auger description which included recordings of physiography, soil surface conditions and soil profile characteristics observed from small natural exposures.

The soil profile and augering description depended on the "Guideline for profile description (FAO-1977) and the Munsell Soil colour charts (1975). All sampling sites surveyed were plotted on APs which were used for base map in the field work.

3.3 Laboratory Methods

3.3.1 General Description

40 representative soil samples were chemically and physically analysed by the soil laboratory of the LLPRD, MOA. Analytical data are presented in the report in Appendix 3.

3.3.2 Methods of Soil Analysis

The soil samples were transported from the soil survey area to the laboratory in polythene bags with proper identification tags.

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- <u>Samples Preparation</u>: The soil samples were air-dried at room temperature by spreading on paper sheets. On drying they were ground in metal mortar and pestle and sieved through a 2 mm sleve.
- Texture: The particle-size distribution was determined by modified Bouyoucos Method. 50 g soil was soaked with 100 ml distilled water for one hour. 60 ml of 9% H₂O₂were added and the contents heated on a hot plate for one hour to destroy the organic matter. Then 2 g of N-hexametaphosphate (calgon) was added and the suspension was transferred to dispersion cup and stirred for five minutes. The suspension was then transferred to the hydrometer jars and volume made to one litre mark. The hydrometer-readings were taken at 40 seconds and 2hours intervals to calculate the silt + clay and clay percentage respectively. Sand percentage was calculated by subtracting silt + clay percentage from 100.
- <u>PH</u>; 20 g soil was treated with 20 ml of water or salt solution (KCl or CaCl for half a day with occasional stirring and the pH was read using standard glass and calomel electrodes.
- Organic Carbon: (Walkley and Black Method) To soil (passing through 0.5 mm sieve) containing 10-25 mg of organic carbon was added 10 ml of <u>N</u> Potassium dichromate and 20 ml of conc. sulphuric acid. After half an hour 200 ml of distilled water, 10 ml of orthophosphoric acid and 0.5 ml of barium diphenylaminsulphonate as indicator were added and titrated with 0.5 <u>N</u> ferrous ammonium sulphate. The percentage of organic matter was calculated from the amount of potassium dichromate used to reduce the organic matter.
- Total Nitrogen: To 1 g soil (passing through 0.15 mm sieve) was added 1 g of catalyst mixture (containing potassium sulphate, copper sulphate and selenium powder in the ratio of 10 4 1) and 6 ml of conc. sulphuric acid in a kjeldahl flask. The contents were digested till clear and cooled. Then transferred to another kjeldahl flask washing with little portions of distilled water (about 60 ml), 20 ml of 40% NaOH added and NH₃ distilled in 10 ml of 0.2 M H₂SO₄. The excess acid was back titrated with 0.1 N NaOH with methyl red as indicator. Percentage of total nitrogen was calculated from the acid used.
- Available phosphorous: To 10 g soil (passing through 1 mm sieve) is added 1 teaspoonful of activated carbon (Darco G60) and 50 ml of Morgan's

extracting solution (10% solution of Na-acetate in 3% acetic acid). The contents were shaken for 30 minutes and filltered. P was determined in 2ml of the extract by adding six dorps of formaldehyde solution, 1 ml of sodium cobaltinitrite and 2 ml of isopropyl alcohol. The turbidity of the samples was compared with the standards.

Exchangeable cations: 5 g of soil (passing through 1 mm sieve) was leached with 150 ml of neutral (pH 7) <u>N</u> NH₄ acetate and made to 250 ml with distilled water. Ca + Ng were determined in 10 ml of the leachate by acidifiying with 0.1N HCl, boiling for a few minutes, complexing Mg with Mg-complexonate, adding 2 ml of 2 % equous solution of KCN and 3 ml of NH₄OH-NH₄Cl buffer. The contents were titrated with 0.02 <u>N</u> disodium salt of EDTA after adding a pinch of Erichrome Black T.

For determination of Ca. a separate 10 ml portion of leachate was titrated with 0.02 M disodium salt of EDTA using a pinch of HHSNN (Paton and Readers reagent) until the color Sources from wine red to blue. Exchangeable Mg was obtained by subtracting exchangeable Ca from exchangeab Ca + Mg.

Exchangeable K and Na were determined by flame photometer using air butane flame.

- Cation Exchange Canacity: The soil previously leached with NH₄-acetate was successively washed with 10 ml portions of 95 % ethanol using a total of 80 to 100 ml of ethanol. Adsorbed NH₄ was then replaced with Na by . extracting the soil with 40 ml of 10 % NaCl. NH₄ was determined in the extract by adding 5 ml of 40% NaOH and distilling NH₃ in 10 ml of 0.2 <u>N</u> sulphuric acid and titrating the excess acid by 0.1 N NaOH.
- Exchangeable Aluminium:: 10 g soil was extracted with 100 ml N KCl by shaking for two hours. 5 ml of KCl extract was diluted to 25 ml with water, 2 ml of 1% thioglycolic acid and 10 ml of aluminium reagents (containing NH₄-aurine tricarboxalate, gum accacia, NH₄CAC and HCl) were added. The contents were heated over boiling water bath for 16 minutes and then cooled. On cooling the volume was mede to 50 ml with water

mixed and absorbance measured at 520 millimicrons.

- Exchange acidity: Exchange acidity was determined by the potassium chloridetristhanalamine .buffer method. 10 g of soil and 25 ml of 0.5 N KCl 0.2 N TEA buffer were shaken for half an hour and filtered through a gooch crucible containing a moist whatman No. 42 filter paper. Additional 25ml of buffer solution were used to transfer the soil to the crucible. The soil was then leached with small portions of 100 ml of replacement solution (0.5 N KCl solution containing 10 ml of buffer solution). The combined leachates in the flask were titrated with 0.1 N HCl using 10 drops of bromo-cresol green and 2 drops of methyl red with the progressive color change from blueish green through violet to pink. The end point was checked against a blank containing 50 ml of buffer solution and 100 ml of replacement solution. Exchange acidity was calculated by the difference between the titration value for blank solution and the leachate.
- <u>CaCO₃percentage</u>: 5 g of soil was treated with 50 ml of 0.5 <u>N</u> HCl by gently boiling for 5 minutes. After cooling the contents were filtered and washed with water to wash all the acid out. The amount of unused acid was determined by adding two drops of phenolphatalein and back titrating with 0.25 <u>N</u>'NaOH. The percentage of CaCO₃ was calculated from the acid used.
- Exchangeable Ca + Mg in calcareous soils: In case of calcareous soils exchangeable Ca + Mg was extracted using 10 g of soil and 40 ml of KCl-TEA buffer (containing 1 N KCl and 0.2 N TEA, pH 8.2) stirring occasionally for one hour. 10 ml of the filtrate were used for Ca + Mg determination by EDTA method (as described under exchangeable Ca + Mg in NH₄-acetate extract
- 3.4 Soil classification and Land scape units
- 3.41 Level of detail of soil characterization

It was decided to describe the soil units in terms of the following characteristics:

- Soil depth
- Soil drainage
- Soil colour
- Soil texture
- Degree of accelerated soil erosion by water
- Slop range
- Soil phase

For a description of the classes employed for the description of each characteristic the referred to landscape units. Soil classification follow FAO soil map of the world.

3.4.2 Landscape unit and landform genesis

A hierarchial classification system is applied in the description of the geomorphology of the landscape units. At the broadest level, 12 sudivisions related to the general physiographic character of the landforms occur as follows:

- l. Wetland
- 2. Seasonal wetland and seasonally waterlogged land
- 3. Plains and undulating sideslopes
- 4. Plains and low plateaux with hills, moderately dissected sideslopes and dissected plains
- 5. Hills with plains
- 6. Low to moderate relief hills
- Moderate to high relief hills, severely dissected sideslopes and plateaux
- 8. High to mountainous relief hills
- 9. High plateaux
- 10. Moderately dissected plateaux, plateaux with hills and rolling to hilly plateaux
- 11. Rubble land and rock outcrop
- 12. Sand and salt deposits

4. SELECTION OF CROPS FOR LAND EVALUATION

The methodology for the study and identification of the requirements of creps was established based on ranges of suitability. The methodology is explained in detail in a standard proforma which has based itself on land qualities and characteristics derived from the survey at a semi-detailed scale.

The main types of land use in the project area are apprec-ably classified as rainfed agriculture (which involves annual, perrenial crops and mixed farming) irrigated agriculture, livestock production and forestry.

4.1 Selection of crops

A list of 5 of the main crops of the area together with other perennial crops except forestry species were selected for consideration as land utilization types (LUT). Identifying the LUT in terms of crop performance and requirements would have the desirable effects to identify the crops and the legend that best suits to grow them in the area. This would support settlers to make an important contrast between the introduced innovation which would enable them to produce more and previous forms of land use. Eesides crop production should not be only realized to produce food production just sufficient to feed the population. In spite of the fact that the production design should gear to produce crop surpluses to meet the basic needs of the living standards of all its members, especially the most basic social services like health, education and other vital needs are required by the Settlement community.

Another factor for treating the following crops is the considerable production of these crops within the project area. Due to the above stated reasons the following list of crops were considered:-

- 14 -

Wheat	Maize
Sunflower	Teff
Sorghum	. C. Le

4.2. Cropping Systems

There is appreciable contrast between the cropping system used within the seed complex farming system in one area and others. Main crops in Harawa cropping system is based on wheat , sunflower, sorghum, maize and teff with other minor crops. Some crops are sometimes mixtured to satisfy the needs of the local community and the cropping calendar is designed to provide ample time for work, whereby crops are planted at appropriate period to give them enough time to mature and fill a food gap.

4.2.1 Crop Establishment

As it was indicated earlier, under the current farming system, the settlement was largely based on wheat production. The cultivation of wheat during the main rainy season starts with the first plowing in mid-November extending untill late January. Second ploughing begins in mid-January to mid-February. This is followed by secondary harrowing from late January to late February.

Seeding times for wheat is practiced between late February and late March whereas weeding is carried out in the months of April and May. The harvesting period for wheat is from late June to early August. The number of plowing decreases to one time :plowing and two times harrowing on areas previously cultivated. (For detailed information on cropping calendar refer to Figure 2.

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Figure. 2.

CALENDAR OF OPERATION HARAWA SETTLEMENT PROJECT

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W		1	[1					
H		1	1									
Sorghum				· · ·								1
LP												
PF			40007									
W.				200000		1		F				
Н												
· · · · · · · · · · · · · · · · · · ·												
· · · · · · · · · · · · · · · · · · ·												1
									1			
		1										
										Į		

LP-Land Preperation W-Weeding PF planting fertilizing H-Hervesting

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4.3 Agro-Forestry in Relation to Crop Production

The present inadequate fuelwood supply in the settlement has led to a serious shortage of wood for fuel and construction purposes.

The semi-arid areas of settlement sites are more marginal for crop production than the humid areas. These are also the areas most likely to be taken up for the development of settlements and state farms, but they also have the most fragile ecosystems. In prehumid areas, once the forests are removed the soils quickly loose their fertility, the climate becomes more harsh, on steep slopes in particular, the soil can erode easily.

These adverse effects are not always immediately apparent as the yields in the first few years after the natural vegetation has been cleared and can be dramatically high. But under prehumid conditions, the original fertility of the soils is leached away and increasing amounts of inorganic fertilizers have to be added to maintain even moderate crop yields.

This landuse cover the settlement nearly 85 percent of the land area mainly on cultivate areas . However all the woodland and grazing areas are under extreme pressure from both human and livestock demands for fuel and fodder and in many areas unproductive.

Reforestation in the settlement sites with mainly eucalyptus species and cupressus luistancia on reverian area has been carried out, but it is possible that the range of species could be extended to include suitable multy purpose tree species which could provide fodder and food for animal and human consumption. Suitable species could also include indigenous multipurpose species such as accacia, albida and tamaríndus indica which are drought tolerant.

In addition, the ' ntroduction of multi-purpose crops like pigeon pea could serve to protect soil erosion, used for forage, feed for animals and and human consumption, stand as windbreaks and provide fuelwood as well as its branches can be used for basket making. To overcome future problems of soil erosion and shortage of fuelwood supply, there is a need to give greater attention to associate such useful crops with traditional food crops in the planning and extension activities of settlement development.

The present inadequate supply of fuelwood is obtained from the plains and undulating slopes of the settlement where it is diminishing and being degraded at accelerated rate as a result of land clearing, exploitation of existing trees for building materials and fuelwood.

Thus, reafforestation and existing woodlots should be given serious consideration to avoid future disasters in fuelwood crises and soil erosion.

The humid areas are the most suitable for rainfed crop production, They are still susceptable to environmental degradation.

In areas where serious depletion of tree species occurred, careful selection of suitable species which could grow fast such as eucalyptus saligna, globules spp could solve the major problems.

As benefits from forest development are only attained in the longterm, due consideration should also be given to the local indigeneous tree species that grow in these areas by avoiding damage during establishment.

The type of tree species raised and planted in Harawa Settlement project are as follows:

Acia Albida Acacia Melanoxylon Casvarina Equisetifolia Cordia Africana Croton Macrostachus Eucalyptus Gamphecephala Eucalyptus Saligna Eucaly ptus Globules Leucana Leucooephala Grevillea Rubusta

Emphasis for tree plantation was given from 1983 to 1985. The afforestation programme had raised and planted a total of 1.5 million seedlings on 940 ha.

5. CROP ENVIRONMENTAL REQUIREMENTS

5.1 General description

The total area within the study area has been shown by identifying or indicating the land qualities to be considered for evaluation, rainfed agriculture and land characteristics needed to describe these land qualities:-

The definitions of a land quality and land characteristics are:-

- A land quality is an attribute of land which acts in a distinct manner in its influence on the suitability of the land for a specific kind of use.
- A land characteristic is an attribute of land that can be measured or estimated. First, land qualities are fewer in number (than land characteristics), secondly, they direct attention to the effect upon land use and thirdly, they take account of interactions between environmental factors.

For each crop considered the requirements are indicated in two ways: The basic requirements as employed in the land evaluation, are shown on the tables in standard form at Appendix 2. The land qualities, the land characteristics by which they are measured 17 for estimated. Abbreviations used for t he suitability ranges are :-

- Soil texture follows:

- S Sand L Loam LG Loamy sand SCL Sand clay loam SL of Sandy loam
- Sil Silt loam
- CL Clay loam
- Sicl Silty clay loam
- SC Sandy clay
- Sic Silty clay
- C (rd) Clay (red)
- C (bl) Clay (black)
- Slope classes:
 - 0-2% Flat or almost flat
 - 2-8 Gentle slope
 - 8-16 Slope
 - 16-30 Moderately steep
 - 30-50 Steep
 - 50⁺ Very steep
- Drainage classes follow FAD, as above, but for this exception: For land subject to seasonal flooding two classes are given, one for the period during the rainy season and one for the rest of the year. This was done to accommodate requirements of the land evaluation.
 - VP Very poor
 - P Poor
 - I Imperfect
 - MW Moderately well
 - W Well
 - S Somewhat Excessive
 - E Excessive

- Rock outcrop descriptions follow FAO as above stoniness classes are:
 - > 1% None
 1-3 Fairly stony
 3-10 Stony
 10-50 Very stony
 50-90 Exceeding stony
 90> Rubble land
- Effective soil depth are (in Cm)

< 25	Very shallow
25-50	Shallow
50-100	Moderately deep
100-150	Deep
150>	Very deep

- PH soil reaction

< 4.5	Strongly acid
4.5-5.5	Medium acid
5.5-6.5	Slightly acid
6.5-7.5	Neutral
7.5-8.0	Slightly alkaline
8.0-8.5	Medium alkaline
8.5>	Highly alkaline

- Electrical conductivity mm hos/cm at $25^{\circ}C$

< 4 mm hos/Cm	Non -saline
4-8	Slightly saline
8-15	Medium saline
15 >	Highly saline

The classes used for the description of soil drainage, soil texture refer to the standard soil description classes as in FAO "Guideline for soil profile description"

.

- Organic matter classes are (in% ,)
 - <1 Low
 - 1-3 Medium
 - 3-10 High
 - 10> Very high
- Cation exchange capacity classes are: (me/100g)

< 16	Low
16-35	Medium
35-70	High
70>	Very high

- Available phosphorous (Olsen) classes are (in ppm)

- Erosion (All lands)

Symbol	Description Term	
1	None to slight erosion	Less than 35% of original top soil removed
2	Moderate erosion	From 25 to 75% of original top soil removed; occasional gullies may be present.
3	Severe erosion	From 75% of oringinal top soil to 25% subsoil removed; occasional deep gullies may be present.
4	Very severe erosion	All of original topsoil and 25% to 75% of subsoil removed.

Symbol	Description Term	
GL1	Slightly & Moderately Gully land	An intercate network of very frequent moderately Gullies presents. The soil has been eroded to the extent that all or practically all of the original surface soil, or A horizon, has been removed. (This GL1 will be practiced only planting trees and grass).
GL2	Deep Gully land	An intericate network of very frequent deep gullies are present. Soil profiles have been destroyed except in small areas between gullies. (This GL2 will be practiced planting trees, and structures)
EMP	Exposed parent material and/or Rock	Areas consisting of exposed parent material and/or rock resulting from the complete, removal of all of the original topsoil and subsoil by natural processes, it will be differentiated by placing the symbol in parenthesis.

5.2 Modifications to Crop Requirements for High Level of Input

Consideration was initially given to identifying separately the requirements of each crop at each of the three input levels, i.e. low, medium and high e.g. drainage impedence by drainage works, erosion hazard by soil conservation works. On the other hand, one feature of the high level mechanization may call for more stringent environmental requirements.

At high input levels like in settlements the following adjustments in the values of the land characteristics are made:-

Soil drainage (land quality; drainage). For imperfect drainage improve the suitability by one class, i .e. N (Not Suitable) becomes S3 (Marginally Suitable) and S3 becomes S2 (Moderately Suitable) and S2 becomes S1 (Highly Suitable).

Stones and Rock outcrops (land quality; management, land preparation and mechanization potential).

Change the suitable ranges of most crops are as follows :-

N2 exceeding stony and (over 50% of the an	S1	None to fairly stony	(O-1% of the area)
N1 very stony (10-50% of the area N2 exceeding stony and (over 50% of the area	S2	fairly stony	(1-3% of the area)
N2 exceeding stony and (over 50% of the an	S3	stony	(3-10% of the area)
	N1	very stony	(10-50% of the area)
NUDDIE	N2	exceeding stony and nubble	(over 50% of the area)

This adjustment is made on the basis that stones and rock outcrops impede land preparation and mechanization activities.

Slope angle (land quality: - degradation hazard)

S1		Slopes	of	0	 8%
S2	-	53		8	 16%
S3		F9:		16	 30%
N1		88		30	 50%
N2		95		50%	+

The adjustment is made on the basis that at high input levels, slope of 8-16% are moderately suitable to be cultivated on settlements provided that very careful attention is given to the construction and maintenance of soil conservation works.

The Harawa Settlement Project Environmental Requirement for crop combination is given in the tables of Appendix 2.

6. LAND RESOURCES MAP

6.1 General Description

The description of the main components of the Land Resources map given below are basically thematic maps of thermal zones, lengths of growing periods, geomorphology and soils. Mapping of thermal zones (TZ) and length of growing periods (LGP) is based on the FAO Methodology Agro-Ecological Zone Project, and ETH/82/010 Project. Geomorphology and Soils data result from geomorphology interpretation . of aerial photo, from available survey and field traverse and agroclimatic information.

6.2 Land Resources Units

The Matrix tables shown below was developed as part of the comprehensive Land Resources map lengend for the map units derived from the integration of information contained in the thematic maps referred to above.

A brief description and illustrated example could assist the user in understanding the nature of Land Resources Units shown on the map and the means by which thematic data of thermal zones, lengths of growing periods, geomorphology and soils have been integrated to delineate them see appendix 4.

6.2.1 Land Mapping Units

The combination of landscape units from the Geomorphology and Soils Map and the various zones from the lengths of growing periods map. The symbols are comprised of two parts. For example, $\text{Rm}_{\nu}V^2/7$. The first part of the symbol, $\text{RM}_{\nu}V^2$, represents the landscape component, the second para /7, represent the growing period zone. Both aspects are explained in more detail as follows:-See Land Resources Maps 2.

6.3 Explanation of Thematic Map Units

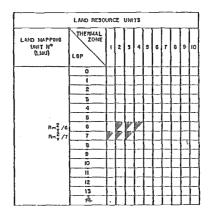
6.3.1 Thermal Zones

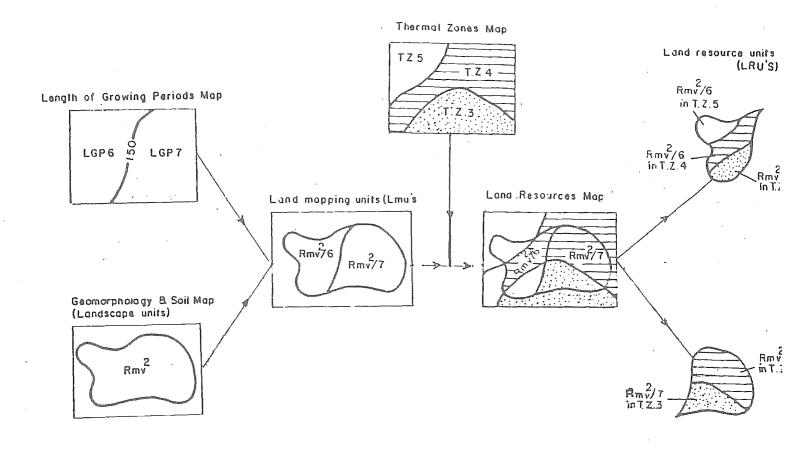
Thermal zones are defined by mean daily temperature (in $^{\rm O}$ C) during the growing season.

The following relation between temperature and altitude was determined from the data collected in 155meteorological stations throughout the country.

Figure 3

Method of integrating thematic data and lad resources units





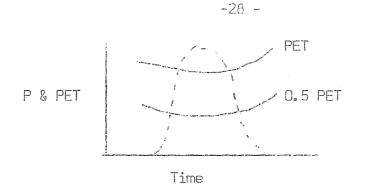
	Thermal Zone	Corresponding Altitude in Meters
10	7.5	3800
9	7.5 - 10.0	3400 - 3800
8	10.1 - 12.5	3000 - 3400
7	12.6 - 15.0	2600 - 3000
6	15.1 - 17.5	2200 - 2600
5	17.5 - 20.0	1700 - 2200
4	20.6 - 22.5	1300 - 1700
3	22.5 - 25.0	900 - 1300
2	25.1 - 27.5	500 ~ 900
1	27.5	500

6.3.2 Length of Growing Periods

The LGP's are closely related to altitude (temperature) and the mean annual rainfall. The latter in all it's three attributes of amount, distribution and pattern, two main types of LGP's were identified, normal and intermediate.

NORMAI 150

A normal growing period is defined as the period (in day) during a year when precipitation exceeds half the potential evapotranspiration (PET), plus a period required to evapotraspire an assumed 100 mm of water from excess precipitation (or less if not available) stored in the soil. Normal LGP's is 150 days.



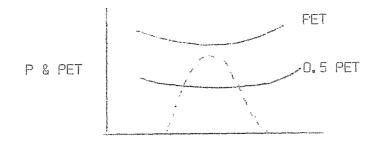
Intermediate - - - - - - 45/90 - - - - - -

An intermediate growing period implies that throughout the year the average monthly precipitation does not exceed the full rate of the average potential evapotranspiration.

The teginning and end of such an intermediate growing period are defined as the points where the precipitation, Curve Crosses the 0.5 PET Curve.

Intermediate growing periods are common in semi-arid areas and their codes are indicated on this map enclosed in parenthesis e.g. $RMV^2/(3)$.

The Harawa Settlement Project Site of LGP's is 150 days and also overlapping 45/90 days of intermediate zones.

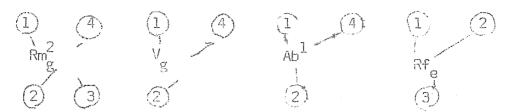


LGP Zone (in days)	LGP Zone Code
0	
1-45	1
46-60	2
61-75	3
76-90	4
91-120	5
121-150	6
151-180	7 *
181-210	8
211-240	9
241-270	10
271-300	11
301-330	12
331-364	13
365	14

For convenience of Tabulation LGP zones are assigned numerical codes as follows:-

6.4. Explanation of Landscape Units Legend

Landscape Units, defined as mapping units which are reasonable homogenous with respect to geomorphology, soils and vegetation, have been delineated on this map. Manual interpretation of aerial photo 1:50 000 scale, existing survey, field surveys, agroclimatic information, and geologic and topographic maps have been used in the delineation and description of these landscape units. The symbols on the map represent on hierarchial classification of landscape units. An explanation, with examples, of the operation of the classification follows: See map 2.



(1) Six subdivisions, represented by the capital Letters reflect the genesis on the landforms, i.e. the geomorphic types.

Alluvial	Α	Volcanic	V
Deolian	D	Structural	S
Evaporite	E	Residual	R

- (2) Subclasses of these geomorphic types are indicated by the first lower case letters, 'm in Rm²g refers to the subclass of the residual geomorphic type that is 'moderate to high relief hills' 'b' in Ab' refers to the subclass of the alluvial geomorphic type that is basins and depressions with seasonal drainage deficiencies. The full range of subclasses, or geomorphic unit, is given below in the summary legend.
- (3) Structural and residual landforms require a third character, the subscript lower case letter, which identifies the main parent material origin of the landform. Alluvial, aeolian, evaporite and volcanic landforms do not have this third character. The subscript letters are as follows:

Volcanic (basalts, tuffs, etc.)	V
Felsic precambrian basement	
(gneisses, granites, etc.)	50 0
Metamorphic precambrain basement	
(saltes, schists, phyllites, etc.)	m
Evaporite (predominantly gypsum)	е
Sandstone	S
Calcareous (predominantly gypsum)	С

Such symbols are normally used alone but may be used together, for example, ^{sh}cg, where parent materials are mixed and not easily separated at this scale of mapping.

(4) Geomorphic units are further subdivided on the basis of soil association which occur within them into final landscape units of the type described above. This final subdivision is represented by superscript numbers. The superscript number is absent where each occurrence of the geomorphic unit has the same soil association.

They are listed below in the legend, organized according to the general physiographic character of the landforms, for example, wetland low to moderate relief hills and high plateaux in Marawa settlement site. See map 2.

6.4.1 Summary Legend

- High to mountainous relief hills
 <u>Residual landform</u>
 Rh (Rmg²) High to mountainous relief hills
- Moderately dissected plateaux, plateaux with hills and rolling to hilly plateaux

Volcanic landform

Vg High volcanic pledmonts and lava plateaux

6.5 Significant Land Facets

The specific features upon which the detailed descriptions of landscape units are based on the legend of the map are land facets.

Characteristics used to describe significant land facets

Landscape Unit No. Geomorphology Total Area (Km²) Significant land facets Area (%) Geology Slope range Dominant ve getation and/or land use Remarks (by land facet) (by landscape unit) Soils FAO classi fication Colour (Moist) Texture Drainage Class Rock outcrop Surface stones Effective depth ph OM (organic matters) (%)

CEC (Cation Exchange Capacity) Available p SMU No. (Soil Management Unit) Erosion

The description of landscape unit is presented in Appendix 4.

7. LAND SUITABILITY CLASSIFICATION MAP

7.1 Land Suitability Evaluation

The results of the land suitability classification conducted in settlement project are presented in two main ways:

- Land suitability maps
- Land suitability classification tables

For the 5 crops considered within the rainfed agriculture, one group combination 1:50,000 scale of land suitability maps have been prepared for the Harawa settlement project.

Similar land suitability maps for the forestry LUT's and a livestock LUT's have also been compiled at 1:50 000 scale.

The second major result of the suitability classification is contained in Appendix 2, Land Suitability Classification Tables. Here, details of suitability limitations for S2 (moderately) S3 (marginally). Suitability and N (not suitable) are indicated for all matchings involving these two classifications. No limitations are assumed present for these areas indicated as S1 and are thus not tabulated.

7.2 Land Suitability Classes

Suitability classess indicate degrees of suitability, within the order (S). It is usual to recognize three classes, 'highly", moderately and marginally suitable. The following names and definitions may be appropriate in a qualitative classi fication:

Class Sl	Land having no significant limitations to sustained
Highly Suitable:	application of a given use, or only minor
	limitations that will not significantly reduce
	productivity or benefits and will not raise inputs
	above an acceptable level.

Class S2 Moderately Suitable: Land having limitations which in aggregate are moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on class S1 land.

Class S3 Marginally Suitable: Land having limitations which in aggregate are severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified. Class Nl currently not suitable : Land having limitation which may be surmountable in time but which cannot be corrected with existing knowledge at currently acceptable cost, the limitations are so severe as to preclude successful sustained use of the land in the given manner.

> Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner. According to the land suitability evaluation detailed above,12075 hectares of land in the area, comprising land suitability units I and II, have been recommended for cooperative farms and homestead production of crops adopted to the area, i.e. wheat, sorghum, maize, teff.

On the other hand, 0,533 hectares, which combines all the other land suitability units, are available 3893 hectares for livestock grazing lan d and afforestation 777 hectares.

7.3 Land Suitability Subclasses

Class N2

suitable

Permanently not

Land suitability subclasses reflect kinds of limitations, e.g. moisture deficiency, erosion hazard. Subclasses are indicated by lower-case letters with minemonic significance, e.g. S2m S3me. There are no subclasses in Class S1.

Examples of symbols are given below:

- w Drainage deficiency
- e Erosion hazard
- p Management limitation
- x Toxicity limitation
- r Rooting condition deficiency

7.4 Land Suitability Units

The land in Harawa Settlement Project site has been evaluated for rainfed agriculture and classified into 7 suitability units. Their distribution is indicated in Map 3 of land suitability classification map. See table 3.

Land Suitability Classes	Ч	SZW	ips S3e Va- ition es.
Recormencied Use and Treatment	Cultivation of wheat, teff sorghum, maize pulses and sunflower, Fields to be on the contour, grass strips every 50 m and grass water way along the depressions and limited applications of DPA fertilizer especially on wheat.	Grazing during dry season or horticulture after draining. Soils needed drainage water on ditches every 50 m interval along the depressions after drain cultivation of cereals and pulses.	Same as Sl but narrow grass strips better soil and moisture conserva- tion, best suitable to pasture development after soil conservation cultivation of cereals and pulses.
Limitation	Low phosphorous soil difficult to manage.	Low phosphorous water logs during wet season	Low phosphorous moderate erosion
e Significant Land Facet	Plains and undulating gentle sideslopes interfluences on C-8% slopes	.larshy depression on 0-2% ɛlopes	Moderete sideslopes on 8-16% slopes
Landscape Unit Symbol		96 -	د د

Limitations and Recommended use of Land Suitability Classification in Harawa

Table 3

Land Suitability Classes	MIM	NZe	e M.	erossion. soil conservation 32g every 50 m and . DPA Firtilizer
Recommended Use and Treatment	Afforestration and building materials and grazing during the dry season. Micro basins for afforestration.	Afforestration in selected areas, if large areas keep in wildlife conservation.	Grazing land, range pasture, fuel wood plantations and fruit trees. When land preapre by Bench terrace can cultivated few selected crops.	Same as Sl but slight erossion. Field to be more need soil conservation measures grass strips every 50 m and limited application of DPA Firtilizer especially on wheat.
Limitation	Swampy, very irregular on sandy	Very severe erosion and gully land. Very steep and/or rocky.	Moderate to severe erosion moderately deep soil	Low pheopharous slight erosion
Significant Land Facet	Intermantance valleys on O-8% slopes	Very steep sideslope to escarpments on 30-50 and 50°% slopos	Steep sideslopes on 16-30% slopes	Plateau terrace and gentle sideslope
Landscape Unit Symbcl		τ, ω - 7ε -	μ	

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8. DEVELOPMENT PLAN

The development plan incorporating at improvements most suited to the subwatershed and offering optimum benefit to the settlements.

Any activity that will improve or at least sustain production, or that is of benefit to the settlement, may be termed a development option. The options considered are those that will lead to improving or at least sustaining agriculture, forestry or livestock production. Marketing and storing produce, together with water development (springs, farm ponds, dams and diversion weirs) are also considered. Farm management is considered as an essential continous input components such as reforestration or strip cropping established as a development input must be continued under good farm management programme.

8.1 The Development Plan Map

The development plan may and the table of inputs are the most important parts of the development plan, plan to locate on the ground where the various soil and water conservation measures are to be built.

Furthermore, the map is essential to the planner for determining the extent of the areas and the volume of inputs required.

Any development work that has been previously implemented should be transferred to the developme nt map using the symbols as given in Table $^4\cdot$

The additional development work, including maintenance or improvement of existing structures should be added to the plan. These areas are scheduled for soil or stone bunding, hillside terraces, microbasins, etc. The location of farm ponds, spring development, waterstorage dam, diversion wier, check dam are shown on the development map, using symbols as given in table 4. Thus the complete development map of the physical work is prepared development map, to a scale of 1:20 000, seen in Map 4.

Legend	Detailed
CU	Arable land (cultivated)
GL	Grazing land
FS	Forest shrubland
WL	Wasteland
RD	Rock outcrop/boulders
FP	Forest Planatation
RP	Range pasture
NU	Nursary site
2w	Water logging
	Settlement site
 A subseque and a configer of the application devices and a configer of the application of the application devices and a configer of the applica	Road (with gravel all weather)
արդեր հունց կրներու երեն, ուտը էջ։ Ապատ էջջ տունը, երկին, ուր եւ	Farm Road
میش ردهه محمود موجود بردهان -	Path
	Seasonal)
) Rivers and water courses Permanent
	Existing dam
) and a second sec	Bridge
峇	School
古	Church
Development workand Improvement	
na a ga antigana a mang mana a mang mana a mang mang	Soil and stone faced bunds
(UUVU)	Micro basins for 🕜 micro basins for afforestation
-tt	Check dam (gully control)
<u> </u>	Channel improvement
manung manager of the second ge	Drainage water way and hillside drains

 \mathbf{x}_{i}^{i}

Table _ Legend for Development Plan Map

Table 3. Cont'd

Legend	Detailed
Summer of some states	New Bridge
之	New Church
À	New School
	Pasture range development
en en en en en e e	Unit boundary
19 2-1	Unit number
annan an a	Road repair
in a management reg and a state of the sta	Diversion Dam

Development Plan Work Component Harawa

Work Component	Unit LUN	1	2	3	4	5	6	7	8	9	10	Total
Present Land Use												
Cultivated land	1	1110	888	767	595	963	1136	856	631	802 ⁻	325	8,073
Water logging	2	50	69	15	253	-	-					194
Escarpment or severly eroded	3		-			160	10			13		183
Forest/shrub land	4	-	7	747	306	616	259		-	-	300	1,488
Woodland/Accacia	5	197	61	500	344	-	37	101	-	578	87	1,905
Grass land	6	210	116	40	-		167	367	344			1,244
River Valley	7	29	50	116	100	88	50	104	87	673	200	1,497
Mixed cultivated land	8	401	723	1073	689	151	-				1034	4,071
Tree plantation	TP	10	-		-	-	6		-	7		23
Nursery	N	-	-	-	7				-			7
Settlement	Н	106	100	125	125	101	84	106	119	54	63	983
Total	ha	2113	2014	2636	2166	2079	1749	1534	1181	2127	2009	19,608
Development Flan												
Proposed Cultivated land		1511	1611	1840	1284	1114	1130	856	631	766	1323	12,075
Drainage Improvement		50	69	15			-	-			-	134
Afforestration		24	25	58	57	44	131	52	43	343	100	777
Pasture Development		407	177	540	344	-	204	468	344	578	87	3,149
Natural grazingland		15	25	58	50	44	25	52	44	337	100	750
Hillside terrace Soil a stone bunds	Ind		7	-	306	616	259		-	13	300	1,501
Wield life conservation	1	-	-	-	-	160	10	-	-			170
Settlement		106	100	125	125	101	90	106	119	90	90	1,052
Total	ha	2113	2014	2636	2166	2079	1749	1534	1181	2127	2009	19,608
Check dams	Site	6	6	10	6	11	6	2	4	11	12	74
Dam, weirs	Site	1	-	-	-	1	1	1	1	-	1	6
Water way hill side drains	Km	4	4.5	1.5	0	1.5	3	3	3	5	2	27.5
Farm road improve	Km	-	-	-	1	2.3	-	-	-	3	-	6.3
Bridge	Site		1				1	_		1		4

Proposed Land Use Plan

Proposed Land Use	Present Land Use and Land scape Unit No
Cultivated land Drainage Improvement	 Cultivated land (C-8%) 8. Mixed cultivated land with grass (2-8%) 2. Water logging and seasonal swamp (O-2%)
Afforestration (Micro basins)	7 River valleys half of total area (0-8%) TP Rece plantation N Nursery
Bench terrace or pasture improvement	6. Grassland (8-16%) 5. Woodland with acaciá (16-30%)
Natural grazing land	7. River valleys half of total area (0.8%)
Hillside terrace soil and stone bunds	4. Forest shrubland (30-53%)
Wild life conservation	3. Escarpment severely eorded (50%)
Settlement	At presently less than 90 ha of homestead, increased up to 90 ha unit 6 and 10.

8.2 Engineering Measures for Soil Conservation

Any measure that involves the physical movement of soil or stones, or requires construction, call termed an engineering measure. Usually such measures are not complete in themselves and require the addition of a negative cover before becoming fully effective and permanent.

8.2.1 Soil and stone Bunds

The construction of soil and stone bunds is an effective method of retarding rainfall runoff and thereby reduce soil erosion from arable and forest areas. Well maintained bunds will eventually develop in level bench terraces.

The bunds are constructed along the contour at intervals of 10 to 20 m, apart and from 0.5 to 1.0 m in height. The distance apart and height will be dependent on the degree of slope and rainfall intensity.

8.2.2 Hillsite terrace

Hillsite terrace may be considered as closely spaced developed stone bunds. They are constructed on slope 30% and over, where there is adequate soil depth and an abundance of stone. The width of these terrace should not be greater than 1.5 to 2.0m. while their height will vary from 0.5 to 1.0m.

8.2.3 Micro Basins

Micro basins, or eyebrow terraces as they are sometimes called, are small basins (depression) cut into the hillside to enhance the growth of seedlings.

They are generally constructed on any slopes and are less costly to build the hillside terraces. Each seedling has an individual basin. These basins are circular or semi-circular and 0.5 to 1.0 m in diameter. Their spacing apart will depend on the species to be planted.

Micro basins will retain only a small portion of runoff during intense rainfall. If this runoff is likely to build up into a large volume, as would occur on long slopes, hillside drains should be constructed at intervals to intercept this surface runoff.

8.2.4 Gully Control

Outside of units one and two areas, gully erosion are serious problem. Gullies are formed by or concentration of rainfall runoff flowing down a hillside. Frequently road culverts or worn footpaths and cattle tracks are the initial cause of a gully. Graded bunds hillside drains constructed without proper outlets may be another cause. Once established, a deep gully is exceedingly difficult to repair. Seldom it is possible to do more than stabilize its condition, thus preventing further growth.

8.2.5 Grass water way

Interception ditches at the bottom of each row of plots will generally have a slight gradient towards grassed waterways. The uppermost interception ditch must be large enough to accept the considerable runoff from the ridge. The grassed waterways will convey the runoff downhill and terminate in natural depressions. If possible they should be sited in a wide natural depression or gully, shaped so as to spread out the flow as widely as possible to reduce the velocity. Excavated waterways will be needed where natural channels are absent.

Where stone is available a narrow stone channel, debouches from the plots areas into the farmland, it should flare out into a grassed waterway.

In most cases, the interval roads or tracks which allow access to the row paths and to the farmland will be on the catchment divide. Since they run radially downslope, they will develop into gullies.

Therefore where these roads cross the interception ditches they should be slightly humped i.e. the hump of the road is an extension of the ridge of the ditch, and runoff will be stopped by the hump and diverted into the dit.ch channel.

8.3 Vegetative and agronomic measures for soil conservation

A good vegetative cover is a very effective method of controlling soil erosion. Unfortunately this cover, so valuable for the protection of the soil, is constantly removed by man's activities, However, with some discipline, there are methods by which the cover can be maintained and at the same time provide a greater yield than if left to undisciplines exploitation.

Ideally, vegetative measures for the control of soil erosion should if practical, always take procedure over engineering measures. The fact that engineering work involves physical movement of the soil is, in itself creating an erosion hazard if it is not carefully carried out.

8.3.1 Tree Plantations

Trees can be planted to protect the soil and to provide fuel wood, ploes, fodder, or fruit. They can be established on steep slopes not suited for cultivation or for stabilization of an area, minimizing erosion rates without excluding production. The kinds of trees to be chosen depend on the agro-ecclogical conditions, the soil and the priorities of the settlers in the settlement. Tree planting has been carried out in the villages, common service areas, along farm roads and gully-dissected lands. In general, the area is without forest cover which is needed to support the needs of the settlers for fuel-wood for fodder, construction poles etc. In previous years, thousands of trees were planted. However, due to natural circumstances such as the condition of the soil and the prevalence of drought and absence of cultivation practices after planting the aurvival rate has been below 65%.

Species to be raised as follows:

- Wood lots species to be raised Acacia melanoxylon Casuarian equistifolia Cupressus liustania Eucalyptus camaldulens

Eucalyptus globules Eucalypts saligna Melia azandrachta (Melka Oda Settlement site) -Wind Break species to be raised Acacia melanoxylon Casuarina equistifolia Cupressus luistanica Gravillea robusta Melia azandrachta)- (Melka Oda Settlement site) Parkinsonia aquilata Schinus molle - -Other species to be raised for Beeflora Cordia africana Delonix regia Eucalyptus camaldulesis Eucalyptus saligna Spathodea nilotica - Agro forestry Acacia albida Leuceana leucacephala

Moringa olifera Cajanus cajana (Pige on pea)

8.3.2 On pasture and Grazing Land

Pasture and grazing lands comprise a large area in Harawa. These lands carry a large number of livestock, so large that over-grazing has taken near the surrounded settlement areas. This results in a fall in the quality and quantity of fodder, so few animals can be supported.

The soil is left without a cover, thus prone to erosion by water and wind. Loss of topsoil through erosion reduce the fertility of the soil, and thus the likelihood of reestablishing ; a good quality pasture goes down.

The land is with 8-16% slope with no worse than slightly eroded or irregular topography. The implication is that the land can be cleared and cultivated for reseeding, pasture and that it can be cropped from time to time in a long ley system to exploit the fertility buildup without incurring excessive erosion penalities.

The pasture management will probably require a system of rotational grazing and forage conservation. Access to pasture poses the problem of straying :into field of growing crops. Desirable shade and browse trees should be planting in the pasture areas.

Natural grazing can be recommended will come from two classes of land. One is dissected slopes 16-36% slopeland will provide the upland grazing in the wet season. The more areas will need to be managed with care and needed strict grazing control. The depressional areas along the stream should provide the source of the grazing during the dry season. These areas could also be used for water storage in the future as suggested in water storage dams.

8.3.3 On arable land

For case of mechanization, trees have been cleared from arable lands, which will lead to serious soil erosion problem. This underlines the need for developing agroforestry land use system (introduction of multy purpose trees for conservation, fuel, fodder and food etc.)

An agroforestrys system would provide a further alternative, especially for arable lands supply of N through nitrogen fixing trees may decrease purchase price of urea, increasing forage for livestock and fuel wood. Establishment of a system of wind break will protect crops from desicating winds.

8.3.4 On cultivated land and Homestead Plots

Apart from the physical structures for soil conservation, a number of agronomic measures can be used in combatting erosion on cultivated land

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and homestead plots.

The methods directly increasing surface storage capacity would be tillage systems like contour cultivation, chiseling and ridging.

Contour cultivation aims at intercepting the flow of water and spreading it across the slope, thus increasing the time for infiltration. Chiseling loosens the soil without turning it around, and while the infiltration is improved, the soil is left less susceptible to eriosion than if it had been ploughed.

Ridging, as done for sweet potatoes, shape the soil into micro basins which retain the water and leave it a longer time to infiltrate. Indirect methods of increasing infiltration rates are by the use of farmyard manure, green manure and crop residues, as well as by some types of minimum or zero tillage. The higher content of organic matter in the scil increases the infiltration by creating more stable aggregates less suceptible to splash erosion and by encouraging a higher porosity through higher biological activity. Ordinary agricultural methods for increasing productivity, i.e., supporting a higher plant population, like rotation systems and the use of fertilizer and manure, lead to increased vegetative cover and therefore can be said to have beneficial effects for soil conservation.

Showing down the speed of the water on certain parts of the slope are strip cropping, narrow grass strips residue or much lines and hedges. In a strip cropping system, contoured belts of crops inviting high erosion risk are alternated with belts of crops with low erosion risk. Narrow grass strips, much lines or hedges used for building up a terrace. The strip shows down the speed of the water and the soil settles in the bund. Therefore, a terrace slowly develops. The process can be enhanced by the farmer ploughing up soil to the bund from both sides when cultivating.

It is important that the plots be equal in size according to the settlement model and allocated by the producers cooperative. Since the plots are intended to be cultivated intensively for supplement food and obtain cash for the family, vegetable garden, fruit trees, raising poultry, etc. unfavourable soil should be identified by a soil survey in advance and not used for plots or, extra area should be allowed.

Unless the topography is very even, plot dimensions will not be uniform, generally narrower at the upper end. Plot dimensions should aim to be 40-50m long, 20-25m wide, but there is no hard and fast rule and the length is dependent on the distance required between interception ditches which protect the upper and of each plot from runoff from the plot above. These ditches will run on the contour or a slight gradient and will generally not be paralleld to each other. Therefore, the plot lengths will vary and plot widths will also vary in accordance. Paths along each row of plots run below the ridge of the interception ditch.

The advantage of more frequent ditch is that they receive smaller volumes of runoff and hence can be of smaller gradient and allow opportunity for runoff to infiltrate in the ditch itself. In this case, trees planted on the ridge would benefit from the improved moisture regime.

8.4 Water Development and Control Measures

Although some components of water development are not directly related to soil conservation, this aspect of subwatershed management and development is considered particularly important.

The development of a farm pond or spring reduces the movement of livestock for watering, this will immediately result in less erosion.

The mere movement of livestock destroys vegetation, and their worn tracks are frequent cause of gully erosion. A good source of clean water is essential for the health of the settlers.

8.4.1 Farm Ponds, Dams ' and Wells

In Harawa there are no permanent rivers or springs, the construction of farm ponds should be considered as part of the development programme. Ideally, the ponds should be located in natural depressions where the soil is impervious, or an impervious layer can be spread on the bottom. See page losses will therefore be small, and if the ponds are relatively deep to their surface area, evaporation loss will be reduced.

- Pollution of the ponds by livestock is a serious problem. The fencing to keep the animal out of the pond, be made to pipe the water from the water from the pond to a nearby water through.
- The siltation of ponds. Generally, dams are constructed across natural water courses. Care has to be taken the spillway is of adequate size to accommodate the runoff from the catchment area. The capacity of the reservoir (dam up to &m in height, dependent on the size of the dam) should be consistent with the volume of runoff.
- A disproportionately large catchment will require a large spillway, and the heavier silt load will more quickly reduce the capacity of the reservoir.
- Where the water table is less than 2 or 3m deep, the construction of wells may provide a good water supply for domestic and livestock needs.

8.4.2. Diversion Weirs

Diversion weirs are structures, usually concrete, built across either permanent or seasonal rivers to divert river flow into a channel. No water storage of the river flow is intended, although sometimes the structure raises the water in the river to facilitate its diversion into a channel. Weirs may be constructed to divert flow for irrigation purposes and to fill pools and sometimes dams in adjacent catchments.

8.4.3 Swamp Drainage

Frequently, there are areas in subwatershed with poor drainage. Where such areas are in deep depressions, it is usually not practical to drain them, and the depth and area of the swamp will fluctuate with the amount of rainfall. However, often swamps occur in shallow depressions or even on gently slopping land such as Units 1,2,3. In these areas, consideration should be given to drainage. If the water table can be lowered by the construction of a network of drainage channels, greatly improved grazing can be obtained, and possibly arable cultivation may become practical.

8.5. Other Measures

The principal soil and water conservation measures that might be required in a subwatershed development programme have been outlined in the three subsections above. These are the measures that will lead to improving or at least sustaining yields. However, in order to obtain the maximum benefits from the soil and water conservation inputs and satisfy the integrated approach to settlement development, other measures are required.

Listed below are some of the measures not directly related to soil and water conservation but all closely connected with agriculture output, and these should be considered in the formulation of the development plan. However, in other circumstances other development options may be appropriate, such as sericulture (silk production), apiculture (bee keeping), and aquaculture (fish farming). Marketing, Food Storage and Energy Conservation.

8.5.1 Access Roads and Tracks

Remote and inaccessible areas are difficult to develop. Ease of access to and from the farmland is an essential requirement when the settlers are to be reached by the extension service or by education and health schemes. As road construction is a frequent cause of landslides and gully erosion, particular care should be taken over their alignment. The improvement of tracks should not be overlooked. In some areas these are vital for the movement of people and pack animals. As in the case of roads, tracks are a common cause of gully erosion. Any accumulation of runoff along the track should be channelled away at frequent intervals. Critical lengths and possibly those on relatively steep grades may have to be rock paved in order to prvent erosion.

Appendix I

Photo-Interpretation and Soil Survey Mapping Legend

SOIL DEPTH (ALL LANDS)

Symbol	Range (Cms.)	Descriptive Term
5	less than 25	Very shallow
4	from 25 - 50	Shallow
3	from 50 - 100	Moderate
2	from 100 - 150	Deep
1	more than 150	Very deep

TEXTURE (ALL LANDS)

Symbol	Descriptive Term for Texture Group	Included Texture Classes
F	Fine (light)	Clay (C) Sandy clay loam (Scl) Silty clay loam (Sicl) Clay loam (CL)
Μ	Medium	Silt loam (Sil) loam (l) Very fine sandy loam (vfsl)
L .	Course (light)	Fine sandy loam (FSL) Sandy loam (SL) Loamy fine sand (Lfs)
C	Very coarse (very light)	Loamy sand (LS) sand (S) Course sand (CoS)

COARSE FRAGEMENTS: ALL LAND)

a) Gravel, cobble, and other coarse fragements will be mapped when they occur in sufficient amounts to influence land use. They will be shown as textural modifiers of the present top soil as follows:

Mapping Symbol	Descriptive Term	<u>Size Range (diameter)</u>
g C	Gravelly Cobbly Stone	up to 3" 3" to 10" 10" to moveable
s r	Rock	unmoveable

b) Quantity of course fragments will be mapped in accordance with the amounts shown in the following table:

Mapping	% gravel	% cobble	% stone	% rock
Symbol	by volume	volume	by volume	by volume
g c Vg Vc S1 S2 S3 R 700	30 - 50 50 - 90	30 50 50 90	30 - 50 50 - 70 70 - 90	10 - 50 50 - 100

c) Areas containing more than 90% of coarse fragments and more than 50% Rocky will be place into an appropriate miscellaneous land type.

COARSE FRAGMENTS : (ALL LAND)

a) Coarse fragments for soil classed as to series will be denoted as follows:

SIZE OF FRAGMENT	コエィ	1 4 15	υr	£ . £	£.12	CI, IVI	1.1	ΤA	1	D
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3'' - 10'' in diameter

More than 10" in diameter to moveable

Class :	/ by /olume		 ng en auf yw off an an a faw off a const har ang h	Clnss		% surface area Occupied by rock
S2 :	30 - 50 50 - 70 70 - 90	2 2 3		R . 700	•	10 - 50 50 - 100

- b) Areas having surface rock outcropping and/or accumulations of loose, detached rock fragments (greater than 10 inches in diameter) in excess of 50% will be classed as Colluvial Rock land.
- c) The "S" and "R" symbols, when mapped, will follow the depth class symbol.

PERMEABILITY (ALL LANDS)

Sumbol .	Permeability Class	Probable Texture	Probable <u>Structure</u>	Approximate <u>Per Rate Cm</u>
2 ^{''} 3	Slow moderately slow	fine (heavy) fine or medium	pr, abk, pl pr, abk pl	0.13 to 0.5 0.5 to 2.0
4 5	moderate moderately rapid	medium coarso	pr, sbK sbk, gr, cr	2.0 to 6.3 6.3 to 12.5
6	rapid	very coarse	er, sg	12.5 to 25.0

5.

Parent Material

This item should include information on the origin of the parent material and, where possible, on the nature of the parent rock(s).

Type & Underlying Material will always be shown regardless of depth of soil material (All Lands).

Symbol	Description
V	Volcanic (basalts, tuffs, etc)
g	Felsic Precambrain basement (gneisses granites, etc.)
m	Metomorphic Preceambrain basement (slates, sehists, phyllites, etc.)
е	Evaporite (predominantly gypsum)
S	Sandstone
С	Caleareous (Predominantly limestone)

Slope (ALL LANDS) Both class and degree of slope will be mapped.

Example:

Degree $\frac{\text{Scil}}{12 \text{ Cl} - \text{Erosion}}$

Class Symbol	Degree in % slope	Descriptive Term
А	0 - 2	Flat or almost flat
В	2 - 8	Gently slopping
С	8 - 16	Slopping
D	16 - 30	Moderately Steep
Ε	30 - 50	Steep
F	50 +	Very Steep

Erosion (All Lands)

Symbol	Description Term	
1	None to slight erosion	Less than 25% of original top soll removed
2	Moderate erosion	From 25 to 75% of original top soil removed; occasional gullies may be present.
3	Severe erosion	From 75% of original top soil to 25% subsoil removed; occasional deep gullies or frequent shallow gullies may be present.
4	Very severe erosion	All of original topsoil and 25% to 75% of subsoil removed.
GL1	Slightly & modera- tely Gully land	An intercate network of very frequent moderately gullies are present. The soil has been eroded to the extent that all or practically all of the original surface soil, or A horizon, has been removed. (This GL1 will be practiced only planting trees & grass).
GL2	Deep Gully land	An intericate network of very frequent doop gullies are present. Soil profiles have been destroyed except in small areas between gullies. (This GL2 will be practiced planting trees, and structures).
EMP	Exposed parent material and/or	Areas consisting of exposed parent material and/or rock resulting from the complete, removal of all of the original topsoil and subsoil by natural processes where attributed to man- induced processes, it will be different- iated by placing the symbol in arenthesis.

Presence of Salt or Alkali

Exact classification of saline, alkali and saline-alkali soil conditions must be based on laboratory data, but the following simple classes, as defined in the Soil Survey Manual, can usually be distinguished n the field and can be included with advantage in a field soil description:

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Class O	Soils free of excess salt or alkali. Practically no crops are inhibited by, or show evidence of injury from excess salts or alkali.
Class 1	Soils slightly affected by salt or alkali. The growth of sensitive crops is inhibited but that of salt-tolerant crops may not be.
Class 2	Soils moderately affected by salt or alkali. Crop growth is inhibited and no crop does well.
Class 3	Soils strongly affected by salt or alkali. Only a few kinds of plants survive.

Where conductivity measurements are available, the following classes of salinity, as defined in the Soil Survey Manual, can be recognized.

Class		Conductivity of Saturation extract in millionhos per cm ²
Class 0 :	Free	0 - 4
Class 1 :	Slightly affected	4 - 8
Class 2 :	Moderately affected	0 - 15
Class 3 :	Strongly affected	above 15

Approximate Limits of Salinity Classes

Drainage

The following definitions for soil drainage classes for use in soil profile description are derived directly from the Soil Survey Manual:-

- Class 0 Very Poorly Drained water is removed from the soil so slowly that the water table remains at or on the surface the greater part of the time. Soils of this drainage class usually occupy level or depressed sites and are frequently ponded.
- Class 1 Poorly Drained water is removed so slowly that the soil remains wet for a large part of the time. The water table is commonly at or near the surface during a considerable part of the year. Poorly drained conditions are due to a high water table, to a slowly permeable layer within the profile, to seepage, or to some combination of these conditions.
- Class 2 Imperfectly Drained water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Imperfectly drained soils commonly have a slowly pereable layer within the profile, a high water table, additions through seepage, or a combination of these conditions.

Class 3

Moderately Well Drained - water is removed from the soil somewhat slowly, so that the profile is wet for a small but significant part of the time. Moderately well drained soils commonly have a slowly permeable layer within or immediately hebeath the solum, a relalively high water table, additions of water through seepage, or some combination of these conditions.

Special Features

Symbol (\mathbf{f}) (\mathbf{f}) 各田若杏 111111 ____ $(S) \rightarrow$ ന്ന <u>\| |||</u> 3333333 2 2

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Tukul Settlement Village Town, Public Buildings Cemetry: Christian, Moslem School, Hospital, Mosque, Church Levee Dam, Reservoir Check Dam, Gully plug All weather raods Farm Roads Culvert Bridge Perennial streams Lake or pond Spring Wells or water tanks Swemp or march Lava flow Outcrop Rock Cliff Escarpment Sand dunes Unit boundary Unit Number Landscape Unit Number Location of major soil samples Reference Numbers Seasonal streams

Description

Land Use

Symbol	Description
	Forest
	Thicket
(Ba)	Bamboo
	Plantation
$\left(\begin{array}{c} \mathbf{R} \end{array} \right)$	Riverine forest
(EW) (S)	Eucalyptus, Woodland
(s)	Scrub
(Sc)	Scattered Treos
	Cultivated Land without Conservation
	Cultivated Land with Conservation
$ \begin{array}{c} (B)\\ (G) \end{array} $	Bareland
G	Grassland
(EPM)	Exposed Parent Material
(GLI)	Moderate Gully Erosion
(GL2)	Severe Gully Erosion
	Strongly Affected Salts andAlkali
	Ridge
$\rightarrow \rightarrow \rightarrow$	Grass water way
	Food path
(\mathbb{N})	Nursery

2					RANGES	S OF SUITABILITY	LTY	
2	NO LAND WUPLLIY	LAND CHAKACTERISTIC UNIT		HIGHLY SUITABLE	MODERILYSUITABLE	MONERTY SUITABLE MARCHNALLY SUITABLE CURRENTL	CURRENTLY Not.5	RERMANENTLY Not .S
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	TEMPERATURE	20010114	ш/		2600-2730	2730-2860	2860 - 3000	> 3000
	Ktalint	Mean Temperature	\ 0		12-16	11-8	6-7	9 >
		LINRYMAL Lone)	ر ۱	C V V	21-22	23 -25-	26-35-	> 35-
3	GROWING PERIOD	Length of Frowing Deriod	day	> 121	120-110	110-100	100-90	<90
	MOINTER	Effective Soil Jepth	Cm	100-15-0	100-50	50-25	25-10	
M	AVAILABILITY		•••••		00/- 0//	100-90		2
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+	TAVAINA	showard line	class		MW - SE	W - SE	SĒ	Ψ
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		(Thermal Zone)	,U	081	21-22	23-25	26-35	>35-
Lc	DEGRADATION	Length of Growing Deviod	day	> 121	120-100	110-100	100-90	< 90
>	RAZARD	Spil Taxture	class	7 - C(1d)	52	C(p)	72	6
		Stoniness	class	None	fairly story	stony	Very Story	Oxciding story
		Slope angle	۵/۵	10	8-16 0	16-36	30-20	507 0
		Soil Texture	Class	L - C(rd)	27	C(bl)	72	У
9	STATUS AND	· - - - - - - - -	~		6.5 - 6.0	60-5.0	5,0 - 4.5	< 45
	RETENTION	Soil Reaction	пд.	D./ C.J	7.0 - 7.5	7.5 - J.O	8.0 - 8.5	> 8.5
		Orgànic Matter	%	3-6	1 I N V N V	2-10	< / 0 > / 0	11
	ROTING	Effective Soil Depth	Cm	100-150	1	50-25	25-10	< ^ 0
F	CONDITION AND WORKARII ITY	stoniness	claad	hore	faily story	stery	very story	exciding story
- 7		Soil Texture	elàoo	7 - C(M)	1 J27 U	C(BP)	N 27 N	S ^U V

APPENDIX

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WHEAT

ENVIORNMENTAL REQUIREMENT FOR CROP

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APPENDIX		5 PERMANEN	212	7.2		exceeding stone	3	RATING	W	Г	I	エ	ЧH	W	⊢		Н	Z	5	S .	Ś	Ś		- ·	Z
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	E SUITABILITY	SZLY SUITABL	8-12	10-13	16-30	story	C(bl)	RATING	T	Σ	I	ЧЧ	Σ	X	Σ	(1	Н	X	V	V)	6		S	Ŷ	S
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三方丁		MORERTL	- >>	9	9	fairly			rgy required	>			=	t											
FOR CROP WHEAT		HIGHLY SUITABLE MORERTLY SUITABLE MARGINALLY SUITABLE CURPEND Y N.S DERMANENTLY. N.S	0-4	9-0	& - Q	hone	z - c(vol)	, cl	VH- Very high energy required	H -Hibh	inni		VL-Verylow	T - Intolerant	M - Medium	T - Tolerant			5 - Senaitive	M - Medún		T - lolerami	,	S - Senaitive	١
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REQUIREMENT		LAND CHARACTERISTIC UNIT	salinity	Alkalimity	Slope Angle	staniness	Soil Texture	LAND CHARACTERISTIC	seed-bed preparation					Allack by Sunface Water			Frost Sensitivity				Hail Somsitivitu				
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EN	ENVIORNMENTAL REQUIREMENT FOR CROP	REMENT FOR CROF	O WHEAT			<u>APP1</u>	APPENDIX 2
No	LAND QUALITY	LAND CHARACTERISTIC	CLASSÈS	CROP	RATING	CROP	RATING
<u>N</u>	CLI MATE HAZARD	Hail Sensitivity	T-Tolepant	Wheat Teff Havicot beano	$\forall \vdash \forall$	Neug Seaoome sunflower	$F \vdash \circ$
m	SALINI TY	Tolerance to Salinity	VH -Veryhightoleance to salinity Sonahum H - High M - Medium L - Low VL - Very Low Tet	inity Songhum Moure Wheat Pepper Teff	Z J T Z J	Chieck pea Noug Seasame	777
4-	SadicitY	Saturation of the exchange complex with Na ions	s - Semeitive M - Modevately T - Tolerant	Songhum Moise Wheelt Teff Havicotbean	ZNZZN	Chielspea Peppen Noug Seamme Sunflewer	いかいかい
-2	TOXICITY	Ca (6 3	L - Lew Tolerance M - Medium Tolerance H - High Tolerance	Songlum Marye Wheet Teff Movietblame	L M L- Not Know Not Know	Chiekper Peyper Nocug Sanflower	Not Know
2	WORKABILITY NON MECHANIZI	Non Machanized tarning (tillage)	2 -Low workinputreguived M- Medium " H - High "		XXIIX	Chickpea Pepper Noug Seadanne Sunflower	ミーエエエ
E	WORKABILI TY	Mechanized Jaming (general)	L - Low M - Medium H - Kigh	Songhum Maire Wheat Tef Haricotbean	T FI X I	Chickper Pepper Noug Samflower	T 1 1 1 1

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ADDENNIX 7

EVI	ENVIORNMENTAL	REQUIREMENT	Lon La	FOR CROP SOL	SOR SHUM			APPENDIX 2
					RANGES	OF SUITABI	LTY	
No	No LAND QUALITY	LAND CHARACTERISTIC UNIT		HIGHLY SUTTABLE	MODERTLY SUITABLE MARGINALLY SUITABLE		CURRENTLY Not. 5 PORMANENTLY Not. 5	CRMANENTLY Not.S
			1		1320-1400	1400-1300	1300 - 1200	21200
~	TEMPERATURE	Altitude	æ	1370 - 2200	2200 - 2270	2270 - 2350	2350 - 2400	22400
	REGIME	Mean Temperature			$L_{1} - h($	02 42	- 1 2 1 2	< 15-
		(Thermal Zone)	ບ ອ	c7- 21	24 - 26			> 35
2	GROWING PERIOD	Length of Growing Deried	day	180 -240	170-180	160-170	150-160	P212
		Effective Soil Jepth	Cm	7150	001-021	100 - 50	50-25	< 25
n	MOIS JUKE AVAILABILITY		-		180 - 200	160 - 180	140-160	07)/>
		trowth cycle	day	200 - 250	250 - 27c	>270		
					d 1	P - VP	L d)	SE = F
4	DKAINAG	Joil Dhamage	class	MM — MM	W - SW	SW - C		
		Maam Tamperature			L' - h'	24 L	21-25-15	<15
		(Thermal Zone)	0	18 - 25	24 - 26			>35
1	DEGRADATION	Length of Growing	day	180 - 2400	04/- 08/	170-160	160-150	2/50
5	HAZARD	Spil Texture	class	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	72-27	Sic - C (b1)	c(hd)	Ś
		Stonimess	class	erel	fairly story	pitter	very story	exceeding story
////		Slove angle	«/٥	8-0	1 20-16 1	16-130	as- oe n	>20 /
		Soil Texture	Class	7 - SC	72 - 27	Sil - C(bl)	C (rd)	λ
	NUTRIENT				6.5 - 6.0	6.0 -5.0	5_0 - 4.5	< 4.5
0	RETENTION	Soil Reaction	Hd	6.5 - 7.0	7.0 - 7.5	7.5 - 8.0	P.O-F.5	7.8.5
		Orgànic Matter	%	3-6	3 - 2.	2-1.	9.0-10.0	> 10.0
	RMTHG	Effective Soil Jepth	E.	>150		100-50	50-25	< 35
Ľ	CONDITION AND	stoniness	\vdash	prove	fairly story	story	very story	exceeding story
		Soil Toxture	elaco		1-3-57	Sic - C(bl)	" c(rd)	-6 ~
	<i>r</i>			-	×		90. ve	4

APPENDIX 2		VZ IENTLY. N.S	> 15	> 15	. PSK	Oxcooling stary	S						 					 						
APPEN		S PERMAN				DXCODE		RATING	X -	1 1	I	= >	X	-	Н	1	Σ	\$	V) v	∩ ^v	ר		-	M
	1 <i>TY</i>	S CURRENTLY N.	12-15	13-15	20-50	Level satismy	C (rd)	CROP	Chickpea	Verge V		SEasame	chick pea	Pepper	Moug	Seasame	Sumflower	Chickpea	pepper	Noug	2 masame		Chickpea	pepper
	= SUITABILITY	FINALLY SUITABL	J - /2	10-13	1630	story	Sic - lc (bl)	RATING	ī Ž	ΞI		5 2	X	X	\leftarrow	Н	Z	v	v v	2 F	8-14 8-14	0	Ŷ	Ś
	RANGES OF	SUITABLE MARG	b	0/	8-16	story	. STU S:	CROP	Songhum	+ Coolin	Tot	Hanicothean	Sorghum	Maize	Wheat	Tett	Havicotbeen	Sorghum	Maize	tor tor		Havicotbeam	Sorghum	Ma; 3e
Sopehum		MORERTLI	- 7	- 9	- &	fairly	7 20-		bay vegui ned	-		. =	m t				<u></u>	 Q					Ω.	
FOR CRUP SOR		HIGHLY SUITABLE MORERTLY SUITABLE MARGINALLY SUITABLE CURRENTLY N.S PERMANENTLY.N.S	<i>7−0</i>	0-6	S-0	Jusit	2 - SC	. Cl		H -Hibh	M - Mealurm	L - Low VL - Very low	t - Intolerant	M - Medium	T - Tolerant			5 - Senvitive	M - Medium			*	S - Semaitive	
FOR			hos/cm	ESP	%	Llass	Class	RISTIC							-906-					vity	~		\$ 	ity
QUIREMENT		LAND CHARACITIKISTIC UNIT	salinity	Alkalimity	Slope Angle	Stanine SS	Soil Texture	LAND CHARACTERISTIC	had-had>	preparation					Allack by Juntace	Water				Frost sensitivity				Hail Somsitivity
ENVIORNMENTAL REQUIREMENT		TAND UNALI Y LAND				LAND PREPARATION		LAND QUALITY	Condition Attraction	GEAMINATION AND	ESTABLISHMENT				FLOOD HAZARD					CLIMATE HAZARD				90°
ENV	1	2 S	Ċ	Ø		0-	_	No		0			 			·				12				

APPENDIX 2	RATING	► I	N		1 1		νž	S V		S	1-	Notraus		f 1	Σ-]	I	T	T			
A	CROP	Noug	Sunflower	Chieck pea	Noug		Chickpea	Noug	Seamone	Sunflower	Chiekpea	Pepper	Seaderine	Sanflower	Chickpea	Pepper	Sondame	Sunflower	Chickpen	pepper	Noug Second	Sunflower
	RATING	Υ	ΗX	X			W	٧.	Σ		1	5-	Not Know	Not Know	7:	ΓJ	: Т			Ξ	L W	I
	CROP	wheat t "	1 eff Havicot bears	wity Songhum) Malaz Wheat	Pepper	Sarahum	Maise	Wheelt	Left Havicotbeany	Sorghum	Marze	Wheat	Hoviestbeams	1 Songhum		Wheat	Hariest beam	Sorghum	Marye	Wheat	Harretbeans
o <u>serghum</u>	CLASSÈS	T-Tolepant		VH - Veryhigh toleance to Sal	H — High M — Medium	L - Low Pepper VL - Veny Low Tell		S - Semeriture	1	T - loverant		L - Low Tolerance	M - Medium Tellerance	H - High Tolerance		T-TOM MONINALINAL AND A	M-MEduum	H - HJU		M. Medium	H-Kigh	~
ENVIORNMENTAL REQUIREMENT FOR CROP	LAND CHARACTERISTIC	Hail Sensitivity			to	Salinity		Saturation of the	exchange complex	WITH IVA 1045		, ,	ره ره ع		41 Wa - 1	Lawing of 11 - 20	laiming innage			Machanized	Jaming (General)	
IIORNMENTAL REQUI	LAND QUALITY	CLIMATE HAZARD			SALINITY				Surrich			シナーノファイ				WORKABILITY	NON MECH, ANIZI			V77 11 98/1401.1	WOKKADICI I	
ENV	No	12			m				4				5			1	0			Ĕ		

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					RANGES	S OF SUITABILITY		
Na	No LAND QUALITY	LAND CHARACTERISTIC UNIT		SI SULARZE	MONERTY SUITABLE MARGINALLY SUITABLE CURRENTI	MARGINALLY SUITAOLE	Y Not.5	REPUTANENTLY Not.S
			1		1700-1500	1500-1300	1300-1000	<1000
•	TEMPERATURE	Altitude	æ	1700-2300	2300-2500	2570 -2600	2600 - 2800	人 2800
	KERIME	111			14 -12	9C 76	ン で の (01 >
		(Thermal Zone)	С e	15-20	シノ ー スチ			>35
3	GROWING PERIOD	Length of Growing	day	90-120	90 - 70	70-60	60-45	<i>245</i>
	1.0.1 1.0.1		Cm	> 50	50 -25	25-10	15-10	01>
n	AVAILABILITY				05-001	90-70	20 170	1 77.5
		trowth cycle	day		02/-02/	>130		01. Y
				i F	- T	D-VP	<i>di</i> t	11
4	DKAINAGE	Joil Dhamage	class	M – T	W-SW	SW-E		
		Maam Tamperature			71-21	A C L c) Le C	Qi>
		(Thermal Zone)	о С	15-20	オピーノア	· 20 20		>35
L	DEGRADATION	Length of Growing	day	90-120	.02-05	70-60	60-45	<45'
<u>с</u>	HAZAKD	1	class	$S_i - C(b_i)$	7 - 27	CT - C(bl)	52	S
		Stonimess (class	hone	fairly story	story	Very setory	exceeding story
		Q	%	8-0	191-8	$16 - \frac{130}{20}$	20-50	> 50 %
			Class	$S_{i}/-c(b_{i})$	7 - 27	CL - C(bl)	SL	С
9	NUTRIENT STATUS AND			1	6.5 - 6.0	6.0 - 5.0	5.0-4.5	< 4.5
)	RETENTION	Soil Keaction	H d	6.5 - 7.0	7.0-7.5	7.5 - 8.0	8.0-8.5	7 8.5
		Orgànic Madler	%	3 - 6	3 - 2. 6.c - 7.5	2-1 2.59.0	9.0-10.0	> 10.0
	Rooting	Effective Soil Depth	Cm	>50	50 -25	25-15	15-10	0'2
L	CONDITION AND WORKARI ITY	stoniness (class	hone	fairly story	story	Very story	exceeding stone
		Soil Texture	clàoo	(la) - c(b)	7 - 27	cL - c(bL)	USL.	-b
				÷.				

APPENDIX 2

TEFF

ENVIORNMENTAL REQUIREMENT FOR CROP

	ENVIORNMENTAL	REQUIREMENT		FOR CROP TEFF				APPENDIX	7
LAND	LAND QUALI TY	LAND CHARACTERISTIC UNIT	חכ טאח		RANGES OF SUITABLE MORERTLY SUITABLE MARGINALLY SUITABLE MORERTLY SUITABLE CURRENTLY N.S	S OF SUITABILITY MARGINALLY SUITABLE CU	LITY E CURRENT Y N.S	NZ PERMANENTLY, N.S	Y.N.S
ł	~~~~~	salinity	hos/cm	0 -4	4-8	8-12	12-15	215	
0	10/10/1/120	Alkalimity	ESP	0-6	9-10	10-13	13-15	-215	
MAG	MAGEMENT	Slope Angle	%	& - 0.	8-16	16-30	30-50	.0-25-0.	
DAND AND	LAND PRE PARATION AND MECHANI7A-	V staniness	Class	hune	fairly story	stony	very story	OR caling stony	Kony
T101	TION POTENTIAL	Soil Texture	Class	51 - d (b1)	1 - 5cy	$c \leftarrow (b \cup - c(b \cup)$	U ST O	-50	>
TAND	VD QUALITY	Y LAND CHARACTERISTIC	TERISTIC	. cl	CROP	RATING	CROP	RATING	
CON. FEAN EST	CONDITION AHECTING GEAMINATION AND ESTABLISHMENT	TING Seed-bed D Preparation	2	VII-Veryhigh energy required H - High " M - Medium ". L - Low ". VL-Verylow ".	rygyreguiped Songhum "Maize "Teff "Hanicathean	H H H H NOOC	Chickpea Pepper Noug Sunflower Seasame	Z J I I Z	
E70	FLOOD HAZARD	Atlack by Sunface water	face	I - Intollerant M - Medium T - Tolerant	t Sorghum Maize Wheat Teft Havicothean	X X H H X K	chickpen Pepper Noug Seasame Sunflower	ΣΗΗΣ	•
CPN	CLIMATE HAZARD	D Frast sensitivity	ivity	5 - Seneitive M - Medium T - Tolerant		m NNN F W	Chickpea Pepper Noug Seasame	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
	-	Hail Someitivity	vity	S - Seneitive M - Madium	Sorghum Maize	5 S	Chuckpea	~ ~	

NMENTAL REQUIR	ENVIORNMENTAL REQUIREMENT FOR CROP	CLASSES	CK&P	RATING	APPE CROP	APPENDIX 2 RATING
Hail Se	Hail Sensitivity	T-Tolevant	Wheat	W	Nong	F
	>		Teff Havicot beano	ΗŽ	Seasone Sunflower	Fν
Tolerance to Salinity	ice to	VH -Veryhigh toleance to salinity Songhum H - High M - Medium L - Low VL - Very Low Teft	nity Sonahum Mouze Wheat Pepper Teff	Z J T J J	Chieckpea Norg Seasame	111
Satura excham with 1	Saturation of the exchange complex with Na ions	5 - Semeitive M - Modevately T - Tolenant	Songhum Moise Wheet Teft Haricotbeany	ZNZZD	Chrickpea Peppen Noug Seamene Sunflewer	NZNZN
ره ره ع	Ŕ	L - Lew Telerance M - Medium Telerance H - High Telerance	Serghum Marze Wheat Teff Howest blama	L Not Know Not Know	Chiekpea Pepper Nocug Semplewer	Not Kauru
Non M. Farmin	Non Machanized tarming (tillage)	2 -Low workinputreguired M-Medium " H-High "	f Songhum Maize Wheat Teff Harieotbean	HYHHY	Chickpea Pepper Noug Seadame Sunflower	エエエトヌ
Mecha	Mechanized Faming (general)	L-Low M-Medium H-Kigh	Sorghum Marge Wheat Teff Acrieotheano	K K K X X	Chickper Pepper Noug Seasame Sunflower	トレイト

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2	VIOKNMENIAL	UNVIOKNMENIAL KONOIKEMENI	r r				·	MILENON E
					RANGES	S OF SUITABILITY	וידדץ	
Ž	No LAND QUALITY	LAND CHARACTERISTIC UNIT		NIGHLY SUMABLE	MONERDY SUITABLE MARGINALLY SUITABLE CURRENTLY	MARGINALLY SUITABLE	CURRENTLY Not.5	RPANENTLYNOLS
			1		1360 -1200	1200 - 1100	2021-0011	< 1000
-	TEMPERATURE	Soutitly	Ę	1300-2200	0722-0022	2270-2350	2350-2400	0072<
•	KERIME	Mean Temperature	6	× C T & T	レノー カノ	07 F6	72 12	<i>サ1 ≻</i>
		(Thermal Zone)	С e		24 - 26	a/ 20		>35
R	GROWING PERIOD	Length of Growing Deriod	day	210-150	150-140	140 - 130	130-120	×120
	2012 FION	Éflective Soil Depth	Cm	> 150	150 -100	100 - 50	50 -25	L 25
Ю	AVAILABILITY		-	0µ1- ч71	150 - 160	140 -150		<r-></r->
		thouth cycle	day	0/1-00/	170 -180	>/80	/ 20-/40	
×	- JANKA				ф Т	9V-9	L C	
4	UNAWAGE	Jon Dramaye	class	M – T	W - SW	SW-L	$\Delta - \Delta \Lambda$)
		Maam Tamperature	¢	r C	14 -17	したーとの		514
		(Thermal Zone)	,U	10 - 00	92- 4C		00-10	>35-
L	DEGRADATION	Length of Growing Deviod	day	210-150	0.41- esi	140 - 130	130-120	2120
>	HAZAKD		Class	L - SC	15 - 51	5; c - C (rd)	c (PI)	Ь
		Stoniness	class	None	fairly story	proto	Very story	exceeding story
		Slope angle	°/0	0-8	3 - 19	16 - 30	(30 -50	>20 0
		Soil Texture	C/255	7 - Sc	72-27	Sic - C(rd)	C(bl)	Ь
9	NUIKIENI STATUS AND		-	ロズーシフ	6.5 - 6.0	6.0-5.0	5.0 - 4.5	24.5
)	RETEN TION	Soil Reaction	нd		7.0 - 7.5	7.5 - 8.0	P.0 - 8.5	>B.5
		Orgànic MzHer	%	5 - 6	3-2	7.5 - 19.0	9.0-10.0	> 10.0
	RODTING	Effective Soil Jepth	C.	> 15-0		100 - 50	50-25	< 25
5	CONDITION AND WORKARI ITY	Stoniness	claod	hore	fairly story	story	Very story	exceeding story
	~	· Soil Toxfure	class	7 - SC	72 - 27	Sic - C(rd)	C(k)	56
		-	-					

MAIZE

ENVIORNMENTAL REQUIREMENT FOR CROP

EN	ENVIORNMENTAL REQUIREMENT		FOR	FOR CROP MAIZE	75				APPENDIX 2	
No	LAND QUALITY LA	LAND CHARACTERISTIC LINIT	1 1	5	RA. 52	RANGES OF	SulTABILITY 53	JTY MI	/	\square
				HIGHLY SUITABLE MORENTLY SUITABLE MARGINALLY SUITABLE CURRENTLY N.S PERMANENTLY. N.S	MORERTLY SUI	TABLE MARGI	INALLY SuiTABL	E CURRENTLY N.S.	5 PERMANENTLY. N	<u>V.S</u>
Ø	TAXICITIES	Salinity	hos/cm	0-4	<u> </u>		8-12	12-15	ら入	
o	10/10/1100	Alkalimity	E SP	0-6	6 - 10	7	10-13	13-15	>15-	
	MAGEMENT	Slope Angle	%	Q-0.	8-16		16 - 30	30 - 50	.ar<	
0-	LAND PREPARATION AND MFCHANIZA-	Staniness	<i>Llass</i>	hore	fairly story		stone	very stary	ax ecoling story	.3
	TION POTENTIAL	Soil Texture	Clàss	L - Sc	7S - S7		Sic - cl(rd)	C(b)	2 N	6
No	LAND QUALITY	LAND CHARACTERISTIC	ISTIC	CI		CROP	RATING	CROP	RATING	
				VH-Veryhigh emergy required		Songhum	E	Chickpea	W	
0	CONDITION AFFECTING GEAMINATION AND	Preparation		Н — Н:Ем		Maise	Z 1	Deplev	-1 =	
	ESTABUSHMENT			INDI		Tor I		Nond	r I	
				_			H ·	Junflower		
				VI- Very 10W		Harrentolean	Σ	Jeasame	H>	
				T - Intolevant		Sorghum	X	chickpen	W	
						Maize	X	Pepper	- 1	
	+TOOD HAZAKD	Atack by Jurtare	Y	T - Tolerant	M	Wheat		Noug		
		Marten				Ha Ha	Н	Seasame	7	
					Hai	Havicotbean	¥	Sumflower	Z	
			_	5 ~ Sensitive		Sorghum	v	Chickpea	\$	
				M - Medium	W	Maize	γn ι	Pepper	N I	
12	CUMATE HAZARD	Frost Sensitivily	ły			ול	n †	Noug	∩ v	
			••••)	Her	Havicotbean	- V	2 masami)	
				< - Semaitive	V	munporc	8	Chickpea	T	
	Бъ.	Hail Sensitivity	~~~~~	1	W	Ma: 3e	ŝ	pepper	"	

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XIA	
PPEN	
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MAIZE

Not Kauru RATING 1 -1 5 NZNZN 1 1 レイト 1 1 エエ ーエ T Σ FFS Sunflower Pepper Noug Seadome Pepper Noug Saccome Sunflower Sanflower er. Noug Seasame Noug Seasame Seamone Chieck pea Sunflower Chickpea Seadonne Chickper Chiek pea Chick pea Peppen Noug Pepper CROP Not Know Not Know RATING ۷L LZL えいえてい Г ZJT TZIIZ I II X Z T Z 1 Havicotbean Teff Howest blems Teff Havieot beans Teff Hariestbeam Teff Harieotbeano Sorghum Maize Wheet VH -Veryhigh toleance to salinity Songhum Marze Wheet Pepper Songhum Songhum Moize Wheet Sorghum Marye Wheat Marze CRAP Wheat L-Low workinputrequired - Medium Televance - High Tolerance L - Low Tolerance z M - Modevately s - Semiltive T - Tolevant T - Tolerant CLASSES H - High M - Medium L - Low V2 - Very Low M - Medium H - High M-Medium H - High MO1-7 T \leq ENVIORNMENTAL REQUIREMENT FOR CROP Jaming (Beneral) LAND CHARACTERISTIC exchange complex Saturation of the Non Machanized farming (tillage) Hail Sensitivity with Na ions Folerance to Mechanized Salinity ره کې CLIMATE HAZARD LAND QUALITY NON MECHANIZI WORKABILITY 17 WORKABILI TY TOXICITY SALINI TY SODICITY m Ŷ М 4 5 ~____

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Sunflower

			, } ,					
					RANGES	S OF SUITABILITY	וחדץ	
No	No LAND QUALITY	LAND CHARACTER ISTIC UNIT	FIND	HIGHLY SUTTABLE	MODERTLYSUITABLE	MARGINALLY SUITABLE	MOBERTY SUITABLE MARGINALLY SUITABLE CURRENTLY Not.5	RESMANENTLYNOT.S
			1		1200 - 1100.	af01 - 2011	1050 - 1000	× 1000
45000.	TEMPERATURE	Altrude	Ę	000 P - 002/	2000 - 2200	2200 - 2500	2500 -2800	72800
*ø	KERIME	MeanTemperature	6		19 - 21	15- 18	h1- 01	0 / >
		(Thermal Zone)	с С	22 - 24	25 - 30.	31 - 35	38 38	738
R	GROWING PERIOD	Length of Growing Deriod	day	90 -150	90 - 85	82 - 22	80 - 75	< 75
	MONTER	Effective Soil Jopth	Cm	100-150	50 - 100	25-50	10-25-	01>
m	AVAILABILITY				10-0-1/0	90-100	o I R	8
		though addie	day	110 -140	140 - 160	>160		0 0 1
~					T	P	P	VP
ト	TAUNIAN	showard has	Class	M M M	SE	SН	Ш	Ē
		Maam Tomperature			12-51	15-18	71-01	Q / >
		(Thermal Zone)	"U	40 - 20	25-30	31-35	36-38	>38
Ŀ	DEGRADATION	Length of Growing	day	90-150	90-85	85 - 50	80 - 75	< 75-
)	hA ZA KU		class	72 - 2CT	5;/	Sic	C(rd)	C(bl)
overen open og føret		Stoniness	class	Jushe	fairly story	setones	Very story	exceeding story
		Slope Engle	°/0	0 - 8	<i>2</i> −16 ⁰	16-30	30-35	>35 0
			Class	LS-ScL	5;/	Sic	C (rd)	C(bb)
ý.	STATUS AND		~	1	6.5 - 6.0	6.0 - 5.5	5.5 -5.0	0:5>
)	RETEN TION	Soil Keaction	нd	0·/ – C·9	7.0 - 7.5	7.5 - 8.0	8.0-8.5	78.5
		Orgànic Matter	%	>3	2-3	/-2	- 1 0	
	ROOTING	Effective Soil Depth	Cm	100 - 150	201-25	25-50	10-25	01>
	WORKABILITY	Stoniness	class	hore	fairly - story	story	Very story	exceeding stories
	19	= Soil Toxfure	elàco	72-27	S:/ "	Sicu	c(hd) - c((bl))	

APPENDIX 2

SUNFLOW ER ENVIORNMENTAL REQUIREMENT FOR CROP

ENVIORNMENTAL REQUIREMENT FOR No LANDQUALITY LANDCHARACTERISTIC UNIT	EQUIREMEN	ETI(N N	RAN RAN	RANGES OF	Surtabill TY	1 T Y	APP ENDIX	
		Salimitu		HIGHLY SUITABLE	MORERTLY SUIT	ABLE MARGI	NALLY SUITABL	E CURRENTY N.S	PERMANENTLY	N.S
TOXICITIES		Alkalim: ty	E SP	0-6	9-10		0-12	12 -15	715	
MAGEMENT		Slope Angle	~ ~	& - 0 _.	91 8		16 30	30-35	>35	1
LAND PRE PARATION AND MECHANIZA-		stonine ss	LIA:SS	hore	fairly story		stone	very story	exceeding strong	ma
		Soil Texture	Class	72 - SCL	S:1 "		Sic	C(nd) - C(b))) N	
LAND QUALITY		LAND CHARACTERISTIC	RISTIC	CI	0	CROP	RATING	CROP	RATING	
CONDITION AHECTING GEAMINATION AND ESTABLISHMENT		Seed-bed preparation		- Veryhigh ene - High - Medium - Low		Songhum Marze Wheat Teff	пΣнУ	Chickpea Pepper Noug Sunflower	ZJII	
				N- very 1000	1100	Harleydlan	Σ	Jeasame	ЧЧ	
FLOOD HAZARD		Allack by Sunface Water	a Ce	I - Intollerant M - Medium T - Tolerant		Sorghum Maize Wheat Teff	ZZHHZ	chick pea Pepper Noug Seasame Seasame	ΣΓΗΗΣ	•
	1				5	>	-			
	1			5 - Senaitive		Sorghum	v	Chickpea	S	
				M - Medúm		Maize	νи	Pepper	N N	
CLIMATE HA JAKD		Frost sensitivity	vity	T - Tolerant	Teff	~	1	Slasame	Ś	
					Heavi	Havicotbeam	0			
			¢	S - Semaitive	20	Sorghum	Ś	Chiekpea	├ •	
26-		I Hail Sensitivity	ity	M — Medium	* Wa	36	S	pepper	×	

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ENDIX	The second s
d	l

SUNFLOWER

Not Kauru RATING 1 ちょう かく •• 5 -1 1 1 レイレ エエエ S Σ トト Pepper Noug Seadame Surflower Peppen Noug Seamanne sunflower Pepper Noug Sacrame Sunflower Peyper No-ug Seasonne Ž Noug Seasame Noug Seaoame Samplewer Chieck pea chickpea Chickper Sunflower Chiels pea Chrick pea CROP Not Know Not Know RATING < / L 7 えいえてい ΣL \Box ーエ エズエエズ Σ \leq エエエズエ \geq \vdash Maine Wheat Teff Horiest blame Teff Hariestbeam Teff Havieot bearso Teff Havicot bean Teff Haricotheano Scrahum Maise Wheelt VH - Veryhigh toleance to salinity Songhum) Malaze Pepper Songhum Songhum Sorghum Marye Wheat Meize CRAP Wheat 2-Low workingutreguived M - Medium Telerance H - High Tolerance L - Low Tolerance M - Moderately 5 - Semeitive T - Tolevant T - Tolerant H - High M - Medium L - Low CLASSES V2 - Very Low M-Medium M-Medium H-High H-Kigh MO-1-7 ENVIORNMENTAL REQUIREMENT FOR CROP Jaming (Beneral) LAND CHARACTERISTIC exchange complex Saturation of the Non Machanized farming (tillage) Hail Sensitivity with Na ions Folerance to Mechanized Salinity ره کې CLIMATE HAZARD LAND QUALITY NON MECHANIZI WORKABILITY WORKABILI TY TOXICITY SALINI TY Sadicity 4 m E Ŷ 91 M 5

LAND USE PLANNING AND REGULATORY DEPARTMENT. MINISTRY OF AGRICULTURE Addis Ababa

Study Area/Project : Location/Coordinates : Harawa Field Number: Porale

API	ENDIX.3
e 9	Unit 1-B

, non at a substance of the		Depth,	syngta yksag gitterstβijilinnia (fraf	Textu	·e,% (Ø= mm)		Texture	pH,	1:1	In	CoCO3	Free Fe ₂ 03
	Field No.	cm.		2-0.2	a2-0.05	0.05- 0.002	<0.002	Class	Η20	KCI	NaF	%	%
1749	<u>[]-1-]</u>	10-30						56	7,30				
17.50	H-1-1	120-140			·			<u> </u>	7.25			ne for the first Million and Source Sources	
17.57	H-1-2	30-50						C	7.40			-	
1752	1-1-3	10-30						4	8.20			-	
1753	H-1-3	110-125						CL	6.60				

		Depth,			- Exch	angeables	, milliequiv	ratent / I	00gm s	bil			Base
Lab. No.	Field No.	· cm.	Na	к	Ca	Mg	AI+H	AI	н	Sum	C.E.C. Sum	C.E.C. Det.	Saturat. %
1749	H-1-1	10-30	0,109	1.984	53	5			1	-		1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	
1750	11-1-1	120-140	0.326	1.536	65	· 3				-			
17(7	H-1-2	30-50	0.271	2.016	45	7							
1-12-7	1	10-30	1		26	2							<u> </u>
nanfanasayin nangi na	1	110-125				9							ļ
1-1-3-2-	fi-i-v	110=1=2	19:5-					1	<u> </u>)	<u> </u>

Lab. No.	F fald No,	Deptis, cm.	Org.C %	Tot. N %	с/N	о.м %	Avail. P ₂ O ₅ ppm	Avail. K ppm	Satur. %	Field capacity %	R W.P %	Available H ₂ 0 %	
1749	17-1-1	10-30	3.105	0.196		3.105	5:0						
1.7.50	H-1T.	120-140	1.898	0.126		1.898	4.8						
17.57	1-1-2	30-50	0.897	0.084		0.897	4.8			<u>``</u>			<u> </u>
1752	H-1.3	10-30	2.691	0.21		2.691	4.8						
2753	11-1-3	110-125	0.863	0,112		0.863	2.4						
	Date	1,		.1		Chief o	f Lab						

LAND USE PLANNING AND REGULATORY DEPARTMENT. MINISTRY OF AGRICULTURE Addis Ababa

Study Area/Project : Location/Coordinates : Hasawa Field Number: Bale

Unit 1-8

		Depth,		Textu	·e,% ()	Ø= mm)		Texture	pH,	[:]	In	CaCO3	Free Fe ₂ 03
	Field No-	cm.	>2	2-0.2	0.2-0.05	0.05- 0.002	<0.002	Class	H20	KCI	NaF	%	%
1754	11-2-1	0-20					,	Sel	6.40				
1755	H-2-1	75-90	- 17-0-0-12-0-0 Chain Broom					C	650				
1756	H-3-1	0-30						<u> </u>	6.05				
1757	H-4-1	20-40						CL.	6.40				
1758	1-4-1	97-110						<u> </u>	7.10				

	Depth,			Exch	angeables	, milliequiv	valent / IC	DOgm so	II	-		Base
Field No.	cm.	Na	к	Ca	Mg	AI+H	AI	Н	Sum	C.E.C. Sum	C.E.C. Det.	Saturat. %
H - 2 - 1	0-20	0.054	2.464	29	.3						1 data par	
H-2-1	75-90	0.054	1.536	28	4			· .			·	
4-3-1	0-30	0.027	2,624	29	5-							
H-4-1	20-40	0.054	3.648	40	2							
H-4-1	97-110	0.109	1.600	43	5						1	
	H-2-1 H-3-1 H-4-1	ст. H-2-1 0-20 H-2-1 75-90 H-3-1 0-30 H-4-1 20-40	Field No. cm. Na <u>H-2-1 0-20 0.054</u> <u>H-2-1 75-90 0.054</u> <u>H-3-1 0-30 0.027</u> <u>H-4-1 20-40 0.054</u>	Field No. cm. Na K H = 2 - 1 0 = 20 0.054 2.464 H = 2 - 1 75 - 90 0.054 1.536 H = 3 - 1 0 = 30 0.027 2.624 H = 4 - 1 20 - 40 0.054 3.648	Field No. Cm. Na K Ca H-2-1 0-20 0.054 2.464 29 H-2-1 75-90 0.054 1.536 28 H-3-1 0-30 0.027 2.624 29 H-4-1 20-40 0.054 3.648 40	Field No. Cm. Na K Ca Mg H-2-1 0-20 0.054 2.464 29 3 H-2-1 75-90 0.054 1.536 28 4 H-3-1 0-30 0.027 2.624 29 5 H-4-1 20-40 0.054 3.648 40 2	Field No. Cm. Na K Ca Mg Al+H H-2-1 0-20 0.054 2.464 29 3 H-2-1 75-90 0.054 1.536 28 4 H-3-1 0-30 0.027 2.624 29 5 H-4-1 20-40 0.054 3.648 40 2	Field No. $\frac{1}{cm}$, $\frac{1}{Na}$ K Ca Mg Al+H Al H-2-1 $0-20$ 0.054 2.464 29 3 H-2-1 $75-90$ 0.054 1.536 2.8 $4H-3-1 0-30 0.027 2.642 2.9 5^{-1}H-4-1$ $20-40$ 0.054 3.648 40 2	Field No. Cm. Na K Ca Mg Al+H Al H H-2-1 $O-20$ $O.054$ 2.464 29 $3H-2-1$ $75-90$ 0.054 1.536 2.8 $4H-3-1 0-30 0.027 2.624 2.9 5^{$	Field No. cm. Na K Ca Mg Al+H Al H Sum $H-2-1$ $0-20$ 0.054 2.464 29 3 $$	Field No. Depin, cm. Na K Ca Mg AI+H AI H Sum C.E.C. Sum $H-2-1$ $0-20$ 0.054 2.1464 2.9 3 $ -$ <td>Field No. Depinson Na K Ca Mg Al+H Al H Sum C.E.C. Sum Def. $H-2-1$ $0-20$ 0.054 2.1464 29 3 </td>	Field No. Depinson Na K Ca Mg Al+H Al H Sum C.E.C. Sum Def. $H-2-1$ $0-20$ 0.054 2.1464 29 3

Lab. No.	Field No.	¢m.	Org.C %	Tot. N %	C/N	о. м %	Avail. P ₂ 0 ₅ ppm	Avail. K ppm	Satur. %	Field capacity %	RW.P %	Available H ₂ 0 %	nganana kanana kanana kanana kanana kanana
1754	14-2-1	0-20		0.224		2.45	8.8						
1755	H-2-1	75-90		0.168		1.932	4.8						
1756	H-3-1	0-30		0.182		2.76	5.8			<u> </u>			
1757	11-1-1	20-40		0.238		1.898	11.2						
1758	#A-1	97-110		0.042		1.38	5.8	·					
·	Date		4		L	Chief of	Lab		1			L	

LAND USE PLANNING AND REGULATORY DEPARTMENT. MINISTRY OF AGRICULTURE Addis Ababa

Study Area/Project : Location/Coordinates : Hanawa Field Number: BALE

Unit 1-8

		Depth,	Textu	e,% ()	Ø= mm)		Texture	pН,	1:1	In	CaCO3	Free Fe ₂ 03
Lab. No.		cm.	2-0.2	a2-0.05	0.05- 0.002	<0.002	Class	H2O	KCI	NaF	%	%
1759	H-5=7	0-25	 	· · · · · · · · · · · · · · · · · · ·			<u> </u>	6,25			<u> </u>	
1760	H-5-1	60-76	 	· · · · ·			C	6.50		-		
17.61	H-6-1	0-30	 	· · · · · · · · · · · · · · · · · · ·			504	6.05				
1762	H-6-1	6580	 				C	6.30				
1763	#=7=1	10-30					-6-	6.35				

		Depth,			Exch	angeables	, milliequiv	valent / K	00gm so	bil			Base
Lab. No.	Field No.	· cm.	Na	к	Ca	Mg	AI+H	Al	н	Sum	C.E.C. Sum	C.E.C. Det.	Saturat. %
1159	11-5-1	0-25		1.728	27	<u> </u>							
1160	H-5-1	60-76	0.163	1.536	26	2				-			
1761	H-6-1	7-30	0.027	1.76	29	3							
1762	H-6-T	65-50	0,109	1.216	30	4							
1963	11-7-1	10-20	0.271	1.92	2(-	4							

Lab. No.	Field No.	cm.	Org.C %	Tot.N %	C/N	0. M %	Avail. P ₂ O ₅ ppm	Avall. K ppm	Satur. %	Field capacity %	R W.P %	Available H ₂ 0 %	
1759	H-5-1	0-25		.0.168		4.14	8.0						
1760	H-5-1	60-76		0,126		1,53	4.8						
1761	1-6-1	0-30		0.182		2.243	3:0			\`			
1162	H-6-1	65-80		0,112		1.380	2.4						
1763	4-7-1	10-30		0.159	i	2.070	0.8						
	Date	La	<u></u>	1		Chief o	1 f Lab		and			an a Caracteria a Canada a Caracteria da Caracteria da Caracteria da Caracteria da Caracteria da Caracteria da	

LAND USE PLANNING AND REGULATORY DEPARTMENT. MINISTRY OF AGRICULTURE Addis Ababa

Study Area/Project	8	HARAWA	Field	Number:	Unit 1-8
Location / Coordinates	4	BALE		<u></u>	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

999-999 999 999 999 999 999 999 999 999		Depth,		Textu	re,% (Ø= mm)		Texture	pH,	1:1	In	CoCO3	Free Feo O a
Lab. No.	Field No-	cm.	> १	2-0.2	Q2-0.05	0.05- 0.002	<0.002	Class	H ₂ 0	KCI	NaF	%	Fe203 %
1764	H-7-1	80-95	langt frýsland finlastyjnurgina		·		- 1	CL	6.90	tgtg			
1765	H-8-1	0-20				·		SCL	6.30				
1766	4-8-1	30-60			· · · · · · · · · · · · · · · · · · ·			C	6.40				
1767	M-L	0-30			<u> </u>			C	8.15				
1868	MI	70-90			<u> </u>			C	3.60				

		Depth,			Exch	angeable	s, milliequi	valent / H	DOgm so	11			Base
Lab. No.	Field No.	cm.	Na	к	Ca	Mg	AI+H	AI	Н	Sum	C.E.C. Sum	C.E.C. Def.	Saturat. %
1764	H-7-1	80-95	0.380	1,216	.30	.7							
1765	H-8-I	0-20	0.163	1.632	25	· /			· · ·				
1766	17-8-1	30-60	0.271	1504	26	5							
1767	M-T	D-30	1.194	0.992	91	16							
1708	M-L	70-90	8.572	0,288	82	13	-						· · · · · · · · · · · · · · · · · · ·

Lab. No.	f leid No,	cm.	Org.C %	Tot. N %	C/N	о. м %	Avail. P ₂ O ₅ ppm	Avail. K ppm	Satur. %	Field capacity %	r w.p %	Available H ₂ 0 %	
1264	H-7-1	80-95		0.048		1,380	3.2						
1765	H=8=1.	0-20		0,280		2,484	64						
1766	H-8-1	30-60		0.042		1.829	4.8						
176.7	M-T	030		0.168		1,725-	6.4						
1968	M-1	20-90		0.084		1.553	3.2						
	Date			I	L	L Chief of	Lab	·····	l		L		

Harawa

Bale

Field Humber

LAND USE PLANNING AND REGULATORY DUPERTMENT MINISTRY OF AGRICULTURE Addis Aboba

Study Area / Project : Locotion / Goordinates :

Lab. No.	Ter Locket Science	Depth,		Textu	0,% (Ø= mm)	4.000 (m.100 m.100 f) = 6)******	Texture	pH,	}:}	ana ara ar an a Ar an ar an	r 1 Cathar	Freu j Fa-63 j
		\$*%.	部黨	2-0.2	0.2-0.05	0.05 0.002	<0.002	C ano	H20	KC I	Maf		re: 03 1
350/86	H91-A_		and a construction of the second s		38.0	32.0	30.0	CL	7.55	-mulaid physicilaria	for the second s	and a strain we have a start of the strain o	
351/86 .	H9-1-B		**************************************		38.0	30.0	32.0	C۷	7.45	The second secon	la de la companya de		n annandistanterist og er og s T T T T T T
352/86	H9-2-A		} 		42.0	28.0	30.0	CL	6.40		and a second out of the provide second	forten and server and the	and an effective state of the s
3531/86	H9-2-B	1			28:0	18:0	54.0	C	6.85	n menelike ganal darhanggara	S S S S S S S S S S S S S S	and a sumplication of the states of the stat	an 1989, The state of the second s
a and a contract of the second s	**************************************			-		e company - contractions - c						and the second sec	ultrillion ar comparing runset of t
and the stand of the second						i	ĩ	2	Ł	2	2	,	fore measurements

Lab.No.	Field No.	Dapth,			Exch	anyoabka	, mill south	nsient / IC	0 ang 00	ii	fharairtí — é gconn ragna a	in The Television of the second s	86.61.
Shi Tan-Balaka baran more dana - dabata	-	¢m.	łia	к	Ca	Мg	Ai+H	AL	ĥ	Saa	C E.C. Jom	T.E.C. Liai	Scaurat. %
350/86	H9-1-A		0.27/_	0.736	54		n an		unis antiditario desprimentajolares Eksentidaren (m.dma), es contras	, nanos antisensis, anti-	Anton nanametrosa - maanda 1 1 1 metros - antones - maanda 1	47.4	hallin han an the source of th
351/86	H12-1-B	212-0-1753/2012/2-0-1753/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2-1752/2	0.488	0.544	57	6	1. 2012 2012 2012 2012 2012 2012 2012 20	ang distance (signific a proop	an a	e delevente george — mustoje e delevente george — mustoje e delevente delevente - n meno e con	2 Sent - Laterston - Hogenstander Monae, Staatsanger, - e	50.0	nadori un no z i nor un cona dan Nation conten or trinageno p
352/86	H9-2-A	anna ann an State Stann Tall ann an State Stanna an Thurston an State State State	0.163	0.640	53	6	al an	1994 1997 1997 1997 1997 1997 1997 1997		- conservation in a second sec	and a second sec	41-6	a tan in dhaaranna aan
353/86	H9-2-8	antina finale survey a paratemetaria se	1.573	0.608	61	14			n a gan yang kanang menangkan Maning kang menangkan pang kang menangkan pang menangkan pang menangkan pang menangkan pang menangkan pang menan		and Maran Prove of the Articles	27.4	- Maratha Addin Jongo Marata ang
Langender oder state der son die Geberer zu der State -	in a freedow, white an address of the second sector of the sector				- Incontractor of the second	9 49 484 30 1 49 40 40 40 40 40 40 40 40 40 40 40 40 40	an a	in second state in the second state of the sec	o demonstration de la management de la companya de	foreite et al constant a millionada a millionador - 1 k - Traject a mi	Sea at a "se meno internation regionages 	ferris - Shipton Lordon	

 Lat. No.	i iold No.	Варш, ст.	org.c %	To1.N %	с/н	0. м %	Avail. P ₂ 0 ₅ KgPMa	Avail. R ppm	Satur. Ve	Flaid Statig %	R W.P 54	pansikable NgG Ve	
	and and a second second second se	۲ ₁		0.182		4.00	1.6	-		are supported as the support of the support		l 	
and real particular real and r	a und rundsagengegeben bleiten nom u analynnen all an maaine de aater aktere		**************************************	0.154		3.240	0.8			anga kalunan di kaluna sa ka		all and the state of the state	
The of contract provides and	n (er fan i sander omeringen yn manger om i di mer - Staffer (sander omeringen yn manger o dia sander fan ger			0:196		6.000	0.B		an a				1 Angelenge og Arne angels av 5.
post - materialisation is between the	1			0.168		2.970	1.2			(1470-107-107-107-107-107-107-107-107-107-1	and a stand distance of the product distance of the stand distance		and the second s
************************************									a			2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
	the second state of the state o	Summer Amazon			1	the second as a state of second	a and the second second			Remains Rantidus	- and territorial with - all highligh	Lanon a) k k alama ang angar sala
	Dala	\$\$\$\$.mx%;\$**\$\$\$ \$	99219-01-0 ⁴ -09-0809-02-09-02-09-	1418-569-11-0-0409-529-19-19-19-19-19-19-19-19-19-19-19-19-19	&}++ **=+:10#**** -109	Chief of	Hab	tymestaphtus wie, the in wi	an -Qualinia (10 a.15- haadtarpite s)	genimed charge of the William 1	natur (transference - a algebra	e	9

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Unit 9

LAND USE PLANNING AND REGULATORY DUPORTMENT MINISTRY OF ACRICULTURE Addis Abuba

Study Area/Project : <u>Harawa</u> Field humber: <u>Unit 9</u> Location/Coordinates : <u>Bale</u> Locotion / Coordinates :

		Depth, cn.	an a	Tex Su	0,% ()	2:= mm)	ana kanan kana	Texture	рΗγ	1:1	in .	Cach 3	Frie Fazula
Lab. No.	Field No.	cm.	>2	2-0.2	0.2-0.05	-20.0 0.002	<0.002	Ciarac	E20	NG I	naf	%	16
354/86	H9-3-A_		an a tanan manakan kapanan tang dari dari dari dari dari dari dari dari	a	30.0	24:0	46:0	C	6.55	agaaning and a subscription	and the second		
355/86	H9-3-B	ĨĸĸŢŔŊĹĸġĊĸIJĊĸŎĊŢĸŢŶŎŢĊĬĬŦŢĬŔŦŢ ĸĸŊŔŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎŎ			34,0	20:0	46.0	C	6:05	anger Banamangarbarbahanan Pampo - Ana antidakan na	1. Januari, 1. S. Shirida analar Marina ang kanalari 1. Ang kanalari ang	ndendigenden steringender steringen V steringseringen stringen	n of the second s
356/86	H9-4-A				36.0	26.0	38.0	CL	5.90		and a service is to be a service of the service of		2019 m (Saadiga, Siri Walanda, 1990 m), a - 1,6 a (199
257/86	119 <u>-4-B</u>	2 		a a a a a a a a a a a a a a a a a a a	34.0	20:0	46.0	C	6.60	a strategister and a strategister	an forenander of a systemistic sec		piles kalanteer – – i nationalisettee a Moritani Kalendationen aattike Makapuri Mahapiteitiing
					1				and the second s	Controlotion Sprawland		+	

an a		Cepth,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1400 USEN - 14 CARLEN IN BOARD AN ANNA	Exch	angeables	, millisquin	islant / IC	Ogm so	17 27 27	, name, e, store frankreferinde	and an experience of the second s	BCAC
Lab.No.	Field No.	C171.	Ha	к	Ca	Mg	Al+H	Al	Н	Sam	D.E.C. Som	C.E.C. Lot.	Se inro t. Ka
354/86			0.108	1.792	36	8.0		nangina pana danggaba		jan en yantan en ya		38,2	1
355/86	H9-3-B	989	0;163	1:728	47	6.0	an a	an anti-artemany gran and a sur-	, , , , , , , , , , , , , , , , , , ,	Anthenes system from cess		33:6	and a statement of provide the statement of the statement
356/86	H9-4-A	ananana 2017, 2018, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2017, 2	0:108	2.624	31	9.0		anggaga na anganggana akin'nya angangganangangga na angang	a sharan na sa sharan i s	i en internette en i i i en internette en internet		39:4	gar () - an () () - an () an () - an (
357/86	<u> 9-4-B</u>	arije e ljesti dinesijenov svorov na vorov na svoj Politika u svojeka u svorov na darj	0.759	2.144	44	10	and a set of	er na timer a statut ya ya timera dan } } } } }	terner i serenenenenen ; ; ; ; ;	a milionitani antologi		44.6	and the second s
		Tallan an an an Anna an						Spanarshined and a start of the		in delta departmente en está colorado El contenuo dobaster - to a dobaro El contenuo dobaster - to a dobaro			

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	and and a subscription of the subscription of	vy wy Normanatia, referi chrolina	-	0.056	**************************************	70 3.93	8.4	nia antono2 o tamentare a		fordigite and or research and	() Providence - La Construir en une	(nodera i nativara paga na na paga na fi	n - marine and a second se
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n den en separateurs generalmente segura generalmente en generalmente en generalmente en generalmente armente en anti-	ар саларынандар тардалаг тар Кабасаландартар адардаг	a Structure patient Structure a Structure and Stragget fills must serve an automatication of an		6.196		4.350	trace					3 Statistics constrained per sylvages, 646 4 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	and the second sec
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LAND USE PLANNING AND REGULATORY DEPARTMENT MINISTRY OF AGRICULTURE Addis Abobs

Harawa Field Number Unit 9 Bale Study Area/Project : Locotion / Goordinutes

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LAND USE PLANNING AND REGULATORY DEPARTMENT

MINISTRY OF AGRICULTURE Addis Ababa

Bale

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Study Area / Project + Locotion / Coordinates

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365/86	<u>H9-8-B</u>		here and the second		38.0	20.0	42:0	C	7:50		 S. S. S		стан народна — — ан танского Спанта народна — - Эненкого
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365/86	H9-8-4	and the second s	0.868	0.800	86	13	and a second	an a		entropaliensentelonen hen General Palentelonen		48:0	
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364 /86	H9-8-A			0.098		2.415	2.0		-	and a set of the second second second	- Application (- North States)		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1
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Unit 9

LAND USE PLANNING AND REGULATORY DEPARTMENT MINISTRY OF AGRICULTURE Addis Abgda

Study Area / Project : Harawa Field Number: Unit 9 Locotion / Coordinates : Bale Q......

Lob. No.	It Laket here	Depth,	Texture, % (Ø= mm)							1:1	16	Cat'r :	Free Feso y
	ļ	10/112-	>2	2-0.2	0.2-0.05	0.05-	<0.002	Ciasa	H20	KG I	MaF	6.2	64 C C S
366/86	H9-9-A	in - production of the fill for a constant fill for a f		llinitten neuronteen de hee	38.0	38.0	24.0	Z	7:75	โกรค เคราะรับสามุระหม่า 		and a standard and a standard	*
367/86	H9-9-2		* 1947)-1947)-1947)-1946)-1944)-1944) 4 *	**************************************	3.6:0	16.0	48.0	C	7.90		a nunivality statustications	1 Formalistic and a state of the state formation and a state of the st	an and the state of the state o
368/86	H9-10-A				34.0	26:0	40.0	C	7:00	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	and the second s		
369/86	<u> Н97Ю-В</u>				36.0	28.0	36.0	Ch	7.30	- Transformer - 7 betty age of			
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	Depth,		Exchangeables, millisquival of / 100 gm soil										
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366/86	H9-9-A	2	0:108	V:152	55	34	angelei is a' chant parter faite and is a faite	n fordet av son ander ander ander ander	una soft of the same stated for	ferendet of the second second		52.00	ft datain an an stadain ar
367 /86	H9-9-B		01488	0:928	81	Ŧ	······		, (2000)	nalitisis mpr. Litippis, ex. Lit. n S. Bilana, Vistas papalas are		48.0_	f Transfor off 5 off, Proficientials have, o
368 /86	IA-10-7	······	0:108	1,280	64	27		17 gener, ar - ar an a sanna san	an ar an			35:0	
369 186	H9-10-B	and - Bring of the Landson and Solar and	0.108	0:928	_ 7 9	34			n agus da nk p heas antispada Naimhneachan agus c (- Sa	angaga dan manan karak ang	n - 1760 and 1780 an 1870 ang an 1970 ang	52.8	
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366 186	149-9-A	laydeplateness () was grutherarily.		0.126		3:036	2:4		- Sin Shared and a set a second state to the second		an a		·
367 186	H9-9-8			0.140		4:000	0.4		-			and the second	
368 /86	H9-10-A			0:028		2:312	2:8			ang analogi di panja - siamato majoji 1992 (1992) pri produka kan akarata		•	andre marine and
369 186	H9-10-B			0:098		4:209	28		-	- 1948-1960 - 19 - 1844-1986-4 1991-1991 - 1997 - 1944-1986-4		7. 142 militar anto managari	
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HARRAWA LANDSCAPE UNITS	
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Landscape Unit No. Vg 1/1 Geomorphology : High volcanic piedmonts and lave plateaux central highland. Total Area : 9km²) Remarks (Landscape Unit) : Some occurences of this unit are severely eroded and vertic combisols of depths approaching 50cm are frequent, as in North Eastern Shewa and Southern Wello; ash layers are frequently found in the soil profile. Significant Land Facet : piedmont plains and lava plateaux Soil Management Unit No. : 6 Area (%) (km^2) 8 : tertiary basalts and tuffs Geology Slope Range (%) : 0 - 8 Soils: : pellic vertisols. FAO classification Colour (moist) : very dark gray to black : clay and clay loam Texture : imperfectly Drainage class Rock outcrop : none · Surface stones : none Effective depth (an) : >150 : 5.5 - 6.7 рH : 3 - 10 OM (%) : 35 - 70 CEC (me/100q) : <5 Avail. P (PPM)

Dominant Vegetation and/or Land use : Intensive rainfed peasant cultivation of cereals and pulses.

Remarks (Significant Land Facet)

Stony phases occur; where very flat this facet is susceptible to seasonal waterlogging.

Landscape Unit No. Vg 1/2 Geomorphology : See above Total Area : (km²) Remarks (Landscape Unit) : See above Significant Land Facet : marshy depressions Soil Management Unit No. : 6 Area (%) 0 (km²) Geology : shallow colluvium over tertiary basalts and tuffs. Slope Range (%) : 0 - 2 Soils: FAO classification : pellic vertisols Colour (moist) : very dark gray to black Texture : clay to clay loam Drainage class : poorly / imperfectly Rock outcrop : none Surface stones : none Effective depth (cm) : >150 pН : 5.5 - 6.7 OM (%) : 3 - 10 CEC (me/100g) : 35 - 70 Avail. P (PPM) : <5 Dominant Vegetation and/or Jund use : Seasonal marsh with seasonal peasant

livestock grazing of grassland and peasant cultivation of cereals and pulses as water recedes.

Remarks (Significant Land Facet)

Harawa - 3

Landscape Unit No. Rh v/6

Geomorphology : See above Total Area : See above Remark (Landscape Unit)

Significant Land Facet : escarpments

Soil Management Unit No.	0	1
Area (%)	0 0	(km²)
Geology	0	tertiary basalts and tuffs
Slope Range (%)	60	50 ⁺ .
Soils:		~
FAO classification		: not applicable
Colour (moist)		: not applicable
Texture		e 11 11
Drainage class		5 99 98
Rock outcrop		8 89 89
Surface stones		8 tt tt '
Effective depth (an	ດ)	91 FF
рH		, 11 II
OM (%)		8 79 77
CEC (me/100g)		: 11 11
Avail. P (PPM)		8 89 89

Dominant Vegetation and/or Land use : Rock surface

Remarks (Significant Land Facet)

Geomorphology : High to mountainous relief hills central highlands Total Area : (km²) Remarks (Landscape Unit) : Chromic cambisols predominate in some occurence of this unit

Significant Land Facet : very steep sideslopes

Soil Management Unit No. :	42
Area (%) :	(km²)
Geology :	tertiary basalts and tuffs
Slope Range (%) :	30 - 50 ⁺ .
Soils:	
FAO classification	: chromic luvisols (stony phase)
Colour (moist)	: reddish brown to dark reddish brown
Texture	: clay to sandy clay loam
Drainage class	: well
Rock outcrop	: rocky
Surface stony	: very stony
Effective depth (cm)	: 50 - 100
pH	: 5.5 - 6.7
OM (%)	: 3 - 10
CEC (me/100g)	: 35 - 70
Avail. P (PPM)	: <5

Dominant Vegetation and/or Land use : Dense mixed scrub forest

Remarks (Significant Land Facet) :

Lithic phase occur; chromic cambisols (lithic phase) occur.

Geomorphology : See above Total Area (km²) : See above Remarks (Landscape Unit)

Significant Land Facet : steep sideslopes

Soil Management Unit No. :	112
Area (%)	(km²)
Geology :	tertiary basalts and tuffs
Slope Range (%) :	16 🚥 30
Soils:	
FAO classification	: chromic luvisols
Colour (moist)	: reddish brown to dark reddish brown
Texture	: clay to clay loam
Drainage class	: well
Rock outcrop	: fairly rocky
Surface stories	: stony
Effective depth (cm)	: 100 - 150
pH	: 5.5 - 6.7
OM (%)	: 3 - 10
CEC (me/100g)	: 35 - 70
Avail. P (PPM)	: <5

Dominant Vegetation and/or Land use : Dense mixed SCPU b forest.

Remarks (Significant Land Facet) Eutric nitosols occur.

Geomorphology : High to mountainous relief hills central highland Total Area : (km²) Remarks (Landscape Unit) : Chromic cambisols predominate in some occurance of this unit.

Significant Land Facet : Moderate sideslopes

Soil Management Unit No.	0 0	36
Area (%)	9 5	(km²)
Geology	0 0	tertiary basalts and tuffs
Slope Range (%)	e 0	8 - 16
Soils:		
FAO classification		: entric nitosols
Colour (moist)		: reddish brown to dark reddish brown
Texture		: clay to clay loam
Drainage class		: well
Rock outcrop		: fairly stony
Effective depth (a	n)	: >150
рН		: 5.5 - 6.7
OM (%)		: 3 - 10
CEC (me/100g)		: 35 - 70
Avail. P (PPM)		: <5

Dominant Vegetation and/or Land use : Dense mixed Scrub' forest.

Remarks (Significant Land Facet)

Geomorphology : See above Total Area : (km²) Remarks (Landscape Unit)

Significant Land Facet : intermontane valleys

Soil Management Unit No.	0 0	13
Area (%)	6 6	(km ²)
Geology	•	shallow colluvium over tertiary basalts and tuffs
Slope Range (%)	6 9	0 - 8 -
Soils:		
FAO Classification		: entric fluvisols
Colour (moist)		: dark brown to dark reddish brown
Texture		: clay to sandy clay loam
Drainage class		: morderately well
Rock outcrop		: none
Surface stones		: fairly stony
Effective depth (cm))	: >150
pH		: 5.5 - 6.7
OM (%)		: 3 - 10
CEC (me/100g)		: 35 - 70
Avail. P (PPM)		: <5

Dominant Vegetation and/or Land use : Dense mixed high forest

Remarks (Significant Land Facet)

Chromic vertisols occur in wider less inclined valleys.

Geomorphology : See above Total Area : (km²) Remarks (Landscape Unit)

Significant Land Facet : plateau terraces and gentle sideslopes

Soil Management Unit No.	0 0	9
Area (%)	6 0	(km ²)
Geology	\$ 0	tertiary basalts and tuffs
Slope Range (%)	5	2 - 8
Soils:		
FAO classification		: entric nitosols
Colour (moist)		: reddish brown to dark reddish brown
Texture		: clay to clay loam
Drainage class		: well
Rock outcrop		: fairly rocky
Surface stones		: fairly stone
Effective depth (a	n)	: >150
pН		: 5.5 - 6.7
OM (%)		: 3 - 10
CEC (me/100g)		: 35 - 70
Avail. P (PPM)		: <5

Dominant Vegetation and/or Land use : Dense mixed Scrubforest.

Remarks (Significant Land Facet) Chromic vertisols occur.

$\frac{3000}{100}$ $\frac{V_{1}}{2} \begin{pmatrix} (a - b \ \%) \\ (b - b \ \%) \\ (b - b \ \%) \\ (b - b \ \%) \\ (c - b \ \%) \\$	
HARRAWA UNIT 9 LANDSCAPE UNIS	
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Landscape Unit No. Vg 1/1 Geomorphology 0 6 High volcanic piedmonts and lava planeaux central highlands Total Area $: (km^2)$ Remarks (Landscape Unit): Some occurrences of this unit are severely eroded and vertic cambisols of depths approaching 50 cm one frequent, ash layers are frequently found in the soil profile. Significant Land Facet: Piedmont plains and lava plateaux Soil Management Unit No.: 6 $: (km^2)$ Area (%) : Tertiary basalts and tuffs Geology Slope range (%) : 0 - 8 Soils: : Pellic vertisols FAO classification Colour : Very dark grey to black : Clay to caly loam Texture Drainage class : Imperfectly : None Rock outcrop Surface stones : None Effective depth (cm) :)150 : 5.5 - 6.7 pН 3 - 10OM (%) 8 35 - 70CEC (me/100g) 6 6 Avail. P. (PPM) : <5

Dominant Vegetation and/or Land use: Intensive rainfed peasant cultivation of cereals and pulses.

Remarks (Significant Land Facet): Stony phases occur; where very flat this facet is susceptible to seasonal waterlogging.

Harawa Unit #9 (3)

Landscape Unit No: Vg 1/3

Geomorphology :	See above
Total area :	(km ²) See above
Remarks (Landscape Unit)	: See above
Significant Land Facet	: Low relief hills
Soil Management Unit No.	: 56
Area (%)	: (km^2)
Geology	: Tertiary basalts and tuffs
Slope Range (%)	: 8 - 16
Soils:	8
FAO classification	: Eutic nitosols
Colour	: Reddish brown to dark redddish brown
Texture	: Clay to clay loam
Drainage	: Well
Rock outcrop	: None
Surface stones	: Stony
Effective depth (cm) :>150
pH	: 5.5 - 6.7
OM (%)	: 3 - 10
CEC (me/100g)	: 35 - 70
Avail. P. (PPM)	:< 5

Dominant vegetation and/or land use: Opengrassland with peasant live-stock grazing.

Remarks (Significant Land Facet): Chronic levisols occur, particularly in eroded areas; in northeastern Shewa and southern Welo eutric cambisols occur; stony phases occur.

Geomorphology : See above Total Area (km²) : See above Remarks (Landscape Unit)

Significant Land Facet : steep sideslopes

Soil Management Unit No.	0	112
Area (%)	8	(km²)
Geology	00	tertiary basalts and tuffs
Slope Range (%)	e 0	16 - 30
Soils:		
FAO classification		: chromic luvisols
Colour (moist)		: reddish brown to dark reddish brown
Texture		: clay to clay loam
Drainage class		: well
Rock outcrop		: fairly rocky
Surface stories		: stony
Effective depth (an)	: 100 - 150
pH		: 5.5 - 6.7
OM (%)		: 3 - 10
CEC (me/100g)		: 35 - 70
Avail. P (PPM)		: <5

Dominant Vegetation and/or Land use : Dense mixed scrub forest.

Remarks (Significant Land Facet) Eutric nitosols occur. (5)

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Geomorphology : See above Total Area : (km²) Remarks (Landscape Unit)

Significant Land Facet : intermontane valleys

Soil Management Unit No. :	13
Area (%) :	(km ²)
Geology :	shallow colluvium over tertiary basalts and tuffs
Slope Range (%) :	0 - 8
Soils:	
FAO Classification	: Eutric fluvisols
Colour (moist)	: dark brown to dark reddish brown
Texture	: clay to sandy clay loam
Drainage class	: morderately well
Rock outcrop	: none
Surface stones	: fairly stony
Effective depth (cm)	: >150
pH	: 5.5 - 6.7
OM (%)	: 3 - 10
CEC (me/100g)	: 35 - 70
Avail. P (PPM)	: <5

Dominant Vegetation and/or Land use : Dense mixed forest

Remarks (Significant Land Facet)

Chromic vertisols occur in wider less inclined valleys.

98

(7)

Landscape Unit No. Rh $\frac{1}{v}/4$

Geomorphology : See above Total Area : (km²) Remarks (Landscape Unit)

Significant Land Facet : plateau terraces and gentle sideslopes

Soil Management Unit No.	0 0	9								
Area (%)	8 8	(km ²)								
Geology	•	tertiary basalts and tuffs								
Slope Range (%)	9 9	2 - 8								
Soils:		-								
FAO classification		: entric nitosols								
Colour (moist)		: reddish brown to dark reddish brown								
Texture		: clay to clay loam								
Drainage class		: well								
Rock outcrop		: fairly rocky								
Surface stones		: fairly stone								
Effective depth (a	n)	: >150								
рН		: 5.5 - 6.7								
OM (%)		: 3 - 10								
CEC (me/100g)		: 35 - 70								
Avail. P (PPM)		: <5								

Dominant Vegetation and/or Land use : Dense mixed scyub forest.

Remarks (Significant Land Facet) Chromic vertisols occur.

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												Umdaudma Suddivers		Rfz/12-8%)					HARRAWA UNIT # 10 LA		
						$\langle \rangle$					(c)		Cambic Anemasols	R{2/2(5-16%)					LANDSCAPE UNITS		
					V ····································			Small	Chrom	Rmz	(1) Umanian ing sinesiop		Rt W1 12-2 m	1.17.22							
							news for successful we have been all the second	cll_ValleyS	Chromic Combisols			5	Menderale Succession	Cambic Arenesals	2/m 3/3 (8-16%)						

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R	f v/1
0 6	Undulating sideslopes and piedmont zones strongly influenced by colluvial processes but retaining distinct residual characteristices - Western Gonder, Gojjam, Welega and Sidamo.

Total Area (km²)

Geomorphology

Landscape Unit No.

Remarks (Landscape Unit)

Significant Land Facet : undulating sideslopes

Soil Management Unit No.	00	6
Area (%)	00	km²
Geology	8	shallow colluvium over tertiary basalts and tuffs
Slope Range (%)	00	2 - 8
Soils:		
FAO classification		: chromic vertisols
Colour (moist)		: very dark grayish brown to very dark bro
Texture		: clay to clay loam
Drainage class		: imperfectly
Rock outcrop		: none
Surface stones		: none
Effective depth (an	n)	: >150
рH		: 5.5 - 6.7
OM (%)		: 3 - 10
CEC (me/100g)		: 35 - 70
Avail. P (PPM)		: <5

Dominant Vegetation and/or Land use : Bushed and shrubbed grassland with scattered peasant cultivation of maize and limited peasant livestock grazing and browing; peasant cultivation of perennial crops,

Remarks (Significant Land Facet)

Vertisols grade to eutric nitosols as slopes increase toward 8%

Landscape Unit No. Rf s/1Geomorphology : Undulating sideslopes and piedmont zones strongly influen ced by colluvial processes but retaining distinct residual characteristices - Bole and Tigray Total Area (km²) Remarks (Landscape Unit) Significant Land Facet : undulating sideslopes Soil Management Unit No. : 32 (km²) Area (%) 0 : shallow colluvium over mesozoic sandstones Geology : 2 - 8 Slope Range Soils: FAO classification : chromic cambisols Colour (moist) : reddish brown to dark reddish brown Texture : loam to sandy clay loam Drainage class : well Rock outcrop : none Surface stones : fairly stony Effective Depth (cm) : 100 - 150 рΗ : 7.3 - 8.0 QM (%) : 1 - 3 CEC (me/100g) : <16 Avail. P (PPM) : 10 - 15

Dominant Vegetation and/or Land use : Intensive rainfed peasant cultivation of cereals and pulses.

Remarks (Significant Land Facet)

Cambic arenosols occur: gleyic cambisols occur.

Landscape Unit No. Rm $\frac{2}{s/3}$

Geomorphology : Moderate to high relief hills - Northern Bole Total Area (km²) Remarks (Landscape Unit)

Significant Land Facet : moderate sideslopes, severe eroded

Soil Management Unit No. :	a 138
Area (%) :	(km²)
Geology :	mesozoic sandstones
Slope Range (%) :	8 - 16
Soils:	
FAO classification	: cambic arenosols (lithic phase)
Colour (moist)	: red to dark reddish brown
Texture	: sandy clay loam to sand
Drainage class	: sonewhat excessively
Rock outcrop	: very rocky
Surface stones	: very stony
Effective depth (cm)	: 25 - 50
рH	: 7.3 - 8.0
OM (%)	: 1 - 3
CEC (me/100g)	: <16
Avail. P (PPM)	: 5 - 10

Dominant Vegetation and/or Land use : Dense woodland with nomadic livestock grazing and browsing.

Remarks (Significant Land Facet)

Melka Oda - 4

Landscape Unit No. Rm s/4 Geomorphology : See above Total Area (km²) Remarks (Landscape Unit) Significant Land Facet : small valleys Soil Management Unit No. : 98 Area (%) (km²) 9 0 : shallow colluvium over mesozoic sandstones Geology Slope Range (%) : 0 - 8 Soils: FAO classification : chromic cambisols Colour (moist) : yellowish red to dark reddish brown : clay loam to sandy loam Texture : well Drainage Rock outerop : none Surface stones : stony Effective depth (cm) : >150 : 7.3 - 8.0 рН : 1 - 3 OM (%) CEC (me/100g) : 16 - 35 Avail. P. (PPM) : 10 - 15

Dominant Vegetation and/or Land use : Dense woodland with nomadic live-

Dense woodland with nomadic livestock grazing and browing.

Remarks (Significant Land Facet)

Geomorphology : See above Total Area (km²) Remarks (Landscape Unit)

Significant Land Facet : low hills

Soil Management Unit No.	8	138							
Area (%)	8	(km²)							
Geology	8	Mesozoic sandstones							
Slope Range (%)	0 0	8 - 16							
Soils:									
FAO classification		: cambic arenosols (lithic phase)							
Colour (moist)		: reddish brown to dark reddish brown							
Texture		: sandy clay loam to sand							
Drainage class		: somewhat excessively							
Rock outcrop		: rocky							
Surface stones		: very stony							
Effective depth (cm)	: 25 - 50							
рH		: 7.3 - 8.0							
OM (응)		: 1 - 3							
CEC (me/100g)		: < 16							
Avail. P (PPM)		: 5 - 10							

Dominant Vegetation and/or Land use : Intensive rainfed peasant cultivation of cereals and pulses.

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Remarks (Significant Land Facet)