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Field Document No 3

ASSISTANCE TO SETTLEMENT

ETHIOPIA

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

PROVISIONAL MILITARY GOVERNMENT
OF SOCIALIST ETHIOPIA
RELIEF AND REHABILITATION COMMISSION

UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

ADDIS ABABA 1986

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E T H I O P I A

LAND USE PLANNING AND SOIL AND WATER CONSERVATION DEVELOPMENT PLANNING OF THE A S O S A

by
S.K. Choi

THE PROVISIONAL MILITARY GOVERNMENT
OF
SOCIALIST ETHIOPIA
RELIEF AND REHABILITATION COMMISSION

UNITED NATIONS DEVELOPMENT PROGRAMME
FOOD AND AGRICULTURE ORGANIZATION OF
THE UNITED NATIONS

Addis Ababa 1986

This field document is one of a series of reports prepared during the course of the UNDP/FAO project ETH/82/C12 preparing the Assistance to Settlement Project, Phase IV, identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

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FAO. Assistance to Settlement Project, Ethiopia Land Use Planning and Soil and Water Conservation Development Plans for Asosa. by S.K. Choi. Addis Ababa, 1986 105 p., 5 tables, 3 figures, supplement including 7 map sheets, AG:DP ETH/82/012, Field Document 3.

ABSTRACT

This report describes the result of detailed survey of Land Use Planning and Soil and Water Conservation of Asosa Settlement Project 18,824 ha in western Welegaadministrative region. The Land Resources map, present Land Use/cover, slope and erosion classes map and Land suitability classification map are in scale of 1:50,000 and Soil and Water Conservation Development plan at a scale of 1: 20,000 (consisting of 7 mapsheets and legends) accompanies the report.

The natural resources 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 resources boundaries and basic studies.

ACKNOWLEDGEMENTS

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They are also greatful for the comments made by members of related projectsin Ethiopia, and in particular Land Use Planning Project (ETH/82/010), Soil and Water Conservation Project (ETH/81/003), and National Soil Service (ETH/82/011), and Ato Asrat Yigletou NPC, Ato Yibrah Hagos, Ato Semen W. Berhan, Ato Tessema Chekun and staff in Department of Land Reclamation and Utilization RRC.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

LIST OF APPENDIXES

MAP (IN SEPARATE VOLUME)

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 preparing land use planning and soil and water conservation development planning and implementation for three large-scale settlements, namely Asosa, Tedele/Herole and Harawa of the Relief and Rehabilitation Commission (RRC) of Ethiopia.

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

With respect to the planning exercise 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 Asosa Settlement Site,presented in figure 1).

1.2 Methods and Results

The methodology for the study of land use planning to prepare and explain the land suitability classification was based on the (FAO 1976) "Framework for Land Evaluation, (FAO 1983) "Land Evaluation in Rainfed Agriculture and (FAO 1986) "Guidelines for Land Use Planning" third draft The Soil and Water Conservation plan for the settlement is based on (FAO 1977) Soil Conservation and Management in Developing Countries" and(FAO 1979) Watershed Development with special reference to Soil and Water Conservation".

Analysis of land resources as a basis for land evaluation was based on combination of a land resources map at a scale of 1:50,000 with basic

information on Agroclimatology, Geomorphology and Soils.

As has been pointed out earlier, the land resource map focuses on the land resources inventory. This is because it provides the necessary assemblage and integration of resources data to carryout a land suitability evaluation.

A well formulated Soil and Water Conservation Development plan at a scale of 1:20,000 determines the methodology and technique to be used and to understand the physical and social conditions. This is important to formulate the needs and priorities of the settlers and also to indicate the most suited development options for the settlements.

2. BACKGROUND DATA

2.1 General description

2.1.1 Location

The Asosa settlement project is located adjacent to the Asosa Awraja capital in Welega Administrative region. The distance from Addis Ababe is 730 km west via Addis-Kumruk road.

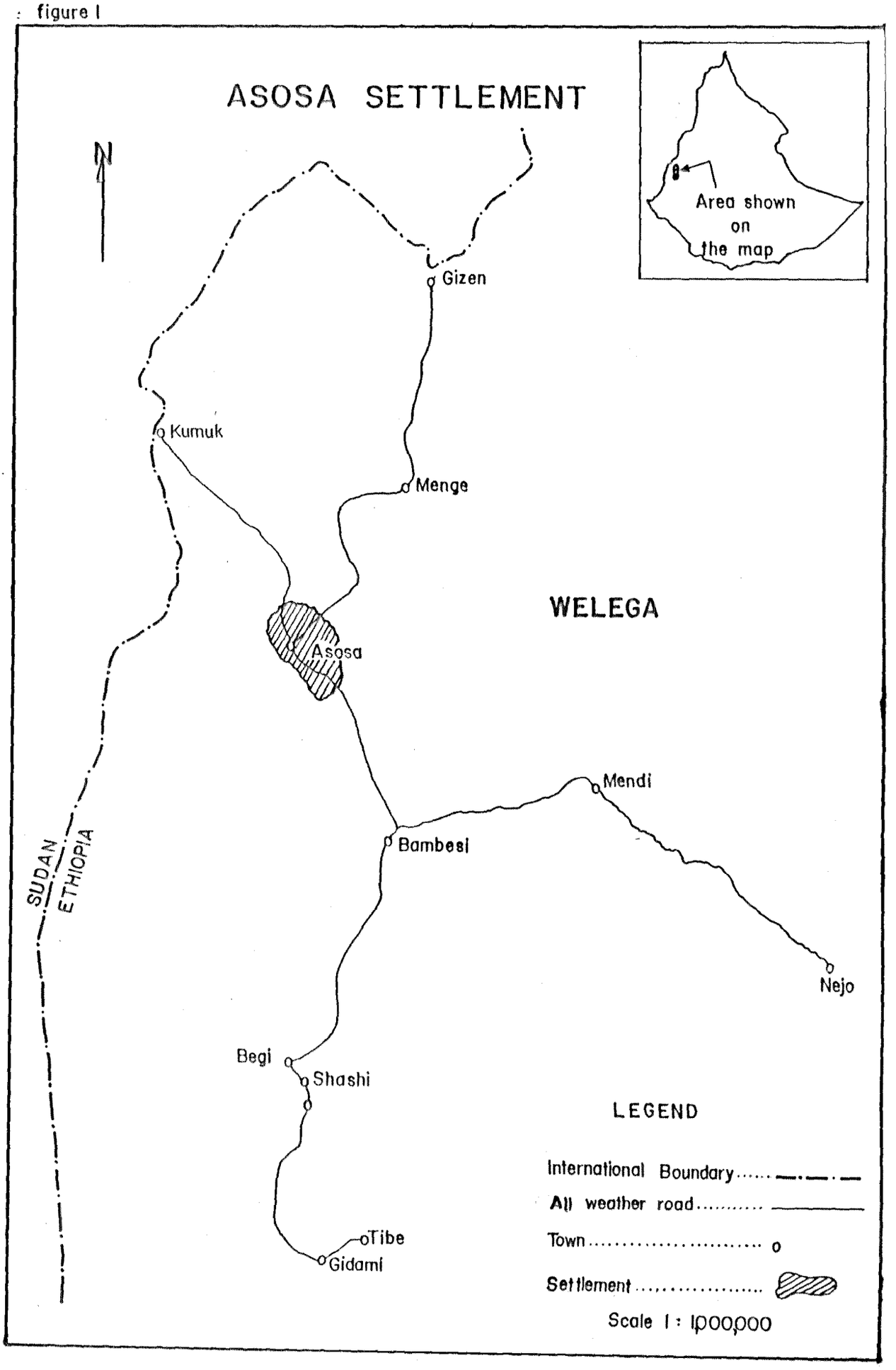
The project area situated at an altitude range of 1300 to 1666 m.a.s.l and between south west of the Dabus River and Asosa mountain extends between latitude 10^{0} N to 13^{0} N and longitudes 38^{0} E to 41^{0} E. It therefore covers an area of 18,824 hectares.

2.1.2 Physiography

The area is gently undulating with interfluves of between one to two kilometers, the maximum reaching four kilometers.

The top of the interfluves is generally flat with slope percentages of 1 to 2% with a sharp increase as one reaches the river valleys. The soils in the area is highly uniform and is mainly deep red clays, i.e. "latosols"

figure I


ASOSA SETTLEMENT
N
Area shown on the map
Gizen
Kumuk
Menge
WELEGA
Asosa
Mendi
Bambesi
SUDAN
ETHIOPIA
Nejo
Begi
Shashi
Tibe
Gidami
LEGEND
International Boundary
All weather road
Town
Settlement
Scale 1 : 1000000

Parent material and climate do not vary much within the project area, consequently, soil formation and differentiation have primarily been influenced by slope, aspect and drainage. The soil on top of the undulations and on the gentls slopes is well developed, deep and well structured. The seasonally flooded areas generelly have a clayey texture and are very compact when dry. In places of weathered parent material layers of gravel are found at variable depths. The texture of the soil is predominantly clay, but the granulating effect of iron oxide on the clay particles permits this dark red soils to behave as clay loams instead of clay. Hence the soils have a fairly stable microstructure that would permit good aeration and reasonably rapid water penetration and movement.

Therefore, with the use of appropriate fertilizers and suitable rotations, these soils are expected to give satisfactory crop yields.

According to the geological formation, the Ashangi Group consists predominantly of alkaline basalts with interbeded pyroclastic and rare rhyolites erupted from fissures.

2.1.3 Climate

The rainfall of the area based on recordings at Asosa town average 1287 mm annually. It's monthly distribution is shown in table 1. The rainfall distribution pattern is monomodal, with most of the precipitation being received in the months of May to October, December, January and February are invariably dry months, while there is small shower occasionally which comes in November March, April and May. As indicated in table 1, the mean monthly maximum temperature ranges from 24.1^{o}C in the month of July to 31.1^{o}C during February and the mean monthly minimum temperatures ranges from 13.6^{o}C in the month of December to 17^{o}C in March. The coldest months are July, August and December while the warmest months are January, February and April. There is no frost in the area as confirmed by the local people.

Table 1: Climatic Data

Station: Asosa	Administrative region: Welega	Rainfall pattern region: B. 1.01	Altitude asl m: 1 560	No. of years for precipitation: 6	No. of years for other data: 5

		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
Mean max. temp. °C		29.9	31.5	31.8	31.5	28.0	25.2	23.9	23.9	25.6	25.8	27.4	29.3	27.8
Mean min. temp. °C		14.5	15.7	17.0	17.2	16.7	15.5	15.1	14.9	14.8	14.9	14.4	14.6	15.4
Mean temperature °C		22.2	23.6	24.4	24.4	22.4	20.4	19.5	19.4	20.2	20.4	20.9	22.0	21.7
Vapour pressure mb	E	12.8	13.7	14.7	15.3	20.2	19.6	18.8	18.9	18.5	17.5	16.3	14.8	16.7
Rel. humidity %	E	48	47	48	50	74	82	83	84	78	73	66	56	66
Wind speed 2 m m/s	E	1.7	1.7	1.4	1.7	1.7	1.4	1.4	1.4	1.4	1.4	1.4	1.7	1.5
Sunshine %	E	81	73	50	71	48	37	33	19	50	61	67	73	55
Total rad. cal/(cm^2 x day)	E	480	493	442	534	441	394	380	331	444	461	446	443	441
Precipitation mm		0	0	31	32	118	189	207	208	207	103	21	0	1 116
PET mm		131	133	144	155	121	98	97	91	106	110	104	118	1 408
Dates					28 BM(S)	16 BH(S)					12 EH	3 EM 9 EHS 27 EMS		

LGP_1 28/4 - 27/11 normal	Days	Mean max. temp. °C	Mean min. temp. °C	Mean temp. °C	Total rad. cal/(cm^2 x day)	P	PET	P/PET
BEG-END	213	25.7	15.2	20.5	415	1 057	731	1.45
BEG-BHS/BH(S)	18	29.0	16.9	23.0	465	54	79	0.69
BHS/BH(S)-EHS/EH(S)	177	25.2	15.1	20.2	406	994	590	1.68
EHS/EH(S)-END	18	27.6	14.3	20.9	444	9	62	0.15
LGP_2								
BEG-END								
BEG-BHS/BH(S)								
BHS/BH(S)-EHS/EH(S)								
EHS/EH(S)-END								

2.1.4 Vegetation and Land Use

The vegetation of the area consists of savannah woodland and swamp vegetation. Open woodland savannah predominantes the top of the undulations while the perennial rivers are lined with swamp vegetation. The trees are broad leaved woodland largely of combretum spp. and H.rufa being very common. Bamboo thickets occur in the north and northeast and on the slope of Mount Asosa.

Much of the area was originally covered by dense Arundinaria alpin, but recently the activities of man, for case of mechanization and Bushfire have affected the natural cover to such an extent that nearly most of the area is with no vegetation; what is left is now small isolated pockets of forests in the river valleys, on uncaltivated lands and in accessible places. The present vegetation comprises a sparse cover of savannah woodland and swamp vegetation. Open wood land savannah predominates the top of the undulation while the perennial rivers are lined with swamp vegetation, broad leaved woodland largely of combratum and termiualia species, the grasses are mainly of Hypernial species.

The present land use system is mainly rainfed agriculture with minor area of irrigated agriculture. The main croped area founded in 1984/85 was 6,200 ha or 34% of the total project area. Maize and Sorghum being staple and important crops,occupied 70% of the total cultivated area. Other crops such as teff, haricto beans, noug, pepper sunflower and wheat are also produced. In addition vegetables such as potatoe, cabbage, onion and orchards are grown along the river and springs using gravity flow diversions.

A number of peasant associations (the indigeneous people who are muslims and members of the Jeblow trib) are found around the project area. Their economy is dominated by rainfed mixed farming. The crop production is based on traditional system of farming using mainly hand tools cultivating half hectare. The main crops grown are maize, sorghum, teff and each family

has 5-6 mango trees around his tukule.

Livestock especially goats, sheep, and a small number of cattle are kept as cash generating resource. Donkeys provide the main means of transportation over most areas.

2.2. Development in the area

Evaluation of the area for it's suitability to enhance rainfed arable mixed farming on a mechanized agriculture indicats land quality and land characteristics which consists predominantly of the top of the interfluves is generally flat with slope percentage of 1 to 3% with a sharp increase as one reaches the river valleys.

Before this, settlement was implemented, however, Dabus State Farm moved to it's present site near Dabus River. The settlers were, therefore, shifted to this area which has become the uncleus of the (settlement) activities. Apart from the limited area previously developed specifically for settlement, most of the area under cultivation is on the old State Farm land and most of the settlers work on this land and divide the proceeds among themselves and additional alocation of settlers in 1984 and 1985. In the mean time, however, development in the settlement possess 16 units in whole Asosa development project area.

The main disease known in the area is malaria. There are also some other diseases such as amoebic dysentery and T.B. This arises from poor hygenic conditions and lack of preventive measures. There is also testse flies infestation in the area which causes trypanosomiasis in cattle.

The 16 development units accomodate 7,875 heads of families. On the basis of earlier proposals by the Relief and Rehabilitation Commission (RRC) the model has been defined as having 500 family heads per settlement unit of 1250 hectares of land. This would be in line with the settlement model which requires each settlement unit of 500 families settlers to have a minimum of 1000 hectares of cultivable land for the cooperative farm, 50 hectares

homestead plots and 200 hectares for grazing and afforestation. The model also permits allowance for infrastructural development and soil and water conservation structures. The plan, of necessity, has to take into account the developed and underdeveloped land.

The settlement area is located along the perennial springs and rivers viz. Hoha , (Units 1.9.10.11 and 2.3.7.8 and project centre) Selga (Units 4.5.6 and 12) Afa (Units 13, 14,15 (belong to New Settlement No26) 16 and 17). At present there is reliability in the quantity of supply of water and they are not far from habitation sites. However, there is no definite assurance in unit 4 if springs are not regularly cleaned and maintained. To facilitate the treatment and distribution of the available surface water in the area, it is proposed to develop a suitable water supply system.

2.2.1 Origin of settlers

The Asosa Settlament Project was developed in 1979 to accomodate the adversely affected population from the drought prune areas of Wollo and Tigrie Administrative regions. Initially there were 8000 settlers and now the population has increased to 28,477 which includes 7,875 families.

The planning of the settlement was carried out in phases to provide for the settlement of 8,000 families in an area of 18,824 hectares divided into 16 units with the necessary infrastracture and services.

2.3 Land survey

The survey intensity in the area was in accordance with specific investigations and obejectives. As a result, an area of some 20,000 hectares was surveyed at semi-detailed and detailed level and classified into five landscape units by taking considerations expressed on difference in landform, soils, hydrographic pattern, slope, relief and vegetation density. Each unit is evaluated for its current and potential land use suitability and the results of the survey were shown on an aerial photo mosaic and topographic maps at a scale of 1:50,000.

Table 2. Distribution of settlers and land in each unit

Unit	No of Families heads	Cropland ha		Non Cropland ha	Total ha
1	497	373	548	303	851
2	500	462	575	484	1059
3	501	378	473	527	1000
4	500	339	692	333	1025
5	475	465	532	393	925
6	488	450	575	1029	1004
7	502	356	762	328	1090
8	492	487	792	626	1418
9	498	408	1083	653.5	1736.5
10	503±	405	461	564	1025
11	488	410	665	573	1238
12	475	367	840	364	1204
13	494	403	933	712	1645
14	489	365	356	656.5	1006.5
16	499	327	425	528	953
17	474	313	540	504	1044
Total	7875	*6168	**10246	8578	18,824

* 1936 1st cultivated area ** Total cropland

3. LAND USE STUDY

3.1 Methods of study

3.1.1 Aerialphoto Interpretation (API)

The essence of Land Use Study for the Asosa Settlement area is to make sure that the development activities being carried and should be carried in the future meet the needs of the settlers and to help them tackle the main problems and development bottle-necks and to lead them make best use of the development plans in their future development endeavour.

As a result aerialphoto interpretation for the area was one of the basic requirements and invaluable method used to guide land-use study in the settlement.

Thus, investigations show that, the photography was flown in 02.12.1980 at approximately 1:50,000 scale. The API was done with Topcon mirror stereoscope with 3x binocular eyepiece.

After scanning the general area and examining stereo pairs, an API legend was prepared with supporting data from the field survey. This legend was reworked into soils oriented legend. See appendix 1.

The API legend is shown in Appendix 2 and is thought to be self-explanatory.

The principle points of the APs were marked on the existing mosaic. Transparent drafting paper was placed over the mosaic and the principle points were transferred and identified by number. The flight lines were drawn by joining the points in the flight line.

The APs 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 transfer. Where distortion was too great, the information was transferred to the alternate APs not previously marked so that only information

in the center of AP was shown. 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 shown.

3.1.2 Area Measurement

Another approach undertaken during the course of land use study was area measurement of landscape units. Individual mapping units were measured by planimeter and adjusted for the appropriate scale.

Areas below 15 ha are given to the nearest 5 or 10 depending on size. The sum of the individual mapping units was checked against the whole unit area. Sinuous riverine forest was taken 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 18,824 hectares were measured by planimeter. This is roughly 94% of the total area surveyed (20,000 ha.)

3.2 Soil Survey and Soil Sampling

Inorder to identify and make a comparison of promising kinds of land-use items applicable to the settlement, soil survey field work was carried in 1986. The approach of the soil survey is described as follows. During the field work observation was made in which approximately 46 descriptions were made (generally to a depth of 180 cm). The augerings were made with a screw-type auger. Both land and soil characteristics were recorded on a standard form for auger descriptions.

Observations include recording of physiography soil surface conditions and soil profile characteristics which were obtained by means of auger taken from small natural exposure.

The methodology for describing soil profile and augerings was adopted from the "Guideline for soil profile description (FAO 1977) and from the

Munsell soil colour charts (1975).

All sampling sites were plotted on AP's which were used as base maps in the field work.

3.3. LABORATORY METHODS

3.3.1 General Description

On the basis of forty six representative soil samples which were chemically and physically analysed by the soil laboratory of the Land Use Planning and Regulatory Department of the Ministry of Agriculture, analytical data were presented in appendix 3.

3.3.2 Method of Soil Analysis

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

Samples Preparation: The soil samples were air-dried at room temperature by spreading on paper sheets. On drying they were ground in metal mortar and & pestle &sieved through a 2 mm sieve.

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% H_2O_2 were 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 2 hours intervals to calculate the silt + clay and clay percentage respectively. Sand percentage was calculated by subtracting silt + clay percentage from 100.

PH: 20 g soil was treated with 20 ml of water or salt solution (KCl or $CaCl_2$) 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 N 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 N ferrous ammonium sulphate. The percentage of organic matter was caluclated 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 NH_3 distilled in 10 ml of 0.2 N H_2SO_4. The excess acid was back titrated with 0.1 N NaOH with methyl red as an indicator. Percentage of total nitrogen was calculated from the acid used.

Available phosphorus: To 10g soil (passing through 1 mm sieve) is added teaspoonful of activated carbon (Darco G60) and 50 ml of Morgan's extracting solution (10% of solution of Na-acetate in 3% acetic acid). The contents were shaken for 30 minutes and filtered. P was determined in 2 ml of the extract by adding six drops 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) N NH_4-acetate and made to 250 ml with distilled water. Ca + Mg were determined in 10 ml of the leachate by acidifying with 0.1N HCl, boiling for a few minutes, complexing Mg with Mg-complexonate, adding 2 ml of 2% aqueous solution of KCN and 3 ml of NH_4OH-NH_4Cl buffer. The contents were titrated with 0.02 N 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 N disodium salt of EDTA using a pinch of HHSNN (Paton and Readers reagent) until the color turns from wine red to blue. Exchangeable Mg was obtained by subtracting exchangeable Ca from exchangeable Ca + Mg.

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

Cation Exchange Capacity: The soil previously leached with NH_4-acetate was successively washed with 10 ml portions of 95% ethanol using a total of 80 to 100 ml of ethanol. Adsorbed NH_4 was then replaced with Na by extracting the soil with 40 ml of 10% NaCl. NH_4 was determined in the extract by adding 5 ml of 40% NaOH and distilling NH_3 in 10 ml of 0.2 N 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 NH_4-aurine tricarboxalate, gum accacia, NH_4OAC and HCl) were added. The contents were heated over boiling water bath for 10 minutes and then cooled.
On cooling the volume was made to 50 ml with water, mixed and absorbance measured at 520 millimicrons.

Exchange acidity: Exchange acidity was determined by the potassium chloride-triethanalamine 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 25 ml 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.

$CaCO_3$ percentage: 5 g of soil was treated with 50 ml of 0.5 N 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 N NaOH. The percentage of $CaCO_3$ 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 N NH_4-acetate extract.

3.4 Soil classification and landscape units

3.4.1 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
- Slope range
- Soil phase

For a description of the classes employed for the description of each characteristics referr to landscape units. Soil classification follow FAO Soil Map of the World.

3.4.2 Landscape units and landform genesis

A hierarchial classification system is applied in the description of the geomorphology of the landscape units. At the broadest level, 15 subdivisions exist, which are related to the general physiographic character of the landforms. These are as follows,

1. 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.

7. 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 overall approach used for identifying the requirements of crops was by taking considerations in terms of ranges of suitability based on a standard devise for recording crop requirements through assessment of land qualities and land characteristics determined in the field survey at a semi-detailed scale.

From the guideline obtained from the survey the major kinds of land-use which involves crop production are rain-fed agriculture (annual perrennial and mixed), irrigated agriculture, livestock and forestry.

4.1 Selection of crops

The fundamental requirements for selecting the list of seven crops as land utilization types (LUT) was drawn up which included other perrennial crops excluding forestry species. In terms of boosting crop production in Asosa settlement, this would mean identifying the crops and the legend that best suit essentially to grow them. This would enable the settlers to make most efficient use of the land to produce more crop production and for utilization of other forms of land-use in the future. A part from planning other forms of land-use, crop production should also be designed to lead to fulfill the basic needs of the community which should be planned possessing local and national level development endeavours with a capital reserve to up-grade the living standards of the settlers.

From the above approach, activities of paramount importance would be reinforcement of health and education and promotion of basic needs required by the settlement site. A further consideration in determining a list of crops to be treated was the identification of priorities which would would have more potentials for crop production within the settlement development.

Based on the crop requirements, the most fundamental list of crops of Asosa settlement project are as follows: Maize, Sorghum, Teff, Haricot beans, Noug Pepper and Sunflower.

4.2 Cropping systems

A farming system practice such as the seed-complex involves various range of crops. The cropping system practicedby settlers within this type of farming system indicates difference from one locality to another.

For example, the Asosa settlement project practiced a cropping system which consists of some cereals, pulses and vegetables. For instance, project area largely based on Maize and Sorghum is 70 percent of total cultivated land.

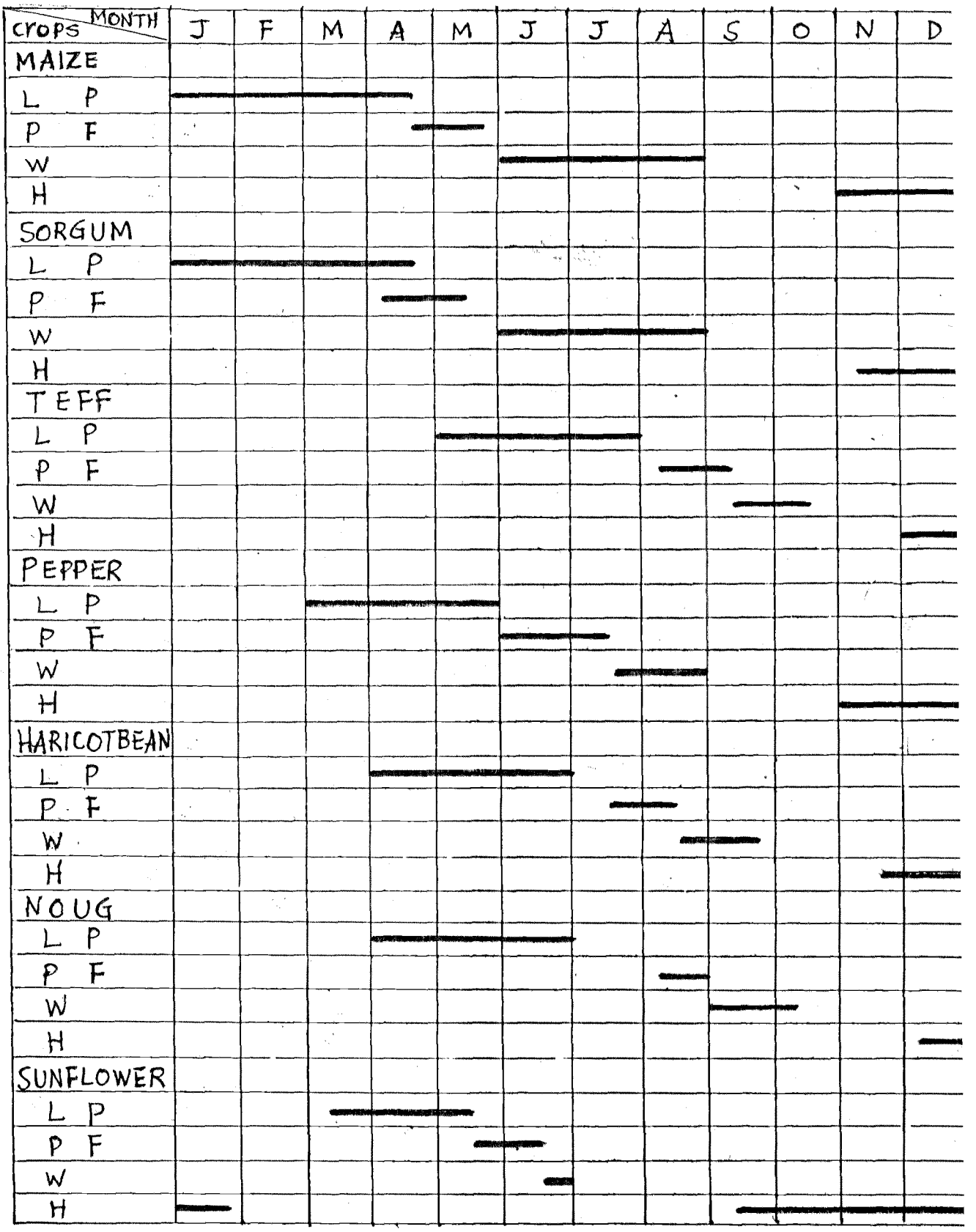
In addition to other undesirable effects, continuous cultivation of Maize and Sorghum could lead to lower crop yield. It is suggested that a crope rotation system be introduced which would include leguminous crops, and Teff, Haricotbeans, Noug, Pepper and Sunflower with other minor crops and vegetables and fruit trees.

The mixture of main food crops and minor crops are cultivated and recommended to meet the needs of the local community. The farming calender is designed to show that crops are grown and nature in adequate conditions for seed repending to fill a food gap to satisfy the needs of the settlement.

4.2.1 Crop Establishment

The main climate factor effecting crop production in the settlement is rainfall and its variation. The average rainfall superior to 30 mm from March to October (8 months). These months represent 98%, having a monthly

Figure.2 CALENDAR OF OPERATION
ASOSA SETTLEMENT PROJECT



L P - Landpreperation P F - planting fertilizing
W - Weeding H - Herresting

rainfall (1095 mm) the wet season (June, July, August and September) represent 72% of the yearly total, which the period of May to October having a monthly rainfall superior to 100 mm/month represents 92% of the yearly rainfall. Consequently, the settlement has a growing period of atleast 6 months (May to October) depending on the storage of soil moisture available after the rains stop.

The months April and June have enough rain for land preparation possibility. After June, the weather becomes probably too wet for land preparation indicating minimization of problems such as destruction of soil structure, formation of plough sole, and insufficient carrying capacity of the soil.

In terms of crop growth and rainfall reliability, the overall climate sitation was not favourable for crop production. First, plowing starts around mid of January and extends to late June. Except for Maize and Sorghum, plowing starts mid of January until mid of April. Other crops start begining of March to May. Weeding and cultivating seems to be accomplished in the months of June to September.to late January. (for detailed information on cropping calender refer to Figure 2).

4.3. The need of reforestation

It is well known that the introduction of settlement is one of the factors that contribute to the progressive reduction of the tree and shrubs for energy and construction needs of the settlers. Tree destraction take place predominantly near settlements and is spreading out into the surrounding woodland and shrublands as the people are obliged to go further to obtain the materials needed for construction and energy.

In Asosa settlement a progressive tree reduction is taking place through the over-exploitation of wood from the limited natural forest resources. Presently the settlers have to travel up to 20 km, to collecting wood. If this excessive deforestation which is faster than the establishment of new plantation continues and is not counter-balanced by intensive reforestation programmes the areas will deteriorate to an extent that they will be incapable

to support the human and livestock population of the settlement. This could mean that settlement will be transporting problems that were existing in drought affected areas to other areas rather than being a solution to alleviate the population from famine relief and make them self-sufficient in particular and promote the national economy in general.

To avoid the ecological deterioration of the settlement areas and to provide trees for the purposes of fuelwood, windbreak, soil stabilization, for production of fodder trees and development of bee keeping, forests have to be developed and indiscriminate destruction of trees has to be stopped in and around the settlement areas.

Asosa settlement site has already established and launched an extensive reforestration programme for its area but it is possible that the range of species could be extended to include trees which could provided fodder and food.

Observing the plains and undulating slopes where much of this settlemen development is taking place shows that they are often devoid of trees or gradually being affected by land clearance for cultivation and search for building materials and fuel wood. Thus, the advantages of those indigenous species such as Acacia Albida is really appreciated except perhaps by the indigenous pastoralities.

The establishment of tree crops and fruit trees in association with the traditional food crops and fruit trees should be given more attention in planning and extension activities for settlement development.

Consideration should also be given to indigenous multi purpose tree species such as Acacia Albida Mangifera indica which not only provide wooden products but possibly serve various purpose such as soil conservation and improvement, fodder production and food.

Establishement of a system of wind break, soil conservation, forage production and food for settlers, wood supply to inhance handicrafts could be made through the introduction of exotic multipurpose tree species such as Acacia decurrens. Laucaana leucocephala, Azandinchta indica, Eucalyptus Camaldulensis.-------.

In existing areas where depletion of tree species has been occurred, careful selection should fit to introduce fast growing trees that could ameliorate immediate problems by giving due consideration to agro-forestry as well.

In Asosa, reaforestation was started in 1981 till 1985. The plan was to raise and plant five million seedlings.

The tree species to be raised in the settlement are as follows:

Acacia albida
Acacia decurrens
Acacia melanoxylon
Albizia lebbek
Azandircheta indica
Casuarina, equisetifolia
Cordia africana
Craten macrostachys
Delonix regia
Eucalyptus comaldulensis
Eucalyptus citriodora
Eucalyptus globulus
Eucalyptus salgna
Gnavillea robusta
Leuceana leucocephala
Mangifera indica
Psidium guajaua
Schinus molle
Meringa stenopetals
Carica papeya

5. CROP ENVIRONMENTAL REQUIREMENTS

5.1 General Description

Crop environmental requirement condition is related to the physical conditions of the settlement covering a wide range of climatic, soil and other issues. Climate data for possible crops environmental requirement includes maximum and minimum temperature intensity and frequency of rains and relative humidity for rain-fed agriculture and the land characteristics needed to describe these qualities. The definitions of a land quality and a land characteristic are as follows:-

- 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. The above definitions involve the following basic statements:

First: (land quality) are fewer in number (the land characteristics), secondly, they direct attention to the effect upon landuse, and thirdly they take an account of interactions between environmental factors.

In accordance with specific investigation for each crop, the requirements are given in two ways. The basic requirements as employed in the land evaluation are given as table in standard form at appendix 2 for 17 land qualities and the land characteristics by which they are measured or estimated.

Approaches considered for crop environmental requirements are as follows:

Abbreviation used for the suitability ranges are:

- Soil texture follows
  - S Sand
  - L Loam
  - Ls Loamy sand
  - Scl Sandy clay loam

Sl	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 as almost flat
2-8%	Gentle slope
8-16%	Slope
16-30%	Moderately slope
30-50%	Steep
50%+	Very steep

- Drainage classes follow FAO methodology as described above except for lands subject to seasonal flooding which are given two classes. One for the period during the rainy season and the other for the rest of the year. This was deliberately done to accomodate requirements of the land evaluation:-

VP	-	Very poor
I	-	Imperfect
W	-	Well
E	-	Execessive
P	-	Poor
MW	-	Moderately well
S	-	Somewhat excessive

- Rock outcrop descriptions follow FAO methodlogy:- Stoneiness classes are:-

None	1%
Farily stony	1-3%
Stony	3-10%
Very stony	10-50%
Exceeding stony	50-90%
Rubble land	90%

-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	High alkaline

-Electriacl conductivity mm has /cm at 25^{0}C

< 4 mm has/cm	Non saline
4-8	Slightly saline
8-15	Medium saline
>15	Highly saline

-Organic matter classes are (in%)

< 1	Low
1-3	Medium
3-10	High
>10	Very high

- Castion exchange capacity classes are: (me/100g)

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

- Available phosphorous clases are (in ppm)

< 5	Very low
5-10	Low
10-15	Medium
15-25	High
> 25	Very high

- Erosion (All lands)

Symbol	Description Term	
1	None to slight erosion	Less than 25% 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 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 & Moderatly Gully land	An intercate network of very frequent moderatly Gullies are 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)
EPM	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 where attributed to man-induced processes, it will be differentiated by placing the symbol in parenthesis.

The classes used the description of soil drainage soil texture refer to the standard soil description classes in FAO "Guidelines for Soil Profile Description"

5.2 Modifications to Crop Requirements for High levels of Inputs

Possible consideration was elaborated initially to identify the requirements for each crop at each of three input levels i.e. low, medium and high. As forseen for the different levels of input, certain environmental deficiencies have to be overcomed or ameliorated at higher levels of inputs. e.g. discontinuation of drainage impedence by introducing drainage works, improvement of erosion hazard through soil conservation work etc.

Besides, phased introduction of the high level mechanization may call for more stringent environmental requirements.

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

Soil drainage (land quality: drainage) for imperfect improve the suitability by one class i.e. N1 (currently not suitable) becomes S3 (Margainally suitable) and S3 becomes S2 (moderately suitable)and S2 becomes S1 (highly suitable).

Stones and rock outcrop (land quality management land preparation and mechanization potential).

Change the suitable ranges of most crops as follows:-

S1	none to fairly stony	(0-1% of the area)
S2	Fairly stony	(1-3% ")
S3	Stony	(3-10% ")
N1	Very stony	(10-50% ")
N2	Exceeding stony and Rubble	(Over 50%)

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

Slope angle (land quality - degradation hazard)

S1	Slope of 0-8%
S2	" 8-16%
S3	" 16-30%
N1	" 30-50%
N2	" 50%

The adjustment is made on the basis that at high inputs levels slope of 8-16% are moderately suitable for cultivation if provision is made to maintain the area through soil conservation works. The environmental requirement

for crop combination for Asosa settlement project is shown in table of Appendix 2.

6. LAND RESOURCES MAP

6.1 General Description

The land evaluation methodology used in the preparation of the land-use plan is in accordance with the FAO framework evaluation (FAO-1976) and the FAO Agro-Ecological Zones (AEZ) project (FAO-1978). The development and proceeding to obtain the land resources basis for land evaluation a series of thematic maps were combined into a land resources map at 1:50 000 scale which has integrated information on Agro-climatology, Geomorphology and Soils.

They are the main indicaters for potential agricultural production. The land resources map involves the framework of the land resources inventory by consisting the necessary assemblage and integration of resource data to carryout a land suitability evaluation.

Thus, the main components of the land resources map are thematic maps of thermal zones, lengths of growing periods geomorphology and soils.

Mapping of thermal zones (Tz) and lengths of growing periods (LGP) is based on the methodology of the FAO Agro-Ecological Zone Project and Assistance to Land Use Planning Project ETH/82/010 Project. The fundamental data for geomorphology and soils results from geomorphological interpretation of aerial photo and available surveys.

Field traverses and agro-climate information eminated from landscape units roughly small groups of land systems.

6.2 Land Resources Units

The matrix table shown below was developed as part of a comprehensive Land Resources Map legend for the map units derived from the integration of information mentained in the thermatic maps described above. However, a brief description with illustrative example is presented to the user to help him

understand the nature of Land Resources units described on the map and the means by which thermatic data on thermal zones, length of growing periods and geomorphology and soils have been integrated to delinate them. See appendix 4.

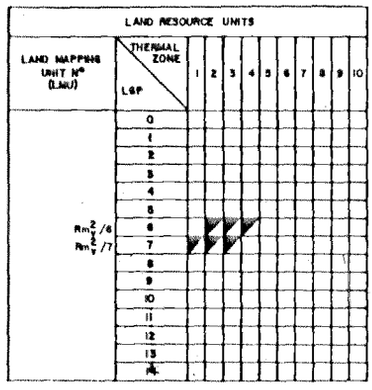
6.2.1 Land mapping units

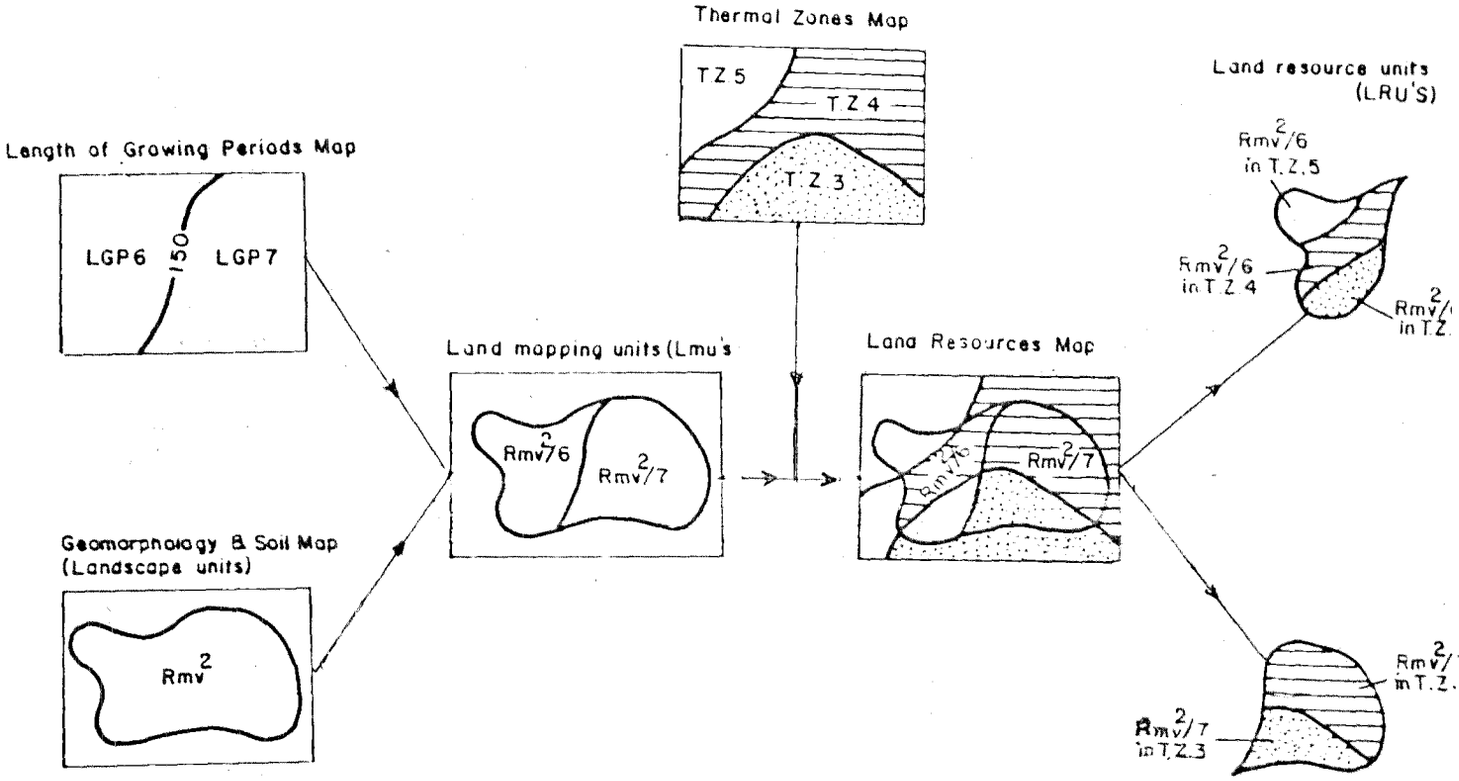
The combination of landscape units from the geomorphology and soils map and the various zones from the length of growing period map. The symbols are comprised of two parts, for example $Rm^{2}_{v}/7$.

The first part of the symbol, Rmv, represents the landscape component, the second part, /7 represents the growing period zone. Both aspects are explained in more detail below see Land Resources map 2.

Figure 3

Method of integrating thematic data and lad resources units





6.3 Explanation of thematic map inputs

6.3.1 Thermal zones

Thermal zones are defined by mean daily temperature (in ^{o}C) during the growing season. The following relation between temperature and altitude was determined from data from 155 meterological stations throughout the country

The relation $T^{o}C = 30.20 - 0.0059 \times$ Altitude was defined, resulting in a gradient of $0.59^{o}C$/100 m altitude.

$R^2 = 0.90$ Gradient = $0.59^{o}C$/100 m rise

Thermal zone	Temperature zone	Altitudinal meteres	Altitude Regions
	^{o}C	m	
1	> 27.5	< 500	Bereha
2	27.5 - 25.0	500 - 900	
3	25.0 - 22.5	900 -1300	Kolla
4	22.5 - 20.0	1300 - 1700	
5	20.0 - 17.5	1700 - 2200	Woina Dega
6	17.5 - 150	2200 - 2600	
7	15.0 - 12.5	2600 - 3000	Dega
8	12.5 - 10.0	3000 -3400	Wurch
9	10.0 - 7.5	3400 - 3800	
10	< 7.5	> 3800	

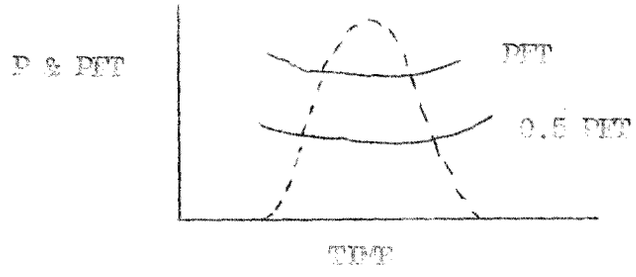
6.3.2 Lengths of growing periods

Moisture availability is a very critical component in determining rainfed crop suitabilities. For the purpose of this evaluation it was estimated by the length of growing period (LGP), which is defined by a simple water balance model comparing rainfall with potential evapotranspiration (PET). The PET is calculated according to Pen man's (1948) formula.

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

Normal _____ 240 _____

The Asosa settlement project has a normal growing period which is defined as the period (in day) during a year when precipitation exceeds half the potential evapotranspiration (PET), plus a period required to evapotranspire an assumed 100 mm of water from excess precipitation (or less if not available) stored in the soil. Normal LGP's in Ell to 240 days.



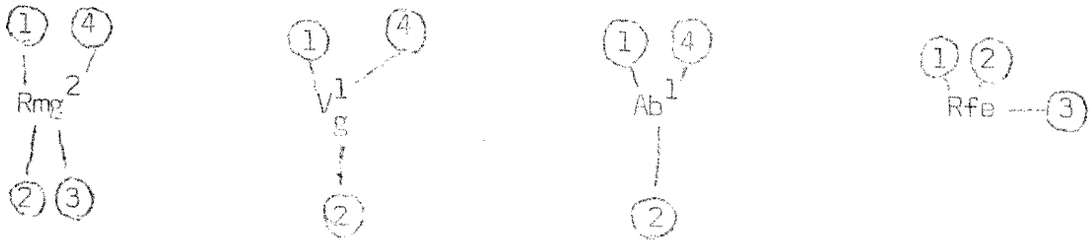
For convenience of tabulation, LGP zones are assigned numerical codes as follows,

Growing period No	Length of growing period Days
0	Less than one day
1	1 - 45 days
2	46 - 60 "
3	61 - 75 "
4	76 - 90 "
5	91 - 120 "
6	121 - 150 "
7	151 - 180 "
8	181 - 210 "
9	211 - 240 "
10	241 - 270 "
11	271 - 300 "
12	301 - 330 "
13	331 - 364 "
14	365 days

Fifteen LGP's are defined for the country as a result of the agroclimatic resources inventory carried out by the Assistance to Land Use Planning Project ETH/82/010. TZ's and LGP's are both mapped as individual thematic presentations and are also incorporated as essential components of the land resources map.

6.4 Explanation of Landscape Units Legend

Landscape units, defined as mapping units which are reasonably homogeneous 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 an hierarchial classification of landscape units An explanation, with examples, of the operation of the classification follows:



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

Alluvial	A
Volcanic	V
Aeolian	D
Structural	S
Evaporite	E
Residual	R

(2) Subclasses of these geomorphic types are indicated by the first lower case letter. m in Rmg^{2} 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 units, is given below

in the summary legend.

(3) Structural and residual landforms require a third character, the subscript lower case letter, which indentifies 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)	g
Metamorphic precambrian basement (slates, schists, phyllites, etc)	m
Evaporite (predominantly gypsum)	e
Sandstone	s
Calcareous (predominantly limestone)	c

Such symbols are normally used alone but may be used together, for example, $sh_{c/g}$, 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.

There 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 Asosa settlement site. See Land Resources Map 2.

6.4.1 Summary Legend

Rn_g^2 - Hilly plains comprised of undulating plains and low plateaux with a substantial proportion of low to moderate relief hills - western highlands

Residual landforms

Rq_g^1 - Hilly terrain of moderate to high relief with a substantial proportion of moderately sloping valleys interspersed throughout Residual landforms

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 facet

Landscape Unit No
Geomorphology
Total area (Km^2)
Significant land facet
Area (%), Geology
Slope range
Dominant Vegetation and/or Land use
Soil FAO classification
Colour (moist)
Texture
Drainage classes
Rockout crop
Surface stones
Effective depth
pH
OM (organic matter)%
CEC (Cation exchange capacity)
Available P
SMU No (Soil management Unit)

The description of landscape unit is presented in the appendix 4.

7. LAND SUITABILITY CLASSIFICATION MAP

7.1 Land suitability evaluation

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

- Land suitability maps
- Land suitability classification tables

For the seven (7) crops considered within the rainfed agriculture, One (1) group combination 1:50 000 scale of land suitability maps have been prepared for the Asosa project.

Similar land suitability maps for the forestry land utilization type and the livestock land utilization types have also been complied 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 suitable), N1 (currently not suitable) and N2 (permanently not suitable) are indicated for all matchings invloving 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 classes indicate degrees of suitability, within the order suitable (s). It is usual to recognize three classes, "highly" "moderately", and "marginally suitable. The following names and definitions may be appropriate in a qualitative classification.

Class S1 Highly suitable

Land having no significant limitations to sustained 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 of bing overall advantage to be gained from the use Although still attractive, it 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 N1 Currently not suitable

Land having limitations 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 suecessful sustaine use of the land in the given manner.

Class N2 Permanently Not suitable

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 12,287 hectares of land in the area, comprising land suitability units CU, 1 & FS,1 have been recommended for cooperative farms and homestead production of crops adapted to the area .i.e. Maize, Sorghum,Teff, and miner pulses, Haricotbeans, Noug, and Sunflower and Pepper. On the other hand 8,557 hectares, which combines all the other land suitability units are available 4,868 hectares for livestock grazingland and afforestation 3,656 hectares.

7.3 Land suitability subclasses

Land suitability subclasses reflect kinds of limitations, e.g.moisture dificiency, erosion hazard. Subclasses are indicated by lower-case letters with mnemonic significance, e.g. S2m, S3m.

There are no subclasses in class S1.

Example of symbols are given below:

m	Drainage deficiency
e	erosion hazard
p	management limitation
x	toxicity limitation
r	rooting condition deficiency

7.4 Land suitability units

The land in Asosa settlement project has been evaluated for rainfed agriculture and classified into five suitability units. Their distribution is indicated in map 3 land suitability classification map.

8. DEVELOPMENT PLAN

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

Any activities that will improve or atleast sustain prouction, 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 atleast sustaining agriculture, forestry or livestock production. Marketing and storing produce together with water development (springs, farmponds, dams and diversion weirs) are also considered. Farm management is considered as an essential continuous input.Components such as reforestration or strip cropping established as a development input must be continued under a good farm management programme.

Table 3. Limitation and Recommended use of Land Suitability Classification in Asosa

Landscape Unit Symbol	Significant Land Facet	Limitation	Recommended use and treatment	Land suitability class
1	Undulating plains and low plateau	No significant limitation deep and well structured granulized clamp low phosphorus.	Land having no significant limitations to sustained application of a given use. Cultivation of maize, sorghu, teff, haricotbeans noug, pepper and sunflower. Field to to be on the contour cropping, grass strips every 30-50 m and grasswater way along the depressions. Use of phosphatic fertilizers, e.g. DAP.	S1
2	Rolling plains and low plateau	Moderate erosion slightly acidic and low phosphorus	Same as S1 but field to be on the contour cropping below 10% slope, more grass strips every 20-30 m and 10-16% of slopland with soil conservation (bench terrace and reducing slope persent down to 10% and countour strips and ploughing along the contour use of phosphatic fertilizers, e.g.DAP.	S2e
3	Low to moderate relief hills	Severe erosion slightly acidic and low phosphours	Same as S2, but narrow grass contour strips for better soil and moisture conservation best suitable to pasture development after soil conservation (bench terrace) cultivation of cereals and pulses.	S3e
4	Moderate to high relief hills	Very severe erosion rockout crops.	Erosion controlled by hillside terrace and/or soil and stone bunds for afforestration in selected area. If lanrge area keep in wieldlife conservation	N2e

Landscape Unit Symbol	Significant Land facet	Limitation	Recommended use and treatment	Land suitability classes
5	Small valleys 0-8% slope	Moderate to poor drainage	Grazing during dry season or horticulture for after draining. Afforestration and building materials (micro basins).	Nlw

8.1 The development plan map

The development plan map 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 esstial as the planner for determining the extent of the areas and the volume of inputs required.

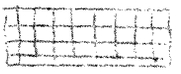
Any development work that has been previously implemented should be transferred to the development map using the symbols as given in table 4. It is important that the new plans are complementary to the existing work and that there is no duplication.

The additional development work, including maintenance or improvement of existing structures, should be added to the plan. Theses are scheduled for soil or stone bunding, hillside terraces, micro basins, etc. The location of farm ponds, spring development, water storage dam, diversion weir, check dam are shown on the development plan 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.

Table 4 LEGEND FOR DEVELOPMENT PLAN MAP LEGEND

Symbol	Detailed
Cu	Arable land (cultivated land)
Gr	Grazing land
Fs	Forest shrubland
Wl	Wood land
R	Rockoutcrop / Boulders
Fp	Forest plantation
Rp	Range pasture
Nu	Nursary site
2w	Water logging


Settlement


Road (with gravel all weather)


Farm road

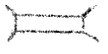
Path

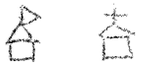

Seasonal

Rivers and water courses

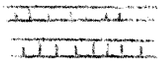

Permanent


Old dam


Old bridge

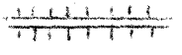

School/Church

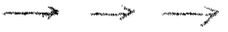
Development work and improvement


Soil and stone faced bunds


Micro basisns for Afforestation


Check dam (gully control)


Channel improvement


Drainage water way and hill side drains

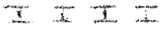

New bridge


Pasture and range development

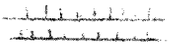
Gully control

Unit boundary

Unit number


New Farm Road or improvement


Diversion weir


Hillside terrace


New Dam

Table 5. Development Plan of Work Components

Work Components	Unit LU'No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	Total
Present Land Use																		
Cultivated land	1	548	575	473	692	532	575	762	792	1083	461	665	840	933	350	425	540	10,240
Cultivated land	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149	-	149
Forest shrubland	1	30	144	157	-	50	-	-	351	155	42	-	-	75	-	-	-	1,004
Forest land	2	75	103	98	123	123	114	95	112	117	205	209	96	92	96	55	117	1,830
Grass land	1	-	-	-	-	-	595	-	-	-	-	-	-	-	187	-	-	782
Grass land	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	167	167
River valley	5	150	165	180	150	160	272	148	113	305	242	275	217	475	307	197	175	3,531
Nursery	1	-	-	-	-	-	-	-	-	1.5	-	2	-	-	1.5	-	-	5
Range pasture	RP																	
IAR	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	13
Bamboo Forest	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	60
Settlement	H	48	72	92	60	60	48	85	50	75	75	87	38	70	65	67	45	1,037
Total	Ha	851	1059	1000	1025	925	1604	1090	1418	1736.5	1025	1238	1204	1645	1006.5	953	1044	18,824
Development plan																		
Proposed cultivated land		578	719	630	692	582	575	762	1148	1238	503	665	840	1008	350	425	540	11,250
Afforestration		150	185	188	198	203	250	169	168	270.5	326	348	204	329	250.5	213	204	3,656
Pasture Improvement	-	-	-	-	-	-	595	-	-	-	-	-	-	-	187	149	167	1,098
Natural grazing land		75	83	90	75	80	136	74	57	153	121	138	109	238	154	99	88	1,770
IAR	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	13
Settlement		48	72	92	60	60	48	85	50	75	75	87	38	70	65	67	45	1,037
Total	Ha	851	1059	1000	1025	925	1604	1090	1418	1736.5	1025	1238	1204	1645	1006.5	953	1044	18,824

Check Dams	Site	2	2	5	5	4	10	3	6	8	3±	10	7	10	7	5	-	87
Dams	Site	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	4
Water way & fill site dams	No.	1.2	-	-	-	-	-	-	-	3.1	-	-	-	-	0.7	1.3	2.1	8.4
Farm road	km	-	-	-	-	-	-	-	-	-	-	-	-	3	-	4	-	7
Flow bridge	Site	-	-	1	-	-	1	1	1	1	1	1	1	2	-	1	-	11
Channel improvement	km	3.7	-	-	-	-	-	-	-	-	-	2	-	-	-	10.6	-	12.6
Diversion weir	Site	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1

Proposed Land Use Plan	Present Land use and landscape unit No.
Cultivated land	1 of cultivated land plus and 1 of forest shrub land
Afforestration	2 of forest land, half of 5 of River valley, Nursary and Bamboo Forestry land.
Pasture Development	1 and 2 of grassland plus lange pasture and 2 of cultivated land
Natural grazing land	Half of 5 river valleys

8.2 Engineering Measures for Soil and Water Conservation

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

8.2.1 Soil and Stone Bunds and Hillsite Terrace

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

The bunds are constructed along the contour at intervals of 10 to 20m. apart and from 0.5 to 1.0m in height. The distance apart and height will be dependent on the degree of slope and rainfall intensity. Hillsite terrace may be considered as a closely spaced developed stone bunds. They are constructed on slope 30% and over, where there is adequate soil depth and an abundence of stone. The width of these terrace should not be greater than 1½ to 2m. While their height will vary from 0.5 to 1.0m. Hillside terrace is not a major soil conservation component in Asosa settlement except at Euzi hill and above units 10 and 11.

8.2.2 Gully control

In units 1, 2, 3, 5, 8 and 14 the majority of the gullies, are of a modest size and can be easily protected by vegetation measures. In unit 16 and part of 17 the gullies are moderately deep and extensive.

In these areas, the revegetation must be supported by the construction of structures. Gullies are formed by a construction of rainfall runoff flowing down a hillside and slopey lands. Frequently road culverts or warm foot path and cattle tracks are the initial cause of a gully. Graded bunds bunds on hillside drains constructed without proper outlets may be another cause. Once established, a deep gully is exceedingly difficult to repair. It's seldom possible to

more stabilize its condition, thus preventing further growth. One way of controlling gullies from developing by stopping the overland flow to enter the gully.

This must be done by diversion drains. Steep side slope must be reduced to slopes less than 1:1 ratio in order to facilitate the revegetation.

The spoil will be put on the bottom of the gully, and strips of grass sods are placed across the gully at a distance 10-20m, depending on the gully bottom slope.

The grass sods (with roots) are to be found in the near vicinity of most gullies. Dimensions of the sods are 10x15 cms, width of the grass strips in 20-30m. If grass strips across the gully are not sufficient, check dams must be constructed.

They can be made of stones or wood (branch). Care must be taken with the application of these construction as they locally increase water velocities and thus the erosive force of the water. There are too many examples of check dams which caused excessive erosion.

8.2.3 Grass water way

Interception ditches at the bottom of each row of plots will generally have a slight gradient towards grassed water ways. 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. When stone channal, debouches from the plots areas into the farmland, it should flareout into a grassed waterway. In units 1, 10, 11 and 5 the majority of the grass waterway are of a modest size and can be easily established and protected by vegetation measures. In unit 2 and 3 there are 6 to 12 % of slopes along the depression, so as to spread out the flow down as widely as possible or established dropping structures between 50 meters interval to

reduce the velocity.

In most cases, the internals roads or tracks which allow access to the row paths and to the farmland will be on the catchment divide. Since they run radially down slope, 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 ditch channel.

8.2.4 Check dams

Check dams are made to slow down excessive water velocity and to promote sedimentation. After introducing check dams the runoff diminish the power of runoff so that it has less effect on vegetation. Although check dams are used to slow down the waterspeed and erosion, the locally increase them. Specially the side slopes just above the checkdam and the botton and sideslopes just downwards must be well protected.

A common error made is to hinder the runoff too much. The discharge capacity of the checkdams must be as big as possible to diminish the risks of collapsing and meandering. Depending on ricks, availability of money and materials, a lot of different types of check dams exist. For permanent use, checkams will be of timbers, masonary, reinforced concrete. These check dams must be trenched at leastO.5 m in the reshaped gully banks and 0.25 m into the gully botton. Unless the gully is very deep (3-5m) check dams must continued to the upper limit of the gully banks.

In units 1, 2, 4, 5, 6 and 17 are 0-8% of sideslopes along the depression.

8.3 Vegetation and Agronomic measures for Soil and Water Conservation

A good vegetative cover is a very effective method of controlling soil erosion. Unfortunately the 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 left to undisciplined exploitation. Ideally, vegetative measures for the control of soil erosion should, if practical, always take procedure over enginaering 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. All agriculture activities must be aimed at diminishing the amount of runoff, specially if gully formation took place. The first possibilities to minimize runoff is to plough in the proper direction and to adopt crops (for crop rotations) to the natural environment. If the amount of runoff is not decreased sufficiently by this measures, strip cropping and the construction of terraces must be considered. Special care must be taken around the gullies, which must be given a good protection against erosion and runoff could be minimized by farming the crops closely.

Livestock Development

Integrating the livestock into the crop production of the settlement is one ways of raising the settlers income and introduction of deversified production system. This is becuse they can be kept for cash income and meat production. Donkeys can also provide means of transportation while oxen will substitute partially the mechanization decreases high cost of crop production.

The major constrains to livestock production, is desease, especially Trcporosomisis and poor nuitrition.

So the most important measure to be taken would be improvement of the vetrinary services, control grazing (rotation closuse of areas) and planting of fodder trees.

Fishery

It is advisable to start fishery development in the settlement which gives additionalnutrition and income to the settlers.

8.3.1 Natural forest conservation and Afforestation

The process of clearing natural forest for need of agriculture land, construction and fuel wood has been in progress since the establishement of the settlement project. What makes the danger of devegetation more feet is that

the soil of the area is highly erodible and the remaining natural forest and shrub ocould be cleared within few years, which could just be sufficient to provide the wood demand of the inhabitant under proper management.

Upto now the natural forests area around the settlement have not been surveyed or managed. So there is anurgent need to survey and identify area of potential wood resources.

Afforestation to assure the supply of fire wood and to stabilize the ecology is being carried on in the settlement. Though 5 million seedlings have been raised and planted over the past 5 years, due to termite problem and absence of cultivation after planting the survival rate has been below 60%.

The continuation of the afforestation programme, with proper species selection and proper management, covering the provision and consuption of fuel wood, agroforestry, wind break and propogation of fruit trees could guarantee the future of the project.

Proposed tree species

a) Species for wood lot establishement

Casuarina equistifolia
Cupressus luistanica
Eucalyptus camaldulensis
" soligna
" citrodora
Melia azandrachta
Leuceana leucocephola
Grevellea robusta

b) Species for the establishement of a system of wind break

Acacia melanoxylon
Casuarina equistifolia
Cupressus luistanica
Grevelle robusta
Melia azandrachta

c) Species for soil conservation and improvement

Acacia albida
Cordia africana
Delonix regia
Leuceana leucocephala
Mangifera indica
Erythrina abysinica
Pilicostigma thonningii
Sesbania aculata
Schinus molle

8.3.2 On pasture and grazing land

Pasture and grazing lands comprise a small area in Asosa settlement. These lands carry a large number of livestock, so large that overgrazing has taken near the surrounded settlement areas. This results in a fall in the quality and quantity of fodder, so fewer animals can be supported. The soil is left without a vegetation cover, thus prone to erosion by water and wind. Loss of topsoil through erosion reduces the fertility of the soil, and thus the likelihood of reestablishing a good quality pasture goes down. The land is with 8-30% slope with no worse than slightly eroded or irregular topography. The implecation is that, it can be cropped from time to time in a long ley system to exploit the fertility built up without incurring excessive erosion penalities. The unit 5, 14, 16 and unit 17 has about 1,008 hectares of pasture potential land. Unit 8 has about hectares of pasture land.

The pasture management will probably require a system of rotational grazing and forage conservation.

Acess to pasture poss the problem of straying into field of growing crops. Desirable shade and browse trees should be planted in the pasture areas.

Natural grazing that can be recommended will come from two classes of land. One is dissected slopes 16-30% slopeland will provide the upland grazing in the wet season. Grazing must be done carefully, more areas will need

to be managed with care and needed strict grazing control: The depressional areas during the dry season, don't graze the gully when the soil is wet or in the dry season, so that the vegetation is not damaged. During the wet season, cattle must not be allowed in the gully and sheeps and goats are preferred. Mowed grasses must be removed out of the gully, so that it does not hamper the runoff.

It can be used as hay or mulch material. These areas could also be used for water storage in the future as suggested in water storage dams..

8.3.3 On cultivated land and Homestead plots and cultivated land

Apart from the physical structures for soil conservation, a number of agronomic measures can be used in combatting erosion on cultivated land and homestead plots. The methods directly increasing surface storage capacity would be tillage systems like countour 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 erosion than if it has 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 soil increases the infiltration by creating more stable aggregates less susceptible 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 raised to have beneficial effects for soil conservation.

Slowing down the speed of the water on certain parts of the slope are strip cropping, narrow grass strips, residue or mulch 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, mulch lines or hedges used for building up a terrace. The strip slows 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 upperend. Plot dimesion should aim to be 40-50m long 20-25m wide along the contour lines, but there is no hard and fast rule and the length is dependent on the distance required between interception ditches which protect the upper end 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 parallel 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 ditches 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 use, 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 particulary important. The development of a farm pond or spring reduces the movement of livestock for watering, this will immediately result in less erosion.

The more movement of livestock destroys vegetation, and their warn tracks are a frequent cause of gully erosion. A good source of clean water is essential for the health of the settlers. Furthermore, if the source can be

made available close to homesteads, much time will be saved for more productive work than collecting water. The Afa, Hoha, Selga, rivers and perennial springs are have good potential for irrigation and water supply for human and livestock use. Units 1, 9, 10, 11 and 2, 3, 7, 8 and project centre get water for drinking from Hoha river and Units 4, 5, 6 and 12 get water for drinking from perennial spring and river. Units 13, 14, 15, 16, 17 get water for drinking from Afa river.

The nurseries unit 14 and 11 get water from perennial river but, it is proposed that the nerseries and horticulture farms that will be established for the settlement will get water by pumping or diversion weirs from these rivers.

8.4.1 Farm ponds, Dams, and Wells,

In Assosa there are seasonal and perennial rivers and have good potential for farm ponds and dams, diversion weirs and wells. The construction of those facilities should be considered as part of the development programme. Idealy, the ponds, and wells should be located in natural depressions where the soil in impervious, or an imprevious layer can be spread on the bottom. Seepage losses will therefore be small, and if the ponds and dams are relatively deep to their surface area, evaporation loss will be reduced.

- Pollution of the ponds by livestock is a serious problem. It is necessary to fance to keep the animals out of the pond, and to pipe the water from the pond to a nearby water trough.
- The siltation of ponds and dams. Generally, pond and dams are constructed across natural water courses. Care has to be taken that the spillway is of adequate size to accommodate the runoff from the catchment area.

  The capacity of the reservoir (dam upto 8m 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 heavier silt load will more quickly reduce the capacity of the reservoirs.

  Where the water table is less than 2 or 3 m 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 Units 9 and between 10 has a good potential sites for diversion weir from perennial river Koha, get water for irrigation of nursury and horticulture.

8.4.3 Swamp Drainage, Waterlogging

Experience with the drainage problems is rather limited as the majority of the unit management, have more than average rainfall. Most problems are related to maize and other crops, that changed its colour (becoming yellow) during the months of heavy rainfall.

This changing of colour can be the symptom of an unbalanced nutrient uptake due to the excess water in on the soil. Other problems were that going in the field was very difficult or impossible for man (July to August) and for tractors (July, August to Mid September).

The introduction of a surface drainage system will solve partly the above mentioned problems. The presence of furrows related to row drilling, facilitates the overland flow and weeding, which favorate both crop performance.

Accessibility of the fields for men can be improved by drainage, but the use of wheel tractors in these clays during the rainy season will always be troublesome.

The use of wheel tractors is even dissuade, as destruction of soil structure is nearly inevitable.in these conditions. Unit 15 to between 16 and near unit 14 has been water logging for 50 days on the depression small valleys.

8.5 Other measures

The principal soil and water conservation measures that might be required in an subwatershed development programme have been outlined in the three subsections above.

These are the measures that will lead to improving or atleast 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) apiory (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 landslide 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 these on relatively steep grades may have to rock-paved in order to prevent 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)
M	Medium	Silt loam (Sil) loam (1) 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	Size Range (diameter)
g	Gravelly	up to 3"
c	Cobbly	3" to 10"
s	Stone	10" to moveable
r	Rock	unmoveable

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

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

S I Z E O F F R A G M E N T S

3" - 10" in diameter		More than 10" in diameter to moveable	
Class	% by Volume	Class	% surface area Occupied by rock
S1	30 - 50		
S2	50 - 70	R	10 - 50
S3	70 - 90	700	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 Structure	Approximate Per Rate Cm
2	Slow	fine (heavy)	pr, abk, pl	0.13 to 0.5
3	moderately slow	fine or medium	pr, abk pl	0.5 to 2.0
4	moderate	medium	pr, sbk	2.0 to 6.3
5	moderately rapid	coarse	sbk, gr, cr	6.3 to 12.5
6	rapid	very coarse	cr, sg	12.5 to 25.0

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.)
e	Evaporite (predominantly gypsum)
s	Sandstone
c	Calearеous (Predominantly limestone)

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

Example:

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

Class Symbol	Degree in % slope	Descriptive Term
A	0 - 2	Flat or almost flat
B	2 - 8	Gently slopping
C	8 - 16	Slopping
D	16 - 30	Moderately Steep
E	30 - 50	Steep
F	50 +	Very Steep

Erosion (All Lands)

Symbol	Description Term	
1	None to slight erosion	Less than 25% 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 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 & moderately 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 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	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 differentiated 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:

Class 0	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.

Approximate Limits of Salinity Classes

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

Drainage

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

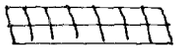
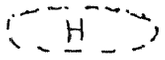
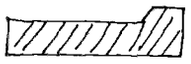
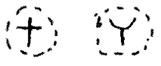
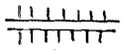
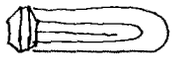
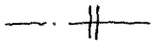
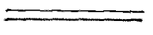
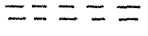
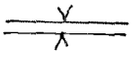
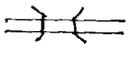
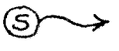
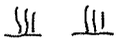
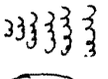
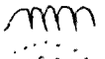
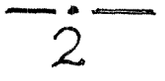
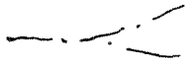
Class 0 Very Poorly Drained - water is removed from the soil so slowly that the water table remains at or on the surface the greater part of the time. Soils of this drainage class usually occupy level or depressed sites and are frequently ponded.

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	Description
	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
2	Unit Number
2	Landscape Unit Number
Ⓢ A-1-5	Location of major soil samples Reference Numbers
	Seasonal streams

Land Use

Symbol	Description
F	Forest
T	Thicket
Ba	Bamboo
P	Plantation
R	Riverine forest
EW	Eucalyptus, Woodland
S	Scrub
Sc	Scattered Trees
L	Cultivated Land without Conservation
Lc	Cultivated Land with Conservation
B	Bareland
G	Grassland
EPM	Exposed Parent Material
GL1	Moderate Gully Erosion
GL2	Severe Gully Erosion
A	Strongly Affected Salts andAlkali
—— ·· ——	Ridge
→ → →	Grass water way
- - - - - -	Food path
N	Nursery

ENVIORNMENTAL REQUIREMENT FOR CROP SORGHUM

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1500 - 2200	1500 – 1400	1400 – 1300	1300 – 1200	< 1200
					2200 - 2270	2270 – 2350	2350 – 2400	> 2400
		Mean Temperature (Thermal Zone)	°C	18 – 23	14 – 17	~~27 30~~	~~31 35~~	< 15
					24 – 26			> 35
2	GROWING PERIOD	Length of Growing period	day	180 – 240	170 – 180	160 – 170	150 – 160	< 150
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	> 150	150 – 100	100 – 50	50 – 25	< 25
		Growth cycle	day	200 – 250	180 – 200	160 – 180	140 – 160	< 140
					250 – 270	> 270		
4	DRAINAGE	Soil Drainage	class	MW – W	I – P	P – VP	~~VP – E~~	~~SE – E~~
					W – SW	SW – C		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	18 – 23	14 – 17	~~27 – 30~~	~~31 – 35~~	< 15
					24 – 26			> 35
		Length of Growing period	day	180 – 240	180 – 170	170 – 160	160 – 150	< 150
		Soil Texture	class	L – SC	LS – SL	Sic – C (61)	C (rd)	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 50	> 50
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	L – SC	LS – SL	Sil – C (61)	C (rd)	S
		Soil Reaction	pH	6.5 – 7.0	6.5 – 6.0	6.0 – 5.0	5.0 – 4.5	< 4.5
					7.0 – 7.5	7.5 – 8.0	8.0 – 8.5	> 8.5
		Organic Matter	%	3 – 6	3 – 2 6.0 – 7.5	2 – 1 7.5 – 9.0	1 9.0 – 10.0	> 10.0
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	> 150	150 – 100	100 – 50	50 – 25	< 25
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	L – SC	LS – SL	Sic – C (61)	C (rd)	S

ENVIORNMENTAL REQUIREMENT FOR CROP SORGHUM

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S1 SUITABLE	MODERTLY S2 SUITABLE	MARGINALLY S3 SUITABLE	CURRENTLY N1 N.S	PERMANENTLY N2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0-4	4-8	8-12	12-15	>15
		Alkalinity	ESP	0-6	6-10	10-13	13-15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0-8	8-16	16-30	30-50	>50
		stoniness	Class	None	fairly stony	stony	very stony	exceeding stony
		Soil Texture	Class	L-SC	LS-SL	SiC-C(bl)	C(rd)	S

No	LAND QUALITY	LAND CHARACTERISTIC	CI	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed Preparation	VH - Very high energy required H - High " M - Medium " L - Low " VL - Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I - Intolerant M - Medium T - Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost sensitivity	S - Sensitive M - Medium T - Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
			S - Sensitive M - Medium	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP SORGHUM

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat	M	Noug	T
				Teff	T	Seasame	T
				Haricotbeans	M	Sunflower	S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum	M	Chickpea	L
				Maize	L	Noug	L
				Wheat	H	Seasame	L
				Pepper	VL		
				Teff	L		
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Modevately T – Tolerant	Sorghum	M	Chickpea	S
				Maize	S	Pepper	M
				Wheat	M	Noug	S
				Teff	M	Seasame	M
				Haricotbeans	S	Sunflower	S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum	L	Chickpea	L
				Maize	M	Pepper	Not Know
				Wheat	L	Noug	"
				Teff	Not Know	Seasame	"
				Haricotbeans	Not Know	Sunflower	"
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum	H	Chickpea	M
				Maize	M	Pepper	L
				Wheat	H	Noug	H
				Teff	H	Seasame	H
				Haricotbeans	M	Sunflower	H
17	WORKABILITY	Mechanized farming (General)	L – Low M – Medium H – High	Sorghum	H	Chickpea	H
				Maize	H	pepper	L
				Wheat	H	Noug	L
				Teff	M	Seasame	L
				Haricotbeans	H	Sunflower	L

ENVIORNMENTAL REQUIREMENT FOR CROP CHILLI PEPPER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1000 - 2000	1000 - 800	800 - 700	700 - 600	<600
					2000 - 2200	2200 - 2300	2300 - 2400	>2400
		Mean Temperature (Thermal Zone)	°C	18 - 24	15 - 17	12 - 14	8 - 11	<8
					25 - 28	29 - 31	32 - 35	>35
2	GROWING PERIOD	Length of Growing period	day	150 - 240	150 - 140	140 - 130	130 - 120	<120
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	100 - 150	50 - 150	25 - 50	10 - 25	<10
		Growth cycle	day	220 - 240	~~200 - 220~~	~~180 - 200~~	170 - 180	<170
4	DRAINAGE	Soil Drainage	class	W	MW	I - P	~~P - SW~~	~~VP - E~~
					SW	SW		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	18 - 24	15 - 17	12 - 14	8 - 11	<8
					25 - 28	29 - 31	32 - 35	>35
		Length of Growing period	day	150 - 240	150 - 140	140 - 130	130 - 120	<120
		Soil Texture	class	LS - CL	sicl	SC	sic - C(bl)	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 - 8	8 - 16	16 - 30	30 - 35	>35
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	LS - CL	sicl	SC	sic - C(bl)	S
		Soil Reaction	pH	6.5 - 7.0	6.5 - 6.0	6.0 - 5.0	5.0 - 4.5	<4.5
					7.0 - 7.5	7.5 - 8.0	8.0 - 8.5	>8.5
		Organic Matter	%	3 - 6	3 - 2 6.0 - 7.5	2 - 1 7.5 - 9.0	1 9.0 - 10.0	>10
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	100 - 150	50 - 100	25 - 50	10 - 25	<10
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	LS - CL	sicl			

ENVIORNMENTAL REQUIREMENT FOR CROP CHILLI PEPPER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S1 SUITABLE	MODERTLY S2 SUITABLE	MARGINALLY S3 SUITABLE	CURRENTLY N1 N.S	PERMANENTLY N2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0 – 4	4 – 8	8 – 12	12 – 15	>15
		Alkalinity	ESP	0 – 6	6 – 10	10 – 13	13 – 15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0 – 8	8 – 16	16 – 30	30 – 35	>35
		Staniness	Class	hone	fairly stony	stony	very stony	exceeding stony
		Soil Texture	Class	LS – CL	SiCl	SC	SiC – C(61)	S

No	LAND QUALITY	LAND CHARACTERISTIC	Cl	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed preparation	VH – Very high energy required H – High " M – Medium " L – Low " VL – Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I – Intolerant M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost sensitivity	S – Sensitive M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
			S – Sensitive	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP CHILLI PEPPER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat Teff Haricotbeans	M T M	Noug Seasame Sunflower	T T S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum Maize Wheat Pepper Teff	M L H VL L	Chickpea Noug Seasame	L L L
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum Maize Wheat Teff Haricotbeans	M S M M S	Chickpea Pepper Noug Seasame Sunflower	S M S M S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum Maize Wheat Teff Haricotbeans	L M L Not Know Not Know	Chickpea Pepper Noug Seasame Sunflower	L Not Know " " "
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum Maize Wheat Teff Haricotbeans	H M H H M	Chickpea Pepper Noug Seasame Sunflower	M L H H H
17	WORKABILITY	Mechanized faming (general)	L – Low M – Medium H – High	Sorghum Maize Wheat Teff Haricotbeans	H H H M H	Chickpea pepper Noug Seasame Sunflower	H L L L L

ENVIORNMENTAL REQUIREMENT FOR CROP HARICOT BEANS APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1400 – 1800	1400 – 1200	1200 – 1100	1100 – 1000	<1000
					1800 – 1900	1900 – 2000	2000 – 2100	>2100
		Mean Temperature (Thermal Zone)	°C	21 – 25	15 – 20	10 – 14	7 – 9	<7
					26 – 28	29 – 31	31 – 35	>35
2	GROWING PERIOD	Length of Growing period	day	100 – 120	90 – 100 120 – 130	80 – 90 >130	70 – 80	<70
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	50 – 100	25 – 50	10 – 25	<10	–
		Growth cycle	day	100 – 120	90 – 100	80 – 90	<10	–
					120 – 130	>130		
4	DRAINAGE	Soil Drainage	class	MW – W	I	I	P – VP	E
					SE	P		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	20 – 22.5	20 – 19	19 – 18	18 – 17.5	<17.5
					22.5 – 23	23 – 24	24 – 25	>25
		Length of Growing period	day	100 – 120	90 – 100 120 – 130	80 – 90 >130	70 – 80	>70
		Soil Texture	class	SL – CL	LS	C (rd)	C (bl)	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 35	>35
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	SL – CL	LS	C (rd)	C (bl)	S
		Soil Reaction	pH	5.5 – 6.7	5.5 – 5.3	5.3 – 5.0	5.0 – 4.7	<4.7
					6.7 – 7.0	7.0 – 7.3	7.3 – 7.6	>7.6
		Organic Matter	%	>3	3 – 2	2 – 1	1 – 0	–
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	50 – 100	25 – 50	10 – 25	<10	–
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	SL – CL				

ENVIORNMENTAL REQUIREMENT FOR CROP HARICOTBEANS

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S_1 SUITABLE	MODERTLY S_2 SUITABLE	MARGINALLY S_3 SUITABLE	CURRENTLY N_1 N.S	PERMANENTLY N_2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0 – 1	1 – 1.5	1.5 – 2	2	>2
		Alkalinity	ESP	0 – 5	5 – 8	8 – 10	10 – 12	>12
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0 – 8	8 – 16	16 – 30	30 – 35	> 35
		Stoniness	Class	None	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	SL – CL	LS	C(rd)	C(bl)	S

No	LAND QUALITY	LAND CHARACTERISTIC	Cl	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed preparation	VH – Very high energy required H – High " M – Medium " L – Low " VL – Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I – Intolerant M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost Sensitivity	S – Sensitive M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
			S – Sensitive M – Medium	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP HARICOT BEANS

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat Teff Haricotbeans	M T M	Noug Seasame Sunflower	T T S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum Maize Wheat Pepper Teff	M L H VL L	Chickpea Noug Seasame	L L L
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum Maize Wheat Teff Haricotbeans	M S M M S	Chickpea Pepper Noug Seasame Sunflower	S M S M S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum Maize Wheat Teff Haricotbeans	L M L Not Know Not Know	Chickpea Pepper Noug Seasame Sunflower	L Not Know " " "
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum Maize Wheat Teff Haricotbeans	H M H H M	Chickpea Pepper Noug Seasame Sunflower	M L H H H
17	WORKABILITY	Mechanized farming (general)	L – Low M – Medium H – High	Sorghum Maize Wheat Teff Haricotbeans	H H H M H	Chickpea pepper Noug Seasame Sunflower	H L L L L

ENVIORNMENTAL REQUIREMENT FOR CROP SUNFLOWER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1200 – 2000	1200 – 1100	1100 – 1050	1050 – 1000	< 1000
					2000 – 2200	2200 – 2500	2500 – 2800	> 2800
		Mean Temperature (Thermal Zone)	°C	22 – 24	19 – 21	15 – 18	10 – 14	< 10
					25 – 30	31 – 35	36 – 38	> 38
2	GROWING PERIOD	Length of Growing period	day	90 – 150	90 – 85	85 – 80	80 – 75	< 75
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	100 – 150	50 – 100	25 – 50	10 – 25	< 10
		Growth cycle	day	110 – 140	100 – 110	90 – 100	80 – 90	< 80
					140 – 160	> 160		
4	DRAINAGE	Soil Drainage	class	MW – W	I	P	P	VP
					SE	SE	E	E
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	22 – 24	19 – 21	15 – 18	10 – 14	< 10
					25 – 30	31 – 35	36 – 38	> 38
		Length of Growing period	day	90 – 150	90 – 85	85 – 80	80 – 75	< 75
		Soil Texture	class	LS – SCL	Sil	Sic	C (rd)	C (bl)
		Stoniness	class	None	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 35	> 35
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	LS – SCL	Sil	Sic	C (rd)	C (bl)
		Soil Reaction	pH	6.5 – 7.0	6.5 – 6.0	6.0 – 5.5	5.5 – 5.0	< 5.0
					7.0 – 7.5	7.5 – 8.0	8.0 – 8.5	> 8.5
		Organic Matter	%	> 3	2 – 3	1 – 2	0 – 1	
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	100 – 150	50 – 100	25 – 50	10 – 25	< 10
		Stoniness	class	None	fairly - stony	stony	very stony	exceeding stony
		Soil Texture	class	LS – SCL	Sil	Sic		

ENVIORNMENTAL REQUIREMENT FOR CROP SUNFLOWER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S1 SUITABLE	MODERTLY S2 SUITABLE	MARGINALLY S3 SUITABLE	CURRENTLY N1 N.S	PERMANENTLY N2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0 – 4	4 – 8	8 – 12	12 – 15	>15
		Alkalinity	ESP	0 – 6	6 – 10	10 – 12	12 – 15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0 – 8	8 – 16	16 – 30	30 – 35	>35
		Staniness	Class	None	fairly stony	stony	very stony	exceeding stony
		Soil Texture	Class	LS – SCL	Sil	SiC	C(rd) – C(bl)	S

No	LAND QUALITY	LAND CHARACTERISTIC	Cl	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed preparation	VH – Very high energy required H – High " M – Medium " L – Low " VL – Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I – Intolerant M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost sensitivity	S – Sensitive M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
			S – Sensitive M – Medium	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP SUNFLOWER

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat	M	Noug	T
				Teff	T	Seasame	T
				Haricotbeans	M	Sunflower	S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum	M	Chickpea	L
				Maize	L	Noug	L
				Wheat	H	Seasame	L
				Pepper	VL		
				Teff	L		
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum	M	Chickpea	S
				Maize	S	Pepper	M
				Wheat	M	Noug	S
				Teff	M	Seasame	M
				Haricotbeans	S	Sunflower	S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum	L	Chickpea	L
				Maize	M	Pepper	Not Know
				Wheat	L	Noug	"
				Teff	Not Know	Seasame	"
				Haricotbeans	Not Know	Sunflower	"
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum	H	Chickpea	M
				Maize	M	Pepper	L
				Wheat	H	Noug	H
				Teff	H	Seasame	H
				Haricotbeans	M	Sunflower	H
17	WORKABILITY	Mechanized faming (general)	L – Low M – Medium H – High	Sorghum	H	Chickpea	H
				Maize	H	pepper	L
				Wheat	H	Noug	L
				Teff	M	Seasame	L
				Haricotbeans	H	Sunflower	L

ENVIORNMENTAL REQUIREMENT FOR CROP NOUG APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1000 – 1200	~~1200 – 1300~~	~~1300 – 1400~~	~~1400 – 1600~~	~~> 1600~~
		Mean Temperature (Thermal Zone)	°C	18 – 23	15 – 17	10 – 14	7 – 9	< 7
					24 – 28	29 – 31	32 – 34	> 32
2	GROWING PERIOD	Length of Growing period	day	120 – 150	110 – 120	100 – 110	90 – 100	< 90
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	50 – 100	25 – 50	10 – 25	–	< 10
		Growth cycle	day	120 – 150	~~110 – 120~~	~~100 – 110~~	90 – 100	< 90
4	DRAINAGE	Soil Drainage	class	MW – W	I	I	~~VP~~ I	E
					SE	P		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	21 – 27	21 – 23	18 – 20	15 – 17	< 15
					28 – 30	31 – 32	33 – 35	> 35
		Length of Growing period	day	120 – 150	110 – 120	100 – 110	90 – 100	< 90
		Soil Texture	class	SL – CL	LS	Sicl – Sic	C(rd) – C(bl)	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 35	> 35
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	SL – CL	LS	Sicl – Sic	C(rd) – C(bl)	S
		Soil Reaction	pH	5.5 – 6.7	5.5 – 5.3	5.3 – 5.0	5.0 – 4.7	< 4.7
					6.7 – 7.0	7.0 – 7.3	7.3 – 7.6	> 7.6
		Organic Matter	%	> 3	3 – 2	2 – 1	1 – 0	–
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	50 – 100	25 – 50	10 – 25	–	< 10
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	SL – CL	LS	Sicl – Sic	C(rd) – C(bl)	S

ENVIORNMENTAL REQUIREMENT FOR CROP NOUG

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S1 SUITABLE	MODERATELY S2 SUITABLE	MARGINALLY S3 SUITABLE	CURRENTLY N1 N.S	PERMANENTLY N2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0-6	6-8	8-9	9-10	>10
		Alkalinity	ESP	0-6	8-10	10-12	12-15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0-8	8-16	16-30	30-35	>35
		Stoniness	Class	None	fairly stony	stony	very stony	exceeding stony
		Soil Texture	Class	SL-CL	LS	SiCl-SiC	C(vd)-C(Bl)	S

No	LAND QUALITY	LAND CHARACTERISTIC	Cl	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed Preparation	VH - Very high energy required H - High " M - Medium " L - Low " VL - Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I - Intolerant M - Medium T - Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost Sensitivity	S - Sensitive M - Medium T - Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
			S - Sensitive	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP NOUG

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat	M	Noug	T
				Teff	T	Seasame	T
				Haricotbeans	M	Sunflower	S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum	M	Chickpea	L
				Maize	L	Noug	L
				Wheat	H	Seasame	L
				Pepper	VL		
				Teff	L		
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum	M	Chickpea	S
				Maize	S	Pepper	M
				Wheat	M	Noug	S
				Teff	M	Seasame	M
				Haricotbeans	S	Sunflower	S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum	L	Chickpea	L
				Maize	M	Pepper	Not Know
				Wheat	L	Noug	"
				Teff	Not Know	Seasame	"
				Haricotbeans	Not Know	Sunflower	"
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum	H	Chickpea	M
				Maize	M	Pepper	L
				Wheat	H	Noug	H
				Teff	H	Seasame	H
				Haricotbeans	M	Sunflower	H
17	WORKABILITY	Machanized faming (General)	L – Low M – Medium H – High	Sorghum	H	Chickpea	H
				Maize	H	pepper	L
				Wheat	H	Noug	L
				Teff	M	Seasame	L
				Haricotbeans	H	Sunflower	L

ENVIORNMENTAL REQUIREMENT FOR CROP TEFF

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S^1 SUITABLE	MODERTLY S^2 SUITABLE	MARGINALLY S^3 SUITABLE	CURRENDLY N^1 N.S	PERMANENTLY N^2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0 – 4	4 – 8	8 – 12	12 – 15	>15
		Alkalinity	ESP	0 – 6	6 – 10	10 – 13	13 – 15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0 – 8	8 – 16	16 – 30	30 – 50	>50
		Stoniness	Class	none	fairly Stony	stony	very stony	exceeding stony
		Soil Texture	Class	Sil – CL (bl)	L – SCl	CL(bl) – C(bl)	SL	S

No	LAND QUALITY	LAND CHARACTERISTIC	Cl	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed Preparation	VH – Very high energy required H – High " M – Medium " L – Low " VL – Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I – Intolerant M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost sensitivity	S – Sensitive M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
		Hail Sensitivity	S – Sensitive M – Medium	Sorghum Maize	S <	Chickpea Pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP TEFF APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1700 – 2300	1700 – 1500	1500 – 1300	1300 – 1000	< 1000
					2300 – 2500	2500 – 2600	2600 – 2800	> 2800
		Mean Temperature (Thermal Zone)	°C	15 – 20	14 – 12	~~25 – 28~~	~~29 – 35~~	< 10
					21 – 24			> 35
2	GROWING PERIOD	Length of Growing period	day	90 – 120	90 – 70	70 – 60	60 – 45	< 45
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	> 50	50 – 25	25 – 10	15 – 10	< 10
		Growth cycle	day	100 – 120	100 – 90	90 – 80	80 – 70	< 70
					120 – 130	> 130		
4	DRAINAGE	Soil Drainage	class	I – W	I – P	P – VP	~~VP~~	~~SE – E~~
					W – SW	SW – E		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	15 – 20	12 – 14	~~25 – 28~~	~~29 – 35~~	< 10
					21 – 24			> 35
		Length of Growing Period	day	90 – 120	90 – 70	70 – 60	60 – 45	< 45
		Soil Texture	class	Sil – C(bl)	L – SL	CL – C(bl)	SL	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 50	> 50
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	Sil – C(bl)	L – SL	CL – C(bl)	SL	S
		Soil Reaction	pH	6.5 – 7.0	6.5 – 6.0	6.0 – 5.0	5.0 – 4.5	< 4.5
					7.0 – 7.5	7.5 – 8.0	8.0 – 8.5	> 8.5
		Organic Matter	%	3 – 6	3 – 2 / 6.5 – 7.5	2 – 1 / 7.5 – 9.0	< 1 / 9.0 – 10.0	> 10.0
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	> 50	50 – 25	25 – 15	15 – 10	< 10
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	Sil – C(bl)	L – SL	CL – C(bl)	SL	S

ENVIORNMENTAL REQUIREMENT FOR CROP TEFF

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat Teff Haricotbeans	M T M	Noug Seasame Sunflower	T T S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum Maize Wheat Pepper Teff	M L H VL L	Chickpea Noug Seasame	L L L
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum Maize Wheat Teff Haricotbeans	M S M M S	Chickpea Pepper Noug Seasame Sunflower	S M S M S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum Maize Wheat Teff Haricotbeans	L M L Not Know Not Know	Chickpea Pepper Noug Seasame Sunflower	L Not Know " " "
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum Maize Wheat Teff Haricotbeans	H M H H M	Chickpea Pepper Noug Seasame Sunflower	M L H H H
17	WORKABILITY	Mechanized faming (general)	L – Low M – Medium H – High	Sorghum Maize Wheat Teff Haricotbeans	H H H M H	Chickpea pepper Noug Seasame Sunflower	H L L L L

ENVIORNMENTAL REQUIREMENT FOR CROP MAIZE

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				HIGHLY S1 SUITABLE	MODERTLY S2 SUITABLE	MARGINALLY S3 SUITABLE	CURRENTLY N1 N.S	PERMANENTLY N2 N.S
8	TOXICITIES	Salinity	mmhos/cm	0 – 4	4 – 8	8 – 12	12 – 15	>15
		Alkalinity	ESP	0 – 6	6 – 10	10 – 13	13 – 15	>15
9	MAGEMENT LAND PREPARATION AND MECHANIZATION POTENTIAL	Slope Angle	%	0 – 8	8 – 16	16 – 30	30 – 50	>50
		Stoniness	Class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	L – SC	LS – SL	SiC – C(rd)	C (bl)	S

No	LAND QUALITY	LAND CHARACTERISTIC	CI	CROP	RATING	CROP	RATING
10	CONDITION AFFECTING GEAMINATION AND ESTABLISHMENT	Seed-bed preparation	VH – Very high energy required H – High " M – Medium " L – Low " VL – Very low "	Sorghum Maize Wheat Teff Haricotbean	H M H VH M	Chickpea Pepper Noug Sunflower Seasame	M L H H VH
11	FLOOD HAZARD	Attack by Surface water	I – Intolerant M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	M M I I M	chickpea Pepper Noug Seasame Sunflower	M T I I M
12	CLIMATE HAZARD	Frost sensitivity	S – Sensitive M – Medium T – Tolerant	Sorghum Maize Wheat Teff Haricotbean	S S S T S	Chickpea Pepper Noug Seasame	S S S S
		Hail Sensitivity	S – Sensitive M – Medium	Sorghum Maize	S S	Chickpea pepper	T M

ENVIORNMENTAL REQUIREMENT FOR CROP MAIZE

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	UNIT	RANGES OF SUITABILITY				
				S1 HIGHLY SUITABLE	S2 MODERTLY SUITABLE	S3 MARGINALLY SUITABLE	N1 CURRENTLY Not.S	N2 PERMANENTLY Not.S
1	TEMPERATURE REGIME	Altitude	m	1300 – 2200	1300 – 1200	1200 – 1100	1100 – 1000	< 1000
					2200 – 2270	2270 – 2350	2350 – 2400	> 2400
		Mean Temperature (Thermal Zone)	°C	18 – 23	14 – 17	~~27 – 30~~	~~31 – 36~~	< 14
					24 – 26			> 35
2	GROWING PERIOD	Length of Growing period	day	210 – 150	150 – 140	140 – 130	130 – 120	< 120
3	MOISTURE AVAILABILITY	Effective Soil Depth	cm	> 150	150 – 100	100 – 50	50 – 25	< 25
		Growth cycle	day	160 – 170	150 – 160	140 – 150	130 – 140	< 130
					170 – 180	> 180		
4	DRAINAGE	Soil Drainage	class	I – W	I – P	P – VP	~~VP – E~~	~~SE – E~~
					W – SW	SW – E		
5	DEGRADATION HAZARD	Mean Temperature (Thermal Zone)	°C	18 – 23	14 – 17	~~27 – 30~~	~~31 – 36~~	< 14
					24 – 26			> 35
		Length of Growing period	day	210 – 150	150 – 140	140 – 130	130 – 120	< 120
		Soil Texture	class	L – SC	LS – SL	SiC – C (rd)	C (bl)	S
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Slope angle	%	0 – 8	8 – 16	16 – 30	30 – 50	> 50
6	NUTRIENT STATUS AND RETENTION	Soil Texture	class	L – SC	LS – SL	SiC – C(rd)	C(bl)	S
		Soil Reaction	pH	6.5 – 7.0	6.5 – 6.0	6.0 – 5.0	5.0 – 4.5	< 4.5
					7.0 – 7.5	7.5 – 8.0	8.0 – 8.5	> 8.5
		Organic Matter	%	3 – 6	3 – 2 / 6.0 – 7.5	2 – 1 / 7.5 – 9.0	1 / 9.0 – 10.0	> 10.0
7	ROOTING CONDITION AND WORKABILITY	Effective Soil Depth	cm	> 150	150 – 100	100 – 50	50 – 25	< 25
		Stoniness	class	none	fairly stony	stony	very stony	exceeding stony
		Soil Texture	class	L – SC	LS – SL	SiC – C(rd)	C (bl)	S

ENVIORNMENTAL REQUIREMENT FOR CROP MAIZE

APPENDIX 2

No	LAND QUALITY	LAND CHARACTERISTIC	CLASSES	CROP	RATING	CROP	RATING
12	CLIMATE HAZARD	Hail Sensitivity	T – Tolerant	Wheat	M	Noug	T
				Teff	T	Seasame	T
				Haricotbeans	M	Sunflower	S
13	SALINITY	Tolerance to Salinity	VH – Very high tolerance to Salinity H – High M – Medium L – Low VL – Very Low	Sorghum	M	Chickpea	L
				Maize	L	Noug	L
				Wheat	H	Seasame	L
				Pepper	VL		
				Teff	L		
14	SODICITY	Saturation of the exchange complex with Na ions	S – Sensitive M – Moderately T – Tolerant	Sorghum	M	Chickpea	S
				Maize	S	Pepper	M
				Wheat	M	Noug	S
				Teff	M	Seasame	M
				Haricotbeans	S	Sunflower	S
15	TOXICITY	Ca Co 3	L – Low Tolerance M – Medium Tolerance H – High Tolerance	Sorghum	L	Chickpea	L
				Maize	M	Pepper	Not Know
				Wheat	L	Noug	"
				Teff	Not Know	Seasame	"
				Haricotbeans	Not Know	Sunflower	"
16	WORKABILITY NON MECHANIZI	Non Machanized farming (tillage)	L – Low work input required M – Medium " H – High "	Sorghum	H	Chickpea	M
				Maize	M	Pepper	L
				Wheat	H	Noug	H
				Teff	H	Seasame	H
				Haricotbeans	M	Sunflower	H
17	WORKABILITY	Mechanized faming (general)	L – Low M – Medium H – High	Sorghum	H	Chickpea	H
				Maize	H	pepper	L
				Wheat	H	Noug	L
				Teff	M	Seasame	L
				Haricotbeans	H	Sunflower	L

APPENDIX.

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1-17
Location / Coordinates : Wellega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			$CaCO_3$ %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
855	A-1-1				57.6	16.0	26.4	SCL	6.05				
856	A-1-2				35.6	12.0	52.4	C	5.75				
857	A-1-3				33.6	22.0	44.4	C	5.70				
858	A-1-3				37.6	10.0	52.4	C	5.55				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
855	A-1-1		0.271	0.256	20	3						18.2	
856	A-1-2		0.217	0.128	12	2						13.2	
857	A-1-3		0.271	0.192	14	3						15.6	
858	A-1-3		0.217	0.096	5	5						15.4	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
855	A-1-1			0.252		5.969	0.8						
856	A-1-2			0.252		3.519	0.6						
857	A-1-3			0.196		5.589	1.4						
858	A-1-3			0.084		1.829	0.04						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 - 17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 in			CaCO3 %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
859	A-2-1				55.6	28.0	16.4	SL	6.50				
860	A-2-2				53.6	24.0	22.4	SCL	4.75				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
859	A-2-1		0.27	0.416	24	1						23.4	
860	A-2-2		0.27	0.128	5	0						17.4	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
859	A-2-1			0.266		6.452	1.6						
860	A-2-2			0.238		3.347	0.04						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1-17

Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 in			$CaCO_3$ %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
861	A-3-1				45.6	26.0	28.4	CL	6.30				
862	A-3-2				55.6	18.0	26.4	SCL	5.55				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Def.	
861	A-3-1		0.271	0.256	25	5						26.2	
862	A-3-2		0.217	0.096	21	9						20.4	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	R.W.P %	Available H_2O %	
861	A-3-1			0.266		8.142	1.2						
862	A-3-2			0.168		5.451	1.7						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASCSA Field Number : Unit 1–17
Location / Coordinates : Wolega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 in			CaCO3 %	Free Fe_2O_3 %
			>2	2–0.2	0.2–0.05	0.05–0.002	<0.002		H_2O	KCl	NaF		
863	A-4-1				41.6	26.0	32.4	CL	5.95				
864	A-4-2				39.6	16.0	44.4	C	5.40				
865	A-4-3				33.6	10.0	56.4	C	5.85				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
863	A-4-1		0.217	0.128	26	4						12.8	
864	A-4-2		0.217	0.128	12	3						25.6	
865	A-4-3		0.217	0.128	10	4						24.2	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
863	A-4-1			0.162		5.313	1.6						
864	A-4-2			0.14		4.382	1.0						
865	A-4-3			0.098		3.243	0.8						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 – 17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			CaCO3 %	Free Fe_2O_3 %
			>2	2–0.2	0.2–0.05	0.05–0.002	<0.002		H_2O	KCl	NaF		
866	A-5-1				39.6	20.0	20.4	scL	6.20				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil									Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
866	A-5-1		0.217	0.288	24	6						20.8	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
866	A-5-1			0.252		7.314	1.2						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 - 17

Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			$CaCO_3$ %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
867	A-6-1				29.6	18.0	32.4	scL	5.95				
868	A-6-2				47.6	24.0	28.4	scL	5.75				
869	A-6-3				45.6	12.0	42.4	c	5.10				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
867	A-6-1		0.217	0.544	17	4						19.4	
868	A-6-2		0.271	0.192	15	5						19.8	
869	A-6-3		0.217	0.128	8	2						11.8	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
867	A-6-1			0.21		6.762	6.0						
868	A-6-2			0.154		5.865	1.6						
869	A-6-3			0.126		3.45	0.3						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1–17
Location / Coordinates : Wellega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm) >2	2–0.2	0.2–0.05	0.05–0.002	<0.002	Texture Class	pH, 1:1 In H_2O	KCl	NaF	$CaCO_3$ %	Free Fe_2O_3 %
870	A-7-1				49.6	26.0	24.4	SCL	6.10				
871	A-8-1				55.6	22.0	22.4	SCL	5.65				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	Base Saturat. %
870	A-7-1		0.217	0.256	20	10						27.4	
871	A-8-1		0.217	0.096	12	6						15.6	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
870	A-7-1						0.4						
871	A-8-1						0.8						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 - 17
Location / Coordinates : Wellega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			CaCO3 %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
872	A-9-1				53.6	26.0	20.4	SCL	5.90				
873	A-9-2				63.6	20.0	18.4	SL	6.50				
874	A-9-3				39.6	8.0	52.4	C	5.55				
875	A-10-1				39.6	20.0	40.4	C	5.65				
876	A-10-2				29.6	6.0	64.4	C	5.45				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
872	A-9-1		0.217	0.192	18	2						16.0	
873	A-9-2		0.217	0.128	19	1						18.8	
874	A-9-3		0.271	0.128	7	3						13.8	
875	A-10-1		0.271	0.128	10	5						11.0	
876	A-10-2		0.271	0.096	7	3						10.4	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
872	A-9-1						2.4						
873	A-2-2						0.6						
874	A-9-3			0.112		3.519	1.4						
875	A-10-1			0.154		5.21	1.4						
876	A-10-2						0.4						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSI Field Number : Unit 1 – 17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			CaCO3 %	Free Fe_2O_3 %
			>2	2–0.2	0.2–0.05	0.05–0.002	<0.002		H_2O	KCl	NaF		
877	A-11-1				33.6	32.0	14.4	SL	6.05				
878	A-11-2				49.6	18.0	32.4	SCL	5.85				
879	A-11-3				48.6	12.0	44.4	C	5.35				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
877	A-11-1		0.217	0.416	16	2						25.0	
878	A-11-2		0.217	0.196	17	3						11.0	
879	A-11-3		0.434	0.096	8	2						20.6	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
877	A-11-1			0.196		6.555	1.8						
878	A-11-2			0.154		1.818	1.4						
879	A-11-3			0.126		3.657	0.04						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 - 17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 in			$CaCO_3$ %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
880	A-12-1				50.4	33.6	16.0	L	5.85				
881	A-12-2				40.4	39.6	20.0	L	5.40				
882	A-12-3				54.4	31.6	14.0	SL	5.50				
883	A-12-4				52.4	67.6	20.0	L	5.75				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
880	A-12-1		0.271	0.096	12	4						17.4	
881	A-12-2		0.325	0.128	8	2						9.6	
882	A-12-3		0.271	0.224	16	1						15.0	
883	A-12-4		0.217	0.128	14	2						15.0	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
880	A-12-1						0.8						
881	A-12-2			0.112		3.002	0.04						
882	A-12-3			0.154		4.83	1.2						
883	A-12-4			0.168		5.279	1.2						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSVI Field Number : Unit 1-17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm) >2	2-0.2	0.2-0.05	0.05-0.002	<0.002	Texture Class	pH, 1:1 in H_2O	KCl	NaF	$CaCO_3$ %	Free Fe_2O_3 %
884	A-13-1				54.4	27.6	18.0	L	5.60				
885	A-13-2				52.4	25.6	22.0	SCL	7.00				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	Base Saturat. %
884	A-13-1		0.217	0.192	10	2						10.6	
885	A-13-2		0.217	0.888	13	2						9.2	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
884	A-13-1			0.126		3.864	0.8						
885	A-13-2			0.154		3.208	1.0						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 – 17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm) >2	2–0.2	0.2–0.05	0.05–0.002	<0.002	Texture Class	pH, 1:1 in H_2O	KCl	NaF	$CaCO_3$ %	Free Fe_2O_3 %
886	A-14-1				36·4	19·6	24·0	SCL	5·90				
887	A-14-2				60·4	21·6	18·0	SL	5·70				
888	A-14-3				56·4	19·6	24·0	SCL	5·75				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	Base Saturat. %
886	A-14-1		0·271	0·192	12	1						17·0	
887	A-14-2		0·217	0·128	9	1						13·4	
888	A-14-3		0·217	0·256	6	1						10·2	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O. M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
886	A-14-1			0.126		4.278	3·2						
887	A-14-2			0.126		3.829	1·0						
888	A-14-3			0.154		4.106	0·8						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASCSA Field Number : Unit 1-17
Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm) >2	2-0.2	0.2-0.05	0.05-0.002	<0.002	Texture Class	pH, 1:1 in H_2O	KCl	NaF	$CaCO_3$ %	Free Fe_2O_3 %
889	A-15-1				60.4	25.6	14.0	SL	5.85				
890	A-15-1				46.4	17.6	36.0	SC	5.45				
891	A-15-2				60.4	29.6	10.0	SL	5.50				
892	A-15-2				54.4	23.6	22.0	SCL	5.65				
893	A-15-3				78.4	1.6	20.0	SCL	5.50				
894	A-15-3				42.4	5.6	52.0	C	5.75				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	Base Saturat. %
889	A-15-1		0.271	0.736	16	4						22.0	
890	A-15-1		0.217	0.320	12	0						17.2	
891	A-15-2		0.217	0.224	8	2						16.2	
892	A-15-2		0.271	0.224	18	2						17.0	
893	A-15-3		0.217	0.192	15	1						19.0	
894	A-15-3		0.217	0.128	4	2						11.4	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
889	A-15-1			0.21		4.795	1.2						
890	A-15-1			0.14		3.519	1.0						
891	A-15-2			0.14		3.146	0.6						
892	A-15-2			0.182		5.348	1.0						
893	A-15-3			0.182		4.658	0.4						
894	A-15-3			0.042		1.07	0.4						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1-17

Location / Coordinates : Wellega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm)					Texture Class	pH, 1:1 In			CaCO3 %	Free Fe_2O_3 %
			>2	2-0.2	0.2-0.05	0.05-0.002	<0.002		H_2O	KCl	NaF		
895	A-16-1				50.4	13.6	36.0	5c	5.25				
896	A-16-2				52.4	9.6	38.0	5c	5.40				

Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil										Base Saturat. %
			Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	
895	A-16-1		0.217	0.096	9	1						13.8	
896	A-16-2		0.271	0.128	10	5						15.6	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
895	A-16-1			0.168		3.933	0.6						
896	A-16-2			0.126		3.83	0.4						

Date _____ Chief of Lab. _____

SOIL CHEMICAL AND PHYSICAL ANALYSIS

NATIONAL SOIL SERVICE PROJECT
MINISTRY OF AGRICULTURE
Addis Ababa

Study Area / Project : ASOSA Field Number : Unit 1 - 17

Location / Coordinates : Welega

Lab. No.	Field No.	Depth, cm.	Texture, % (Ø = mm) >2	2-0.2	0.2-0.05	0.05-0.002	<0.002	Texture Class	pH, 1:1 in H_2O	in KCl	in NaF	$CaCO_3$ %	Free Fe_2O_3 %
897	A-17-1				32.4	7.6	60.0	C	5.30				
898	A-17-1				36.4	39.6	24.0	L	6.35				
899	A-17-2				34.4	29.6	16.0	SL	6.00				
900	A-17-3				62.4	17.6	20.0	SCL	5.85				

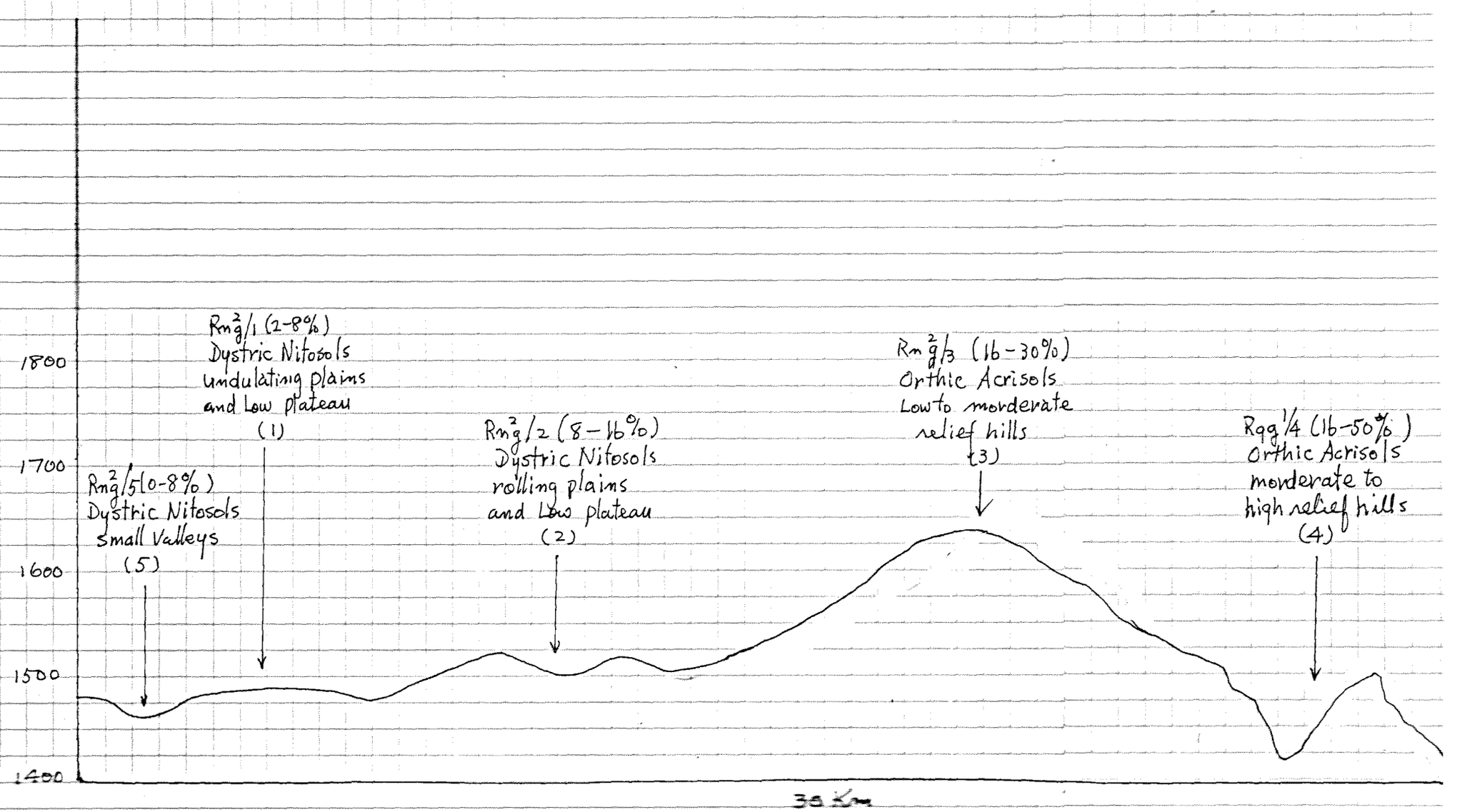
Lab. No.	Field No.	Depth, cm.	Exchangeables, milliequivalent / 100 gm soil Na	K	Ca	Mg	Al+H	Al	H	Sum	C.E.C. Sum	C.E.C. Det.	Base Saturat. %
897	A-17-1		0.217	0.064	8	2						19.0	
898	A-17-1		0.325	0.416	21	5						23.2	
899	A-17-2		0.217	0.256	20	10						28.8	
900	A-17-3		0.217	0.128	16	4						18.0	

Lab. No.	Field No.	Depth, cm.	Org.C %	Tot.N %	C/N	O.M %	Avail. P_2O_5 ppm	Avail. K ppm	Satur. %	Field capacity %	P.W.P %	Available H_2O %	
897	A-17-1			0.182		5.244	0.04						
898	A-17-1			0.224		6.003	2.4						
899	A-17-2			0.252		3.14	1.0						
900	A-17-3			0.21		5.196	1.2						

Date _____ Chief of Lab. _____

APPENDIX 4

ASOSA LANDSCAPE UNITS



Assosa 1

Landscape Unit No: $Rn^2g/1$

Geomorphology	:	Hilly plains comprised of undulating plains and low plateaux with a substantial porportion of low to moderate relief hills - western highlands.
Total Area	:	(km^2)
Remarks Landscape Unit	:	In southern Kefa this unit extends into drier elimates and soils grade to chronic cambisols.
Significant Land Facet	:	Undulating plains and low plateaux
Soil Management Unit No:		8
Area (%)		km
Geology	:	Gneisses, granites and associated felsic materials
Slope range (%)	:	2 - 8

Soil

FAO classification	: Dystric nitosols
Colour	: Hard reddish brown to dark red
Texture	: Clay to clay loam
Drainage class	: Well
Rock outcrop	: None
Surface stones	: Fairly stony
Effective depth (cm)	: >150
pH	: < 5.5
OM (%)	: 3-10
CEC (me/100g)	: 35-70
Avail P (PPM)	: <5

Dominant vegetation and/or land use: Most commonly shrubbed grassland with peasant and nomadic livestock grazing and browing rainfed state farm cultivation of cereals and pulses at Nekemte. Intensive rainfed peasant cultivation and open woodland in western Welega.

Remarks: (Significant Land Facet)

Landscape Unit No. Rng^2/2

Geomorphology : See above

Total Area (km^2) : See above

Remarks (Landscape Unit)

Significant Land Facet : Rolling plains and low plateaux

Soil management Unit No. 60

Geology : Gneisses, granites and associated felsic materials

Slope range (%) : 8 - 16

Soils:

FAO classification	:	Dystric nitosols
Colour (moist)	:	Dark reddish brown to dark red
Texture	:	Clay to clay loam
Drainage class	:	Well
Rock outcrop	:	None
Surface stones	:	Fairly stony
Effective depth (cm)	:	> 150
pH	:	< 5.5
OM (%)	:	3 - 10
CEC (me/100g)	:	35 - 70
Avail. P. (PPM)	:	< 5

Dominant Vetetation and/or land use: Most commonly shrubbed grassland with peasant and nomadic livestock grazing and browsing; intensive rainfed peasant cultivation and open woodland in western Welega.

Remarks (Significant Land Facet).

Assosa 3

Landscape Unit No. Rng^2/3

Geomorphology	:	See above
Total Area (km^2)	:	See above
Remarks (Landscape Unit)	:	See above
Significant Land Facet:	:	Low to moderate relief hills
Soil Management Unit No.	:	71
Area (%)	:	(km^2)
Geology	:	Gneisses, granites and associated felsic materials
Slope range (%)	:	16 - 30
Soils:		
FAO classification	:	Arthic acrisols
Colour (moist)	:	Reddish brown to dark red
Texture	:	Clay to sandy clay loam
Drainage	:	Well
Rock outcrop	:	Fairly rocky
Surface stones	:	Stony
Effective depth (cm)	:	100 - 150
pH	:	< 5.5
OM (%)	:	3 - 10
CEC (me/100g)	:	16 - 35
Avail. P (PPM)	:	<5

Dominant Vegetation and/or land use: Most commonly shrubbed grassland with peasant and nomadic livestock grazing and browsing. Intensive rainfed peasant cultivation and open woodland in western Welega.

Remarks (Significant Land Facet) Dystric nitosols occur.

Landscape Unit No: R9g[1]/4

Geomorphology	:	Hilly terrain of moderate to high relief with a substantial proportion of moderately sloping valleys interspersed throughout - western highland.
Significant Land Facet	:	Moderate to high relief hills
Soil Management Unit No.	:	113
Area (%)	:	km^2
Geology	:	Gneisses, granites and associated felsic materials.
Slope range (%)	:	30 - 50
Soils:		
FAO classification	:	Orthic acrisols
Colour	:	Reddish brown to dark red
Texture	:	Clay to sandy clay loam
Drainage class	:	Well
Rocky outcrop	:	Rocky
Surface stones	:	Stony
Effective depth (cm)	:	50 - 100
pH	:	<5.5
OM (%)	:	3 - 10
CEC (me/100g)	:	16 - 35
Avail. P. (PPM)	:	<5

Dominant Vetetation and/or Land Use: Shrubbed grassland with peasant livestock grazing and browsing.

Landscape Unit No.: Rng^2/5

Geomorphology	:	See above
Total Area (km^2)	:	See above
Remarks (Landscape Unit)		
Significant Land Facet	:	Small valleys
Soil Management Unit	:	
Area (%)	:	(km^2)
Geology	:	Gneisses, granites and associated felsic materials
Slope range (%)	:	0 - 8
Soil:		
FAO classification	:	Dystric Nitsols
Colour	:	Dark reddish brown to dark red
Texture	:	Clay to clay loam
Drainage class	:	Moderate to poor
Rock outcrop	:	None
Surface stones	:	None
Effective depth (cm)	:	>150
pH	:	<5.5
OM (%)	:	3 - 10
CEC (me/100g)	:	35 - 70
Avail. P (PPM)	:	<5

Dominant Vegetation and/or Land use: Most commonly shrubbed grassland with peasant and nomadic livestock grazing and scattered scrub grass vegetation and reverine trees.

Remarks (Significant Land Facet)