CHAPTER I SOILS AND LAND USE

1.1 Soils and Land Suitability

1.1.1 Soil Classification

The soil information of the central Ethiopia is available in the soil report prepared by the Land Use Planning Project, which was conducted by Land Use Planning and Regulatory Department of the Ministry of Agriculture in 1989 in association with FAO/UNDP. The soils of the study area are classified broadly into four (4) units, namely Vertisols, Andosols, Fruvisols and Solonetz according to the legend of the Soil Map of the World (FAO/UNESCO). The extent of major soil groups in the study area is estimated on basis of the soil map with 1:250,000 scale (See Figure III.1.1). The characteristics and spatial distribution patterns of each soil unit are summarized below.

(1) Vertisols

Vertisols are heavy clayey soils enriched with montmorillonite clay minerals that shrink when dry and swell when wet. Through alternation of dry and wet, deep and wide vertical cracks are developed on their profiles. Pelli-Calcic Vertisols (Hidi series) are the most predominant in the hilly area (valcano-lacustrine terrace) extending to the northern study area. They are very deep, black and fine textured, partly sodic (sodium-rich) phase.

(2) Andosols

Andosols originate from volcano-lacustine deposits with volcanic ashes, cinders, pumice (gravels) lapilli or other virtic pytpoclastic materials. Virtic Andosols (Meki series) are predominant on the Rift Valley floor. The soils are neutral to slightly alkaline, calcareous, deep and coarse loamy. They broadly cover the central part of the study area.

(3) Fluvisols

Fluvisols are derived from alluvium on the lakeshore and along the Meki river. Gleyic-Mollic Fluvisols (Abay series) are derived from lacustrine deposits and cover the lakeshore of Ziway. They are deep, black, fine loamy and partly sodic. Due to poor drainage conditions and higher groundwater table, they sometimes show gley layers with hydromorphic properties. They are seasonally flooded for approximately four (4) months in a year. Calcaric Fluvisols and Mollic Fluvisol are also observed along the Meki river. They are well-drained loamy soils.

(4) Solonetz

Solonetz is one of problem soils with high sodium content accumulated through alternation of dry and wet conditions. They sporadically observed in the study area particularly in the bottomlands and slight depression within the flood plains. In both Meki and Alem Tena towns, Mollic Solonetz derived from lacustrine widely covers the flat land. Solonetz with high clay content is very hard when dry.

1.1.2 Reconnaissance Soil Survey under the Study

(1) Soil Profile Survey and Laboratory Tests

Within the framework of the study on the Meki Irrigation and Rural Development Project (the Study), the reconnaissance soil study was carried out in order to confirm the previous soil information mentioned above and to assess their suitability for crop production.

The Study firstly conducted the soil profile observation at three (3) representative sites, which were selected along the transect line from upper Meki river basin to lower basin taking the geomorphological conditions into consideration. The location of the soil pits is indicated in Figure III.1.1. The soil profile was observed up to 250 cm in depth. Their descriptions are presented in Figure III.1.2.

The soil samples were collected from three (3) soil layers at 20 cm, 50 cm and 150 cm in depth of each test pit. The total of nine (9) samples, i.e. 3 samples x 3 profiles, were collected and sent to the soil laboratory in Addis Ababa. The laboratory test was carried out to verify the physical and chemical properties including soil color, bulk density, pH (H_2O), pH (KCl), electric conductivity (EC), exchangeable cations (Na^+, K^+, Ca^{2+}, Mg^{2+}), Cation Exchange Capacity (CEC), organic carbon, available phosphorous and total nitrogen (N). The results of laboratory tests are presented in Table III.1.1.

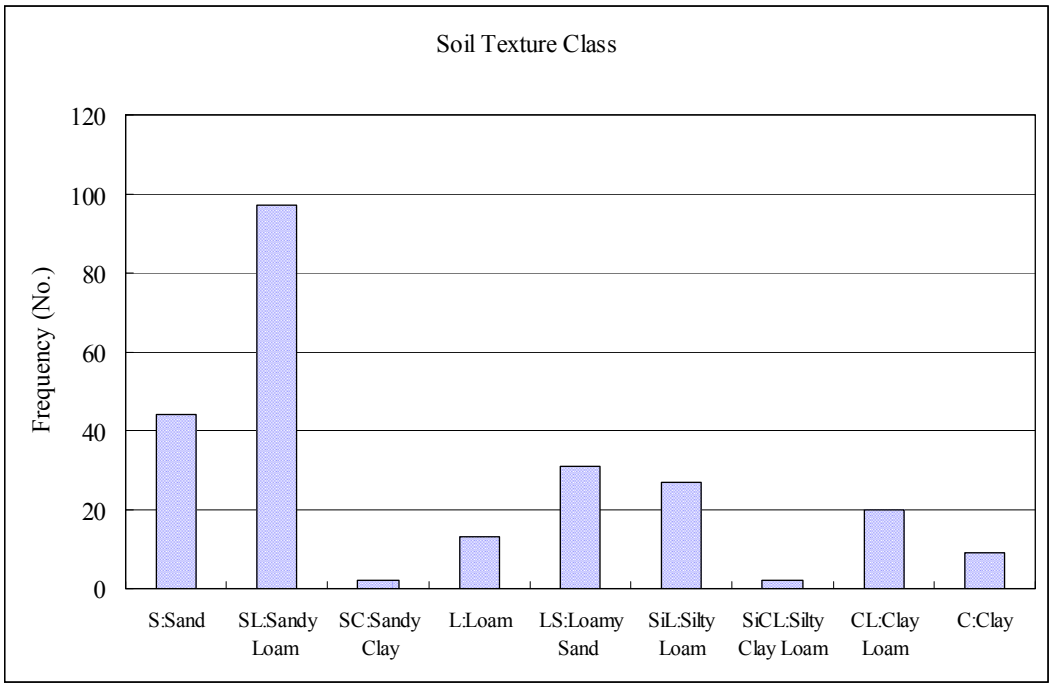
The soils in the root zone are generally very compact. Their bulk density is as high as 1.75 gm/ml, which may hinder healthy root extension. The hydraulic conductivity is in very low ranges. Contents of organic carbon, total nitrogen and available phosphorous are also very low.

CEC ranges from medium to very high. CEC of the Soil Profile No.1 of Vertisols is as high as over 45 meq/100gm soil. Exchangeable cations are represented by Ca^{2+}. Cation saturation percentages (total ex-cations / CEC) often exceed 100%, which is an evidence of crystalline salt accumulation in the profile.

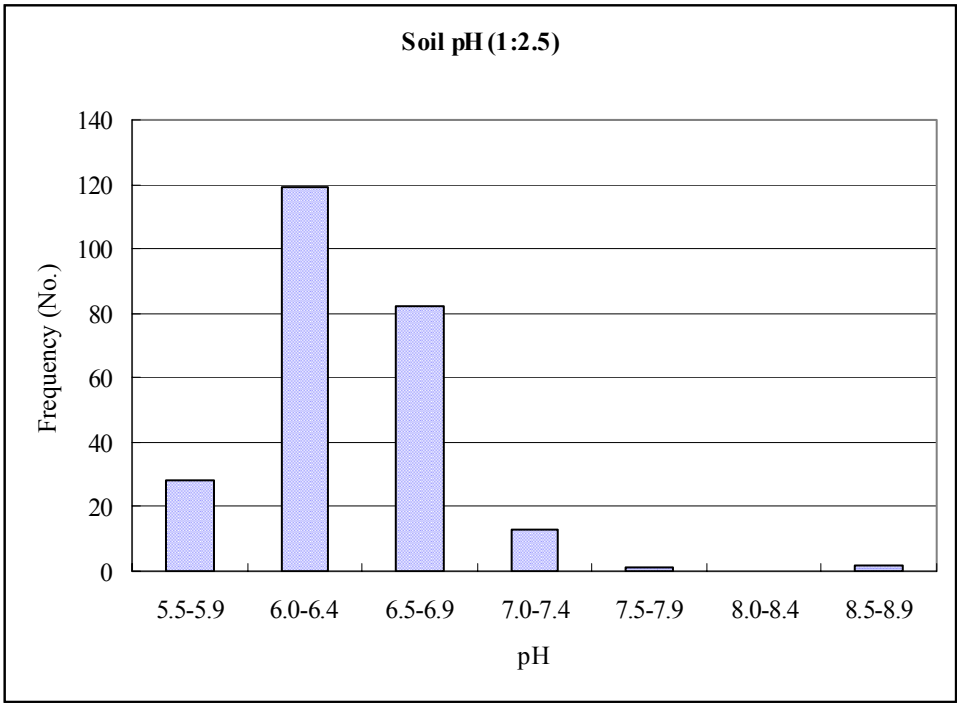
1.1.3 Land Suitability

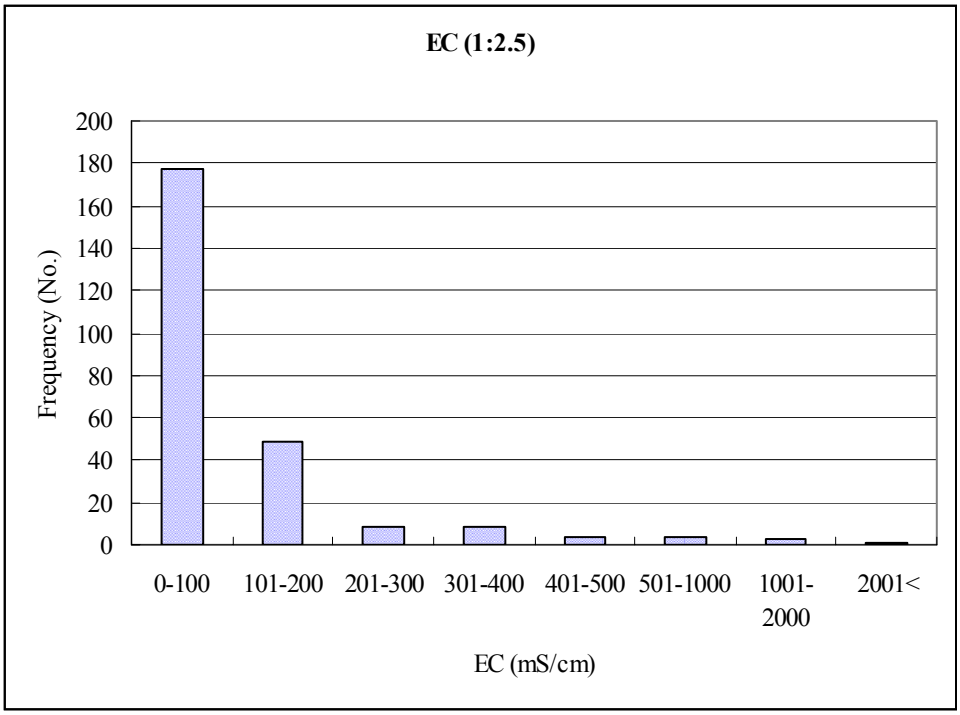
Soil salinity and alkalinity are focused on as major soil hazard in the study area. In order to grasp their occurrence and spatial distribution patterns, the field observation was made at 275 sites with the survey density of one sample per 600 ha. Throughout the survey, 245 soil samples were collected as listed in Table III.1.2. Immediately after sampling, they were transported to the OIDA office at Addis Ababa and the analyses were made for soil pH, soil $EC_{2.5}$ (electric conductivity) and soil texture. The result of soil analyses is presented in Table III.1.3.

Although soil texture changes from place to place, sand to sandy loam are dominant in the study area.



Soil pH of topsoils is in a range between 5.5 and 7.3, which are categorized into medium acid to slightly alkaline. Only two (2) samples collected on the Ziway lakeshore, high pH over 8.8. Soil $EC_{2.5}$ are also in a wide range between 2.0µs/cm (micro siemens) and 1,550µs/cm. The highest EC value was 5,600µs/cm on the lakeshore of Tepo Choroke PA.





The soils in the study area are generally suitable for crop production. It is noted that proper soil husbandry is required to improve their crop productivity and to avoid soil degradation process. The following soil measures are recommendable.

1) Soil consistency : Soils can be soften and porous by incorporating crop

residues and farmyard manure into soils.

2) Soil fertility : Introduction pulses in crop rotation will increase plant nutrient contents, especially for nitrogen.

3) Salinity : Irrigation methodology should be carefully optimized. Crystalline salts are water-soluble. Regardless of irrigation water quality, there is a possibility to induce high soil salinity by irrigation.

Soils are highly susceptible to salt accumulation, which may be easily initiated when intensive irrigation farming is practiced. Since the lake water of Ziway is slightly saline, special attention is required when the irrigation farming is introduced to the lakeshore. One of the advantages in the soil characteristics is their coarse to medium texture with favorable drainage conditions for salt leaching.

1.2 Natural Vegetation and Present Land Use

1.2.1 Natural Vegetation

Natural vegetation of the study area is categorized into tropical savanna dominantly with acacia species occasionally mixed with riverine broad-leaf trees and shrubs. Under semi-arid conditions, grasses are seasonally greenish. They provide huge grazing sources to local animals. Acacia species provide valuable browse to goats. Tree density of acacia species has remarkably been diminished. Indigenous and exotic trees and grass species identified in the study area are listed in Table III.1.4.

Senbelet (*Hyparrhenia ruffa*) is a grass species particularly suitable for grazing and preserved in the Meki area. Otherwise, palatable and digestible grass species have been rapidly replaced with other grass species of low nutritional value in most of rangeland.

1.2.2 Present Land Use

The present land use patterns are classified broadly into four (4) categories, namely farmland, forest/shrub/bush, grazing land and others (residence, road, water body etc). The present land use conditions of each of Dugda Bora Wareda is presented by PA in Table III.1.5 and summarized below.

Summary of Present Land Use Conditions of Dugda Bora

Land Use Category	Area (ha)	Extent (%)
Farmland	67,828	46.2
Forest/Bush/Shrub	19,971	13.6
Grazing Land	36,326	24.7
Others /1	22,757	15.5
Total	146,882	100.0

Remark: /1 including residence, road, swamp, etc

Farmland occupies 68,000 ha of 46% of the Dugda Bora Wareda. Out of 68,000 ha of farmland, 55,000 ha or 81% are currently cropped, while the remaining 12,000 ha or 19% are fallow land as presented in Table III.1.6. The agricultural land use intensity is changed as illustrated in Figure III.1.3.

The study area is characterized by rapidly growing population pressure and animal population. As a result of uncontrolled firewood cutting and overgrazing, vegetation coverage of the study area is generally very sparse. Consequently, soil erosion is accelerated particularly in terrace edges and hilly slopes.

1.3 Land Tenure System and Holding Size

1.3.1 Land Tenure System

The 1975 land reform legislation of the previous regime made all the lands of Ethiopia public property. It prohibited private ownership by either individuals or organizations. Farmers have been given usufructuary rights up to 10 ha of land holding limit per household. Further, the Constitution endorsed in December 1994 explicitly states that all rural and urban land and natural resources belong to the government. It is not allowed to sell or exchange the lands. However, there are many cases of farmland lease agreement in the study area, especially highly demanded land such as the lower river basin of Meki and the lakeshores of Koka, Elen and Zway, where irrigable farmland is expanded. In many cases, land borrowers are large farmers and entrepreneurs, who sometimes live in Meki town and other urban areas. They eager to obtain farmland from individual farmers with agreements to rent a part of land from farmers by affording irrigation water or other inputs to farmers. On the other hand, offspring of farm household sometimes do not inherit farmland due to limited excess land. They are forced to achieve lease agreements with landlords who are facing financial problems.

Lease agreement is mainly on annual basis and land rent varies from place to place. The annual rental charge of rain-fed farmland ranges between Birr 100 and Birr 200 per ha, while irrigated land from Birr 300 to Birr 800 Birr per ha. Needless to say,

such lease agreement is not forwarded through the official channels. Therefore, it is difficult for the Dugda Bora district administration to grasp actual land tenure situation in detail.

1.3.2 Land Holding Size

A typical farmer in the study area has (i) homestead, (ii) crop area in upland, and (iii) furrow and grazing land usually consisting of several scattered small plots.

The majority (75%) of the local farmers are small farmers with land less than 2.0 ha. Land holding size per farm household in the study area is presented below.

Land Holding Size in Dugda Bora Wareda

Below 1 ha	1 – 2 ha	2 – 4 ha	4 – 6 ha	6 – 8 ha	8 – 10 ha
25 %	50 %	10 %	7 %	5 %	3 %

Source: Dugda Bora District Agriculture Bureau Office

1.4 Meki Nursery Center

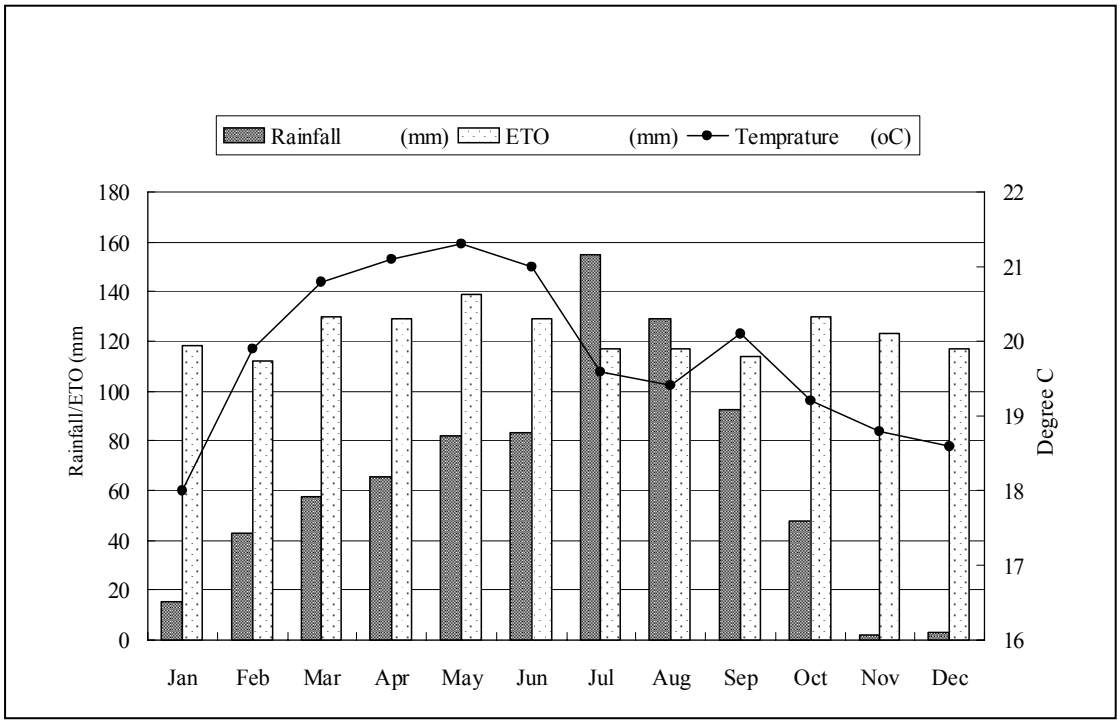
The Meki Nursery Center (MNC) has been established since 1989 assisted by the NGO, Self Help Development International (SHDI), aiming at establishment of state forest and soil conservation under jurisdiction of the District Agriculture Bureau Office. The activities of MNC is summarized in Table III.1.7.

The area of MNC is 0.75 ha with the management office and produced annually around 24 tree species of 800,000 seedlings in a maximum capacity under irrigation from Meki River. The tree species produced by the MNC is based on an annual PA's demand compiled through the Development Agent (extension worker) stationed to each PA. The routine nursing activity will be started from October to gather seeds over different places via local farmers by giving an incentive to buy seeds with 15 to 20 Birr/kg, depending on tree species. The routine annual activity and tree species nursed in the 1999-2000 season are shown in below tables. However, the project term supported by the SHDI has been phased out since January 1999 and the World Food Program (WFP) has taken over a position of assisting the MNC with change of project scope of work that confines to only specified project area approved by the WFP.

CHAPTER II CROP PRODUCTION

2.1 Agro-ecological Zones

The study area situates from El. 1,600 m to El. 2,000 m on the bottom of the Ethiopian Rift Valley system. The area is classified into SA2 (semi-arid 2) zone according to the agro-climatic zoning system of Ministry of Agriculture (1998). The climate in the Meki town is characterized by erratic, unreliable and low rainfall with averaging between 600 mm to 1,100 mm per annum over past 30 years. The rainfall is bimodal with the long rain season (*Meher*) from July to September and the short rain season (*Belg*) from February to early May.



Climatic Conditions of the Study Area (Meki)

As mentioned in Appendix II on Meteorology and Hydrology, the hilly land lying in west to northwest of the study area receives annual rainfalls of 850 to 1,100 mm. On the other hand, annual rainfalls of the lakeshore of Ziway are as low as 700 to 750 mm. Farmers in the lakeshore areas have experienced chronic drought in last 5 to 6 years, especially for the western Ziway lakeshore.

The soils are also broadly grouped into two (2) zones. In the hilly land with relatively higher rainfalls, heavy clays with vertic properties are predominant. In contrast sandy soils cover the central flat plain of Meki area. The Ziway and Koka

lakeshores are affected by seasonal inundation and suffer from saline soils.

Farmers have carefully selected suitable crops taking rainfall patterns and indigenous soil conditions of their farmlands into consideration. Therefore the leading crops show specific distribution patterns, which are highly coincident with agro-ecological zones. The leading crop zoning map is prepared as presented in Figure III.2.1.

2.2 Farming System

As seen in Figure III.2.1, small farmers in the study area cultivate cereals and pulses represented by maize, teff, wheat and haricot beans. In addition, several types of animals are raised in the study area, e.g. oxen, goat, sheep and donkey. The farming system in the region is generally categorized into "livestock-based mixed-farming system" under close linkage between crop production and animal husbandry.

Crop residues provide vital supplemental fodder source left on farm after harvesting. Farmlands after harvested are used as communal grazing purposes among the rural community. Crop production also relies on animal husbandry. Oxen provide draft power source for land preparation, transportation and threshing.

Apart from traditional mixed farming system, market-oriented horticulture production is also practiced along the Meki river and the lakeshores of Ziway, Elen and Koka. Horticulture crop growers are not only local peasants but also private farmers or investors, who live outside the rural area of Dugda Bora.

Off-farm activities are not common in the study area because of not much available for the working opportunities in and out of the study area like Nazareth and Addis Ababa.

2.3 Cultivated Crop and Cropping Patterns

2.3.1 Cultivated Crop

According to the District Agriculture Bureau Office in Meki, the major crops in the study area are as below;

1) Cereals : maize, teff (Eragostis teff), wheat, barley, and sorghum

2) Pulses : haricot beans (*Phaseolus vulgaris*), horse beans (*Vicia faba L*), peas (*Pisum sativum L*), chickpeas(*Cicer arietinum L*), and lentil(*Lens culinaris Medik*)

3) Vegetables : tomato, red onion, cabbage, Ethiopian cabbage (*Brassica oleracea var virdis*), chili pepper, sweet

pepper, carrot, beet root (*Beta vugaris*), watermelon, cucumber, eggplant, sugarcane, garlic, etc.

4) Fruits : mango, avocado, papaya, orange, etc.

5) Industrial crops : coffee

2.3.2 Cropping Patterns

As mentioned in Section 2.1 on Agro-ecological Zones, some alternatives are observed in crop selection within the study area. Crop seasons are also slightly changed. The present cropping pattern in the study area is generally illustrated in Figure III.2.2.

Maize is usually planted on fertile soils with priority. Wheat and teff is usually alternative to maize. Maize is sown immediately before onset of long rainy season in April. Other grains such as wheat, haricot beans and teff follow maize. In case of poor crop establishment of maize under delay of rains, maize is incorporated into soils and other crops are sown.

Although scheduled crop rotation is rarely practiced, some tendency is recognized in crop sequence. For instance, chickpea is sometimes a second crop sown after cereals. The cropping patterns in the study area are described below.

(1) Hilly land

Teff and wheat are leading crops followed by maize and barley. Other crops such as haricot beans, sorghum, horse bean, field peas and chickpea are planted to the limited extent. All crops are cultivated under rain-fed conditions in a single cropping season. Chickpea is planted in early September and harvested around the end of December with utilization of residue moisture retained in soils.

(2) Central study area

In the central study area, most of the grains are planted from May to June and harvesting crop is done through October to November.

(3) Inundation area and seasonal lake

The northern lakeshore of Ziway is seasonally flooded. Heavy clay soils, which are locally called "*Kotticha*", cover this area. By knowing an inundation cycle farmers utilize receding water for second crops. Figure III.2.3 shows a double cropping pattern in the Ziway inundation area, and single cropping of local cabbage and chickpea in the Cheleleka inundation area.

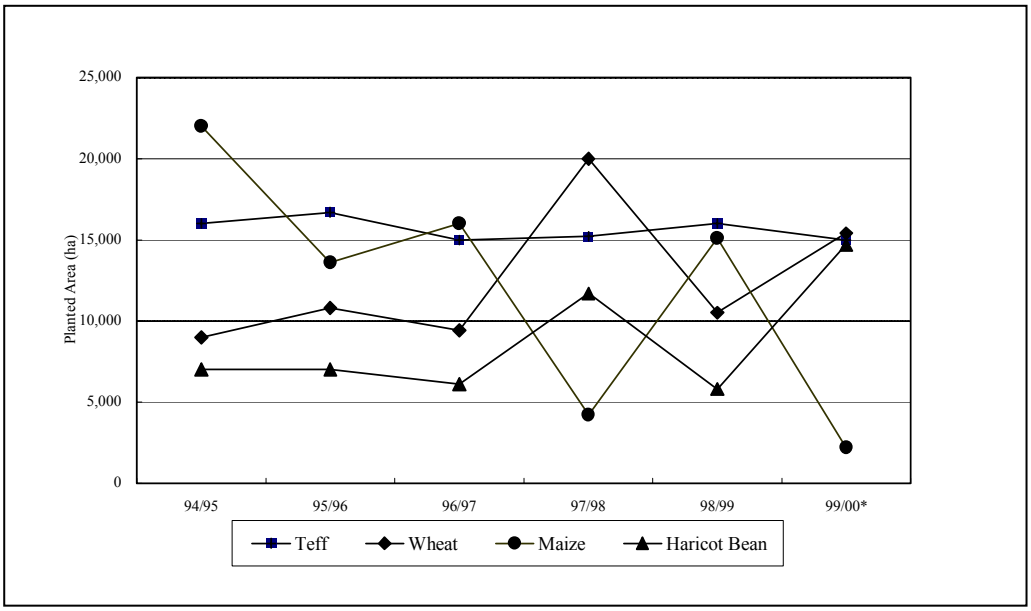
In the Ziway lakeshore area, seasonal flood cycle depends on rainfalls and yearly

changed. Therefore, farmers sow maize in early April and harvest green maize at the end of June when they prospect floods in early July. If not, grain maize is harvested in August. Either chickpea or haricot beans are then sown in the middle of October by using soil residue moisture.

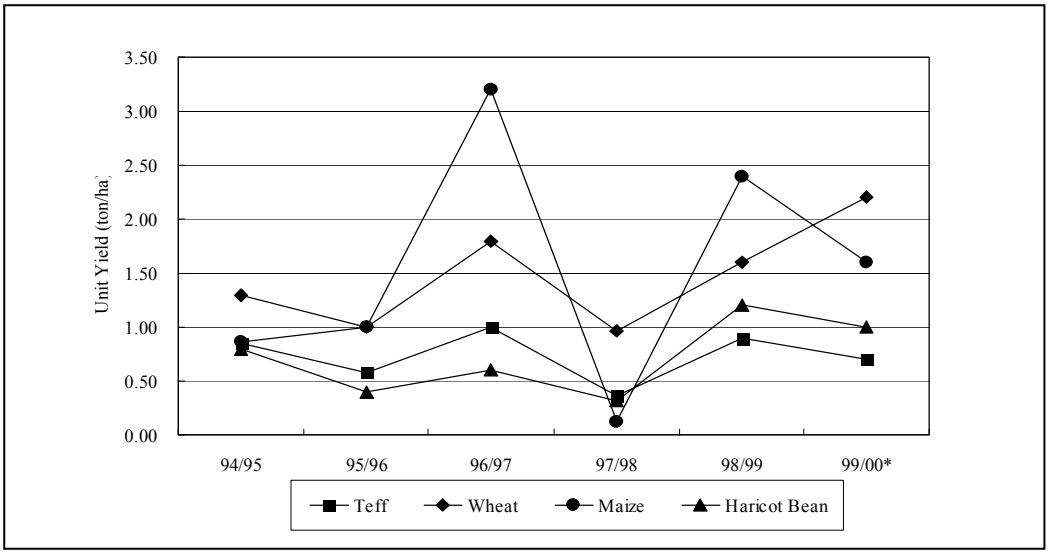
On the other hand, dry season cropping is also observed on seasonally flooded flat land surrounding the Cheleleka lake. The major crops include Ethiopian cabbage and chickpea by utilizing soil residue moisture after flood water ebbs away and land becomes a workable condition from mid-August.

2.4 Planted Area, Yield and Production

The crop production largely fluctuated from year to year. Planted area, production and yield of the major grain crops from 1994/95 to 1999/2000 are presented in Table III.2.1. The planted area of maize is significantly increased in the years with higher rainfalls. As well as maize, the planted area of haricot beans is increased in lower rainfalls of short rainy season. The planted area of sorghum has significantly decreased since 1999/2000.



Crop yield also varied with year to year as illustrated below.



As discussed in Section 1.2.2 on Present Land Use, 67,800 ha or 46% of the district area of Dugda Bora are categorized into farmland, of which 54,900 ha or 81% were cropped with diversity of rain-fed crops in the crop year 2000/01. Planted area, yield and production of the 2000/01 crops in the study area are presented for each PA in Tables III.2.2 to III.2.11. They are summarized below.

Planted Area, Production and Yield of Rain-fed Crops in 2000/01

Crop	Planted Area		Production (ton/ha)	Yield (ton/ha)
	(ha)	(%)		
Teff	15,058	27.4	11,244	0.7
Maize	14,852	27.1	39,910	2.7
Wheat	13,261	24.2	27,105	2.0
Haricot Beans	6,530	11.9	5,071	0.8
Barley	2,310	4.2	3,473	1.5
Sorghum	350	0.6	327	0.9
Horse Beans	1,177	2.1	577	0.5
Field Peas	672	1.2	283	0.6
Chickpeas	483	0.9	288	0.6
Lentil	164	-0.3	86	0.6
Total Planted Area	54,857	100	-	-

It is noted that only four (4) major crops consisting of teff, maize, wheat and haricot beans cover 91% of the total planted area in 2000/01.

In addition, horticulture crops were also planted only 1,804 ha as presented in Table III.2.12. Horticultural crops are represented by tomatoes with 581 ha or 32% of the 1,804 ha. Hot pepper and onion are also prevailing. These three crops cover over

70% of the total planted area of horticulture crops. Vegetables and papaya are generally produced under irrigated conditions along to the Meki river as well as lakeshores. The location of horticultural production areas is indicated in Figure III.2.4. The present crop intensity (CI) of the study area results in around of 83 % but the irrigable land is mostly cultivated with two crops per year and beyond 100 %.

CHAPTER III FARM INPUTS AND PRACTICES

3.1 Farm Inputs

3.1.1 General

In the study area, there are several sources and channels for procurement of farm inputs. They are (i) Extension Package Program (EPP), (ii) input supply shop by NGOs, (iii) middlemen's shop, (iv) cooperatives and (v) retailers in large urban centers.

3.1.2 Extension Package Program (EPP)

The standard EPP consists of improved seeds, pesticides and fertilizer. Only eligible farmers can access to EPP through the OADB wareda office. This access is basically confined to the PA members. The number of EPP applicants is relatively lower in frequent drought area compared to the other areas where have fairly good rainfall such as west to north west of hilly area.

A shortage of improved seeds is currently crucial in the EPP operation. Use of improved seed is a quite limited extent, i.e. 18.9 % of wheat, 2.3 % of maize and 0.2 % of haricot bean as shown in below:

Use of Improved Seeds in Dugda Bora (2000/01)

Crop	Total Sown Area (ha)	Use of Improved Seed (ha)	Performance (%)
Teff	15,058	0	0.0
Maize	14,851	342	2.3
Wheat	13,261	2,511	18.9
Barley	2,310	0	0.0
Sorghum	350	0	0.0
Haricot Beans	6,530	12	0.2
Horse Beans	1,177	0	0.0
Field Peas	672	0	0.0
Chick Pea	483	0	0.0
Lentil	165	0	0.0

Source : OADB - Dugda Bora

Further details can be referred to Appendix V on Agricultural Extension and Support Services.

3.1.3 Other Sources

(1) Input supply shop by cooperative union supported by NGO

The cooperative shop deals with only vegetable seeds (tomato, onion, cabbage, chili pepper, potato and garlic). Cereal seeds are not available. It sells chemical fertilizer (DAP, Urea), some agro-chemicals (herbicide and 3 types of pesticide) and farming implement (portable sprayer). Further, imported vegetable seeds by this shop vary the quality, i.e.germination rate, according to the interview to the shop manager.

A part from this shop, Adami Tulu chemical Co., Ltd adjacent to Dguda Bora District supplies most of agro-chemicals except for the Kocide and Menkozep chemicals which are quite high demand for tomato cultivation.

(2) Middlemen's shop

This access is not stable to get proper items on time and a quality of some items such as agro-chemicals are not reliable. Most of farmers procure grain seeds through this channel.

(3) Cooperatives

This channel is confined to the cooperative member only and cooperative purchases agro-inputs in collective way for the members.

(4) Purchase directly from Addis Ababa

Most of state farm and private farmer who are strong financial status purchase agro-inputs directly from Addis Ababa by themselves.

3.2 Prevailing Farming Practices

3.2.1 General

The farming practice of major food grain and leguminous crops among the subsistent landholder prevailing in the study area is summarized in Table III.3.1. The farming practices prevailing in the study area are highly relied on animal draught power from land preparation to harvesting, namely plowing, inter-tillage locally called "*Shilshalo*", transportation of farm produce and threshing.

3.2.2 Land Preparation

Farmland is generally ploughed by a pair of oxen with traditional plow called "*Maresha*". Number of plowing varies by crop to be planted, e.g. 3-4 times for teff,

2-3 times for maize, barley and wheat, and 1-2 times for the rests including sorghum and pulses. Although the area is limited, private tractor hire service is also available in the study area. The service charge is Birr 260 per ha in 1999/2000.

3.2.3 Sowing

Sowing is manually done. Seed rates are generally higher than recommended seed rate to make up lower germination percentage and seedling damages by drought. The standard seed rates of major crops are presented below.

Standard Seed Rate

Crop	Seed Rate (kg/ha)
Maize	25 kg/ha for row sowing
Teff	30 kg/ha for broadcasting
Wheat	140-160 kg/ha for broadcasting
Barley	100-125 kg/ha for broadcasting 85 kg/ha for drill seeding
Haricot Beans	60 - 80 kg/ha for drill seeding 100- 140 kg/ha for broadcasting

3.2.4 Fertilizer Application

Urea (46-0-0) and DAP (18-46-0) are common in Ethiopia. Most of subsistent small farmers do not use chemical fertilizers for sorghum and leguminous crops but cow dung. Chemical fertilizers are applied to cash crops including wheat and teff. The standard application rates under EPP are presented below.

Fertilizer Application Rates

Crop	Urea (kg/ha)	DAP (kg/ha)
Maize	100	100
Teff	50	100
Wheat	50	100
Barley	50	100
Haricot Beans	0	50

Moisture stressed area is not recommended to practice split application in order to avoid leaf burn caused by fertilizer-itself and waste use of fertilizer generated by moisture stress under erratic rain.

3.2.5 Weed Control

Herbicide such as 2,4 D and U-46 are sprayed for cash crops including teff and wheat at a rate of one liter per ha after emergence. Weeding is done by hand for maize and sorghum at knee-high stage and inter-tilling by ox-plow (*Maresha*) in order to thin plant population and control weeds. Weeding is not done for pulse crops after sowing till harvesting.

3.2.6 Pest and Disease control

Except for the major horticulture crops such as tomato, cabbage, onions, and other cash vegetables, agro-chemicals for grain crops are usually not applied through cropping season. Chemicals used for vegetable cultivation are mainly of Kocide, Mencozeb, Ridomil against disease of blight, powdery mildew, purple blotch, downy mildew, and Malaine, Tiodan against nematodes, aphids, thrips and so on.

3.2.7 Harvesting

Except for maize and sorghum, most of cereal crops are cut as whole plant and bundled and sun dried either in the harvested field or surroundings of homestead, and followed by threshing operation which is down by driving oxen trampling on the spread grain bundles and cleaned by hand winnowing in the same place. Meanwhile, leguminous crop are pulled out by hand and stacked in the filed until dried or brought to the threshing ground and stacked there for drying. Threshing is done by oxen, followed by hand winnowing same as grain crops. Maize is harvested by hand and brought to homestead by donkey cart for shelling by beating cob with stick or near motor- driven corn sheller place.

3.2.8 Storing

Majority of farmers has equipped with traditional storage bin called "*Gotera*", made of woven wood and bamboo splits in homestead and with 15 to 20 quintals capacity. Harvested grains are stored in this *Gotera* or sacs either in-house or open place. However, cash crops like teff, wheat, haricot beans and surplus of farm produce except for self-consumption are immediately sold to middle men followed by processing grains due to very limited

margin for money among the subsistent landholders. Cereal grains are milled at the nearest flour mill and used as food diet of *Injera*, locally brewed beer such as *Tella*, and sprit like "*Arake*". Pulse grains are also used as ingredient of *Injera*, soup or roasting.

3.2.9 Utilization of crop residue and cow dang

Field crop residue after crop harvest is utilized as open grazing land. Maize and sorghum stalk are used as fuel source or construction materials for hut after feeding tender part to animals. Straws of teff, wheat, and barley are also used as important supplemental feeding materials followed by threshing process and leguminous crops as well.

Thus, incorporating the crop residue into the soil is quite limited extent. Cow dung in the study area is used for plastering materials of traditional storage bin, hive, and circular plot of threshing place, and fuel source after drying, however most of interviewed farmer reported about 90 % of cow dung is returned to field.

3.3 Farm Labor

The farm labor balance study was made through the interview to 10 sample farmers. The results are summarized below.

Profile of Typical Farm Household (HH) in the Study Area

Family Size (person)	Family Farm Labor (person/HH)	Arable Land (ha/HH)	Cropped Area (ha)	Cropping Intensity (%)	Working Hours per Day (hr/day)	Available Family Labor per Month (MD)
6.9	3.4	5.0	4.8	95.5	8.6	72.4

On the basis of the above conditions, the farm labor balance study was made as presented in Table III.3.2. Labor shortage appears twice a year in May to June and October. The former is caused by intensive farm works from land preparation to sowing for wheat, teff and haricot bean, and harvesting of four (4) crops, the later is during harvesting of those crops. However, labor shortage is mitigated through a traditional labor exchange custom, so called ”*Debo*”. It is a sort of reciprocal help system with provision of a tiny compensation with beverage and food provided by host farmer. “*Debo*” is not common among irrigation farmers. Large farmers with nearly 10 ha of farmland usually employ a few permanent workers by boarding them as part of family member.

CHAPTER IV CROP BUDGET

4.1 Introduction

The major grain and horticulture crops prevailing in the Study Area were analyzed in terms of crop budget by dividing them into 3 farming technology levels, i.e. 1) traditional farming level under rain-fed condition, 2) improved packaged technology level (EPP), and 3) irrigation farming on horticulture crops. The detail result of crop budget analyses is shown in Table IV.4.1.

4.1.1 Market Price of Major Grain Crops

Below Table shows minimum and maximum producer-based marketing price of the major grain crops over the past 5 years from 1995 to 2000 in Meki area. Generally, sale price in the open market shows a tendency of augmentation except for the '95 to '97 years. The monthly price curve shows a upward flow toward the off-season, while drops just after harvesting crops. Farm gate price fluctuation of the major horticulture crops is mentioned in Chap V.

Marketing Price of Major Food Grains in the Meki Area

	Haricot bean			Maiz			Wheat			Teff		
Year	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
99-00	183	174	190	132	103	153	173	137	202	233	204	295
98-99	162	162	162	100	74	150	159	128	200	221	176	275
97-98	146	140	150	93	81	110	159	150	170	212	196	240
96-97	110	83	147	63	46	89	101	77	141	186	150	231
95-96	157	150	161	82	70	120	117	101	150	210	194	238

Souce: Ethiopia Grain Trade Enterprise(EGTE) Unit: Birr/qt

4.1.2 Traditional farming

In this traditional farming level, the prevailing farming practice on the four major grain crops is relatively extensive under mostly local variety without chemical fertilizer as mentioned in Chap 3. Only teff and wheat like cash crops is usually cultivated by using herbicide among subsistence farmers. Below table shows the summary result of crop budget analyses.

Summary Table for the Traditional Farming Level

Crop	Unit	Haricot Bean	Maize	Wheat	Teff
Expected yield	qt/ha	6.00	9.00	10.00	7.00
Unit sale price	Birr/qt	183	132	173	233
Gross revenue	Birr/ha	1,098	1,188	1,730	1,631
Hired Oxen plowing	Birr	120	210	240	300
Seed	Bir	183	66	260	117
Fertilizer	Birr	0	0	0	0
Agro-chemicals	Birr	0	0	50	50
Labor	Birr	301	370	535	575
Transportation	Birr	30	45	45	45
Post harvest	Birr	40	45	80	80
Production cost	Birr	674	736	1,210	1,167
Net revenue	Birr	424	452	520	464
B/C ratio		1.63	1.61	1.43	1.40

Source: JICA Study Team Unit: Birr/ha

In this table, the unit sale price is applied to a mean value of the 1999-2000 year, and resulted in 1.34 - 1.63 B/C ratio among the crops. However, the net revenue might be varied toward more profit if farm operation including labor is managed through a traditional labor exchange custom called "*Debo*" mentioned in Chap., III.

4.1.3 Extension Package Program

As stated in Appendix V, this packaged technology (EPP) is comprised of improved seed and chemical fertilizer over most of the grain crops except for teff and haricot bean which are limited only chemical fertilizer due to short of improved seeds. The result of crop budget analyses is shown below table based on the 1999-2000 sale price in the Meki area. One of variable cost like "labor" is widely managed through the labor exchange custom like "*Debo*" mentioned before, thus actual production cost appears to be less than the figure.

Summary Table for the Extension Package Program Level

Crop	Unit	Haricot Bean	Maize	Wheat	Teff
Expected yield	qt/ha	10.00	18.00	19.00	10.00
Unit sale price(mean)	Birr/qt	170	120	145	230
Gross revenue	Birr/ha	1,700	2,160	2,755	2,300
Hired Oxen plowing	Birr	60	210	300	300
Seed	Birr	152	60	310	70
Fertilizer	Birr	138	365	365	365
Agro-chemicals	Birr	0	0	50	50
Labor	Birr	600	650	755	715
Transportation	Birr	45	90	105	60
Post harvest	Birr	60	90	100	100
Production cost	Birr	1,054	1,465	1,985	1,660
Net revenue	Birr	646	695	770	640
B/C ratio		1.61	1.47	1.39	1.39

Source: JICA Study Team Unit: Birr/ha

4.1.4 Irrigation farming

Cultivation of horticulture crops in both rainy and dry seasons is theoretically possible, but due to less incidence of disease and pest problem, most of prevailing cropping pattern is confined to the dry season. However due to advantage of the higher marketing price, some of horticulture crops such as onion, tomato and chili are cultivated with some extent during the rainy season. The result of crop budget analysis is shown below table based on a mean value of farm gate price in Meki area. Among the 5 crops, papaya is one of the most profitable crop with B/C ratio of 7.7 followed by chili (2.2) and onion (2.1). In case of cabbage, net revenue is below cost at sale price of 43 Birr per quintal. However, traditional labor exchange custom like "*Debo*" is usually applied, thus cabbage also generates some profit.

Summary Table for the Irrigated Horticulture Crops

Crop	Unit	Papaya*	Tomato	Onion	Cabbage	Chili
Unit of Area	Ha	1	1	1	1	1
Expected yield	qt	500	100	170	120	62
Marketable rate	(%)	70	80	90	90	80
Unit sale price	Birr/qt	15	45	31	30	65
Gross revenue	Birr	5,250	3,600	4,743	3,240	3,224
Hired Oxen plowing	Birr	0	0	0	0	0
Hired tractor	Birr	0	0	0	0	0
Seed	Bir	0	113	400	154	18
Fertilizer	Birr	0	455	455	0	0
Agro-chemicals	Birr	0	626	1,280	930	965
Labor	Birr	0	165	602	189	160
Fuel	Birr	1,314	500	500	500	500
Lubrication	Birr	83	79	99	28	55
Depreciation cost(pump: 8 years)	Birr	875	438	438	438	438
Depreciation cost(Hand sprayer: 6 years)	Birr	0	43	43	43	43
Depreciation cost (poles: 6 cropping)	Birr	0	250	0	0	0
Production cost		2,272	2,669	3,816	2,282	2,179
Net revenue	Birr	2,978	931	927	959	1,045
B/C ratio		2.3	1.3	1.2	1.4	1.5

Source: JICA Study Team Unit: Birr/ha

Note: Expected yield of papaya is estimated based on a mean yield over 5 economic production year and marketable rate of 70 % to the produce..

4.2 Break-Even Point

Beak-even point of the major crops in each farming level is shown below table.

Based on the '99-'00 year market price in Meki, all level of the major grain crops were fallen in a level of generating profit, while the break-even point of horticulture crops like tomato, onion and cabbage exceeded the minimum market price. Thus cropping is very risky with a small profit range depending on market price. However papaya and chili generate a good profit with a wide range of return, especially a break-even point of papaya is only 6.5 Birr /qt compared to 15 Birr per quintal as minimum market price.

Break-Even Points of Major Crops in Meki Area

Farming Level	Crop	Break-even point*1)	Break-even point*2)	Variation of Marketing Price*3) Max	Min	Mean
Traditional	Haricot bean	110.2	-	190.0	174.0	182.0
	Maize	81.1	-	153.0	103.0	128.0
	Wheat	116.0	-	202.0	137.0	169.5
	Teff	166.4	-	295.0	204.0	249.5
EPP	Haricot bean	107.3	-	190.0	174.0	182.0
	Maize	81.4	-	153.0	103.0	128.0
	Wheat	104.5	-	202.0	137.0	169.5
	Teff	165.9	-	295.0	204.0	249.5
Irrigation	Papaya	4.0	6.5	100.0	15.0	57.5
Farming	Tomato	24.2	33.4	200.0	30.0	115.0
	Onion	21.8	24.9	150.0	30.0	90.0
	Cabbage	16.7	21.1	70.0	15.0	42.5
	Chili	27.4	35.1	225.0	60.0	142.5

Source: JICA Study Team Unit: Birr/qt

Remark 1) Cost without depreciation, 2) Cost with depreciation, 3) 99-00 year market price in Meki

CHAPTER V POST HARVEST AND MARKETING

5.1 Post Harvest

No agro-industries exist in or around the study area except for small-scale flour mills operated by private individuals registered by the District Financial Office as below .

Location	Flour Mill (No.)
Meki Town	34
Alan Tena	9
Rural Area (PAs)	9
Tuchi Sumeyo	(2)
Ombile	(3)
Shubi Gamo	(1)
Derara Dalecha	(1)
Koto Bilati	(1)
Berta Sami	(1)

Source : District Financial Office

Some non-registered flour mills also operated in the study area. Apart from flour mill, there are two large agro-storages operated by the Ethiopia Grain Trade Enterprise (ETGE) and the District Agriculture Bureau Office with capacity of 5000 and 500 tons, respectively. The former was temporarily rented to the Disaster Prevention Preparedness Bureau (DPPB) for food relief but restored to EGTE now. In household level, most of farm household has few traditional storage bins (capacity: 10-15 qts locally called Gotera) in their homestead to keep farm produce such as food grains.

5.2 Market Channels

(1) Major Markets

There are four primary markets in the study area. The primary markets are held in town level and first two are held on every Monday and Thursday in Meki town, and 2nd two are daily held in Meki and Alan Tena towns with small scale. The Monday market and daily markets are dealt with farm produce and some daily commodities mainly for local consumers, while the Thursday Market is extensively operated for trading livestock, all kind of food grains, vegetables, daily commodities with outside collector as well as local consumers. And the registered middlemen trading in the Thursday Market is charged 6 Birr/month by the Meki Municipal Office. In this

Thursday market, most of the farmers in the study area will come out to the market with their farm produce such as grains, livestock, firewood, folk craft and etc, and trade with necessary daily goods.

(2)Food grain channel

The schematic food grain channel in the study area is shown in Figure III.5.1. There are four food grain channels from the producers to consumers in the study area. About 70 % of marketing grains are traded through the registered middlemen channel, followed by 20 % of retailers and 10 % of direct trade with individual consumers, respectively. Ethiopian Grain Trade Enterprise (EGTE), a profit-oriented state enterprise playing a role to export surplus grain and to control floor market price of the food grain has irregularly participated to purchase food grains, especially haricot bean from Meki Area. However, food grain such as teff, wheat, maize including haricot bean has almost not been merchandised during the past 5 – 6 years because of no surplus grains available in the market due to drought prone area.

The quantities of major grains annually traded in the study area can be estimated only based on taxation system controlled by the Meki Municipal Office that tax the registered middlemen based on their capitals scale. Farm produce such as vegetables and fruit is directly traded with local consumer as well as middlemen from outside, thus no official census is available.

Estimated Traded Volume of Major Grains (Dugda Bora)

Crop	Middlemen Registered (No.)	Estimated Monthly Traded Volume per Middleman (kg)	Estimated Annual Traded Volume (ton)
Maize	50	2,000	1,200
Teff	50	1,500	900
Wheat	50	1,500	900
Haricot Bean	50	10,000	6,000
Barley	50	300	180
Hoarse Bean	50	400	240
Total			9,420

5.3 Prices

1) Middlemen

Below table shows the prevailing market price of farm produce in the study area. Buying price by middlemen is seasonally changed but not much difference among the buyer (middlemen) because of a tacit agreement among the middlemen made. The commission charge per quintal of grain usually ranges 10 to 20 Birr. But this farm gate price jumps to 125 % -130 % in the Addis Ababa Market, thus it reveals

that middlemen channels squeeze unreasonable profit from the producer.

Buying Price of Major Crop purchased by Middlemen in Meki area

Unit : Birr / 100 kg

No	Crop	Buying price	Selling price to other Middlemen
1.	Peas(Atar)	180	200
2.	Haricot bean (white & red)	140	150
3.	Teff /white grain	220	230
4.	Teff/brawn grain	170	180
5.	Chickpea (nuts)	140	150
6.	Horse bean (beans)	120	130
7.	Maize	70	80
8.	Wheat	130	140
9.	Barley	120	130

Source: JICA Study Team, November 2000

2) The Thursday Market

Below table shows the Thursday market price on farm produce as of October 2000.

Price of farm produce in the Thursday Market Price

Unit : Birr

No	Crop	Buying price	Selling price to Other middlemen
1	Haricot bean (white & red)	165/qt	175
2	Maize	70/qt	80
3	Wheat	140/qt	150
4	Dry hot chili	8 -10 /kg	
5	Ethiopian cabbage	0.5 /bunch	
6	Green chili pepper	0.25/heap	
7	Sugarcane	0.50/stem	
8	Orange	2.0/kg	
9	Pumpkin	2.0/pc (big size) 0.75/pc (medium)	
10.	Tomato	1.5 /kg	
11	Beet root	1.0/kg	
12	Fresh Ginger	10/heap (4 ~ 5 kg)	
13	Potato	1.0 /kg	
14	Carrot	2.0 / kg	
15	Red onion	2.5/kg	
16	Garlic	2.0 /kg	

3) Buying price of major grain by EGTE

EGTE has a branch Office in Shashamane wareda, covering East Shewa by stationing the grain storage in Meki and Ziway in order to purchase major food grains (only white round type of haricot bean, teff, wheat and maize) except for barley which is based on purchase-order made by brewing company. Purchased price

by EGTE seasonally varied and grain quality is subject to the normal stipulated by the Ethiopian Standard Authority but EGTE at least supports a minimum marketing price. Table III.5.1 shows the monthly marketing price of food grains among the producer, wholesaler and retailer over the past 5 years from 1995 to 2000 in Meki area. The commission from producer to retailer ranges from 8 to 16 Birr/qt depending on kind of grain crop. The price fluctuation over monthly and yearly movement tends to show a very arbitrary change, but general trend of market price indicate a higher price during the off-season of crop harvest and lower price during November to March of harvesting season.

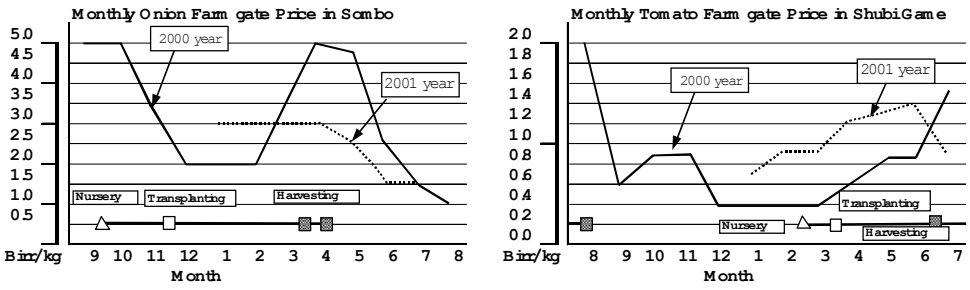
4) Seasonal Farm Gate Price Fluctuation of Horticulture Crops

Price fluctuation on the major horticultural crops in Meki area is shown below table with some case study of farm gate price curve for onion and tomato along to the Meki River bank. The seasonal and annual fluctuation of farm gate price show arbitrarily movement without regular tendency under free market condition. But, farm gate price generally appears to indicate higher price in the rainy season and lower price during the dry season. Also, the result of interviewed survey on farm gate price among the farmers varies from place to place. For instance, the onion and tomato 2000 year price curve (Below Figure) were made by the newly formed WUA member at PRA meeting, while the 2001 price curve and figures in below table were compiled based on the horticulture crop farmer's interview survey in the surrounding area. Namely, the highest price of onion is differed among the informants.

The Farm Gate Price Fluctuation of Major Horticulture Crops

	Horticulture crop	Max Price (Birr)/kg	Min Price (Birr)/kg
1	Tomato	2.0	0.3
2	Onion	3.3	0.3
3	Chili	2.25	1.5
4	Cabbage	0.7	0.15
5	Papaya	1.0	0.6

Source: JICA Study Team



CHAPTER VI CONSTRAINTS AND PROSPECTS

6.1 Constraints

6.1.1 Natural Constraints

(1) Erratic Rain

Erratic rainfall pattern is the most crucial constraints, particularly recurrent dry spell during the reproductive stage of grain crop causes severe bad crops. In the western to northern lakeshore of Ziway is chronic drought prone area and has resulted in continuous bad crop since 5 - 6 years ago.

(2) Infertile soil with low water holding capacity

Crop residues are broadly utilized as supplemental animal feed. Only the limited amount is incorporated into soils. As a result, root zone of soils is very hard with high bulk density of over 1.75, which hinders healthy root penetration.

(3) Decrease of farmlands by soil erosion

Due to irresponsible deforestation by cutting firewood and overgrazing, the land degradation process is rapidly expanded in the study area. Hill slopes and terrace edges are severely incised by large gullies. The potential farmland is being minimized. Flush water passing through gullies often destroy farmland as well as houses of peasants.

(4) Salinity Problem

Salinity problem is partially observed in the farmland adjacent to the Ziway lakeshore and causes physiological desiccation of plant growth.

6.1.2 Socio-economic Constraints

(1) Post-harvest loss

Post harvest loss is usually generated through a traditional threshing method mentioned in Chapter III on Farm Inputs and Practices. Legs of oxen penetrate plastered threshing plot and mix grains with soils and sand to decrease grain quality.

(2) Weak financial status of subsistent landholder

Most of the farmers in the study area is subsistent landholders, while commercial-oriented crop production is rarely operated. Farmers are financially very weak because of low cash income by sale of farm produce under drought prone area. Access to crop credits such as EPP are quite limited among the peasant

farmers. Through the interview survey, some farmer reported to fear getting credits because of unable to refund under recurrent drought.

(3) Poor inputs supply system

Apart from herbicide for grain crop production, most of agro-chemicals are consumed by horticultural crop growers including private farmers. Availability of agro-chemicals is also limited to cooperative union shops, EPP, middlemen or retailers in Addis Ababa. Improved seeds, mostly cereal crops are only available via EPP or on-farm research purpose and local market by middlemen handles only local varieties. Even though EPP suffer from shortage of improved seeds such as teff and haricot beans.

(4) Insufficient of flour mill place

As mentioned in Chapter IV on Post-harvest and Marketing, only 9 flour mills are registered in Dugda Bora. Some of villagers spent long time to go and back from the Meki town for milling.

(5) Shortage of farmland under high land demand

Land tenant usufructuary right is given equally to every farming family without distinction of sex, up to 10 ha in max per family. However, there are many lease agreements of farmland among the subsistent landholders in the study area due to insufficient of the farmland based on economic size per family. One farmer reported that he has no land after his father passed away because his mother inherited land use right, thus he has farmed by renting farmland but unable to be a member of the PA and legally no access to EPA.

(6) High competition between crop farming and livestock farming

Due to rapid increase of animal population, large portion of crop residue is consumed as animal feed. Meanwhile, crop residues are locally available important resources to improve soil fertility. More than half of them are used for feeding materials, fuel source and etc and recycled residue is apt to diminish coupled with increase of livestock population under fragile environment of central lift valley.

(7) Poor marketing system to discourage producer

About 70 % of cereal grains are traded through the middlemen channels at farm gate level, and vegetables and fruits are as well. Most of producers are individual basis to trade with middlemen who make tacit agreement of purchase price from producer before hand, while the producer has no financial margin to build up bargaining power, thus the producer is forced to sell farm produce by asking price

(8) Insufficient extension service to the farmers

1) Frequency to visit farmers by Development Agents (DAs)

The farmer's interview survey by the JICA Study Team verified that beneficiaries accessed by DAs are varied from place to place ranging from one to four times per month or 5 times per year. Most of interviewees want more frequent access by DAs to meet for their technical information demand. Also, the insufficient of practical information of plant protection is reported by horticulture growers.

2) Research-Extension-Farmer's Linkage

In the study area, most of on-farm based demonstration plot occasionally carried out by the research sector for extension purpose is confined to a popularization of new variety on haricot bean and maize coupled with extension package program so far. Thus, the farming practices to conserve soil moisture and sustain soil fertility to improve land productivity are not demonstrated even though the research sector has already verified certain useful technology for improving rain-fed farming in the East Showa.

6.2 Opportunities

(1) Erratic rain

Drought damage on crop growth can be alleviated partially by constructing diversion canal, or dam along to the Meki river, and multipurpose-pond coupled to water harvesting technology on agriculture.

(2) Soil characteristic of low water holding capacity and low fertility

It is possible to prevent soil desiccation by mulching soil surface with locally available crop residue like maize stover to suppress evaporation by decreasing soil temperature. Further, recycling raw organic matter into soil should be practiced as much as possible.

(3) Diminishing of farmland and grazing land due to land degradation

It is urgent issue to take countermeasures of soil conservation because of diminishing of farmland and grazing land coming from land degradation and erosion caused by deforestation, over cultivation, and overgrazing. The rural communities in the hilly area has independently undertaken countermeasures of soil conservation and water harvesting practices under NGO's support, thus it is possible to extend this people participatory project over other area.

(4) Soil salinity

Traditionally, indigenous way to alleviate poor crop growth caused by salt accumulation is empirically verified by applying cow dang into the affected soil among the subsistent farmers, and should be massively practiced where faces salinity problem.

(5) Harvesting loss

It is possible to alleviate harvesting loss by introducing motor driven threshing machine which is locally available instead of traditional threshing method done by animal draught power.

(6) Weak financial status of subsistent landholder

This financial weakness of subsistent landholder comes from compound factors of natural and socio-economic constraints, especially farmers subject to rain-fed condition is afraid of applying credit associated with risk because of low crop yield coming from erratic rainfall coupled to low fertility soil. Thus, there is some possibility to alleviate their financial status by improving land productivity with application of useful technology under rain fed condition.

(7) Limited supply of farming inputs

The cooperative union comprising of WUAs has already launched an union shop to deal with farming inputs under support by NGO, thus it is possible to apply this way to the existing Cooperative Association which has already operated some credit sale for fertilizer.

(8) Severe competition between crop farming and livestock farming

Animal keeping plays a role to insure against emergency case to cope with drought problem. However, it is inferred that vicious circle of overgrazing and over-cultivation coupled to drought coping strategy can be alleviated with proper livestock density via dialog with inhabitants if crop production is improved by applying several countermeasure on rain fed farming.

(9) Poor marketing system to discourage the producer

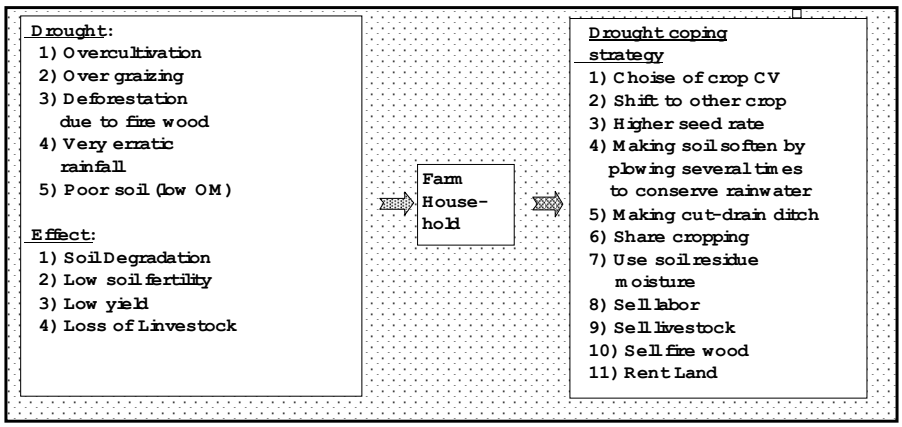
Present marketing system which middlemen purchase farm produce directly from the producer should be shifted to a marketing system from the producer to consumer channel by minimizing middlemen channels. This advanced marketing system has already launched by the cooperative union in the study area, thus it is highly possible to apply it to the existing-cooperative association, and the margin profit squeezed by middlemen can be returned to the producer.

(10) Insufficient extension service and research-extension linkage

The agriculture research stations in the East Shewa have already verified some useful technologies in terms of soil water conservation and keep soil fertility under rain-fed condition but not been disseminated in on-farm level yet. Thus it is essential to extend their useful expertise by verifying in accordance with agro-ecological system in the study area

6.3 Indigenous Drought Coping Strategy

The indigenous drought coping strategy among the subsistent landholder in the study area is summarized as below:



(1) Flexible sowing time along to rainfall pattern

One of indigenous strategies to cope with drought problem is to adjust a sowing time of cereal crops along to rainfall pattern. Maize is generally sown from late April to early May in the central Meki area but immediately shift to barely, wheat or haricot bean if poor rain is anticipated during this short rain period (*Belg*). But if the rain in the *Belg* season is good and dry spell occurs later in the *Meher* season (long rainy season), severe moisture stress causes a mass mortality and no option to avoid drought at the silking/tasseling growth stage. This supported that the poor rain drastically increased an acreage of haricot bean up to 14,730 ha in the 1999-2000 season, but decreased to 6,350 ha in this good rain year (2000-2001 season).

(2) High seed rate more than recommended rate

Most of interviewed farmers by the JICA Study Team employ a higher seed rate as shown below:

Recommended and Farmers' Seed Rates

Crop	Recommended (A) (kg/ha)	Farmers' Rates (B) (kg/ha)	B/A (%)
Maize Lined	25		
Broadcasted	30	40-120	133-400
Haricot Beans	20-30	100	333-500
Teff	30	50	166
Wheat	75	50	133

From this table, higher seed rate to the recommended rate ranges from 133 % to 500%, varying from crop to crop. One interviewed farmer reported that the reason of applying this high seed rate is accounted for their drought coping strategy to ensure a number of good stand and secure the biomass of plant for feeding live stock if dry spell occur later and forced to shift to other grain crop.

(3) Contour ditch made in teff , wheat, and barley fields

In the sloped field where is cultivated with teff, wheat, and barley even in flat field, regular ditches with 2 – 3 m interval along to control line is observed. The ditch play a role to cut drain and infiltrate rainwater into the soil in stead of run-off and protect soil erosion as well. In the flat field, it serves as drainage to avoid suffocation of emerged seed due to stagnant water in the field.

(4) *Shilshallo* (process of rough thinning/weeding)

Locally called "*Shilshallo*" referring to a rough thinning and weeding operation by using ox-plow, locally called "*Maresha*" is applied to sorghum and maize field at knee high stage. This practice contributes to elimination of excess plants, and weeds, conserve soil moisture by making the soil soft, and protect the crop lodging.

(5) Application of cow dung to salinity affected area

In the surrounding of the Ziway lake area, soil salinity problem suppressing crop growth is observed in the farmlands. Farmer cope with this problem by applying cow dung manure, which appears to have some effect to alleviate soil salinity and results in some harvest according to the interviewed farmer.

(6) Indigenous variety

Apart from the improved seeds on food grains, there are few indigenous varieties of major food grain crops like maize, wheat, teff and haricot bean, which have been traditionally multiplied and kept by farmers themselves. Characteristics of these cultivars are summarized as below:

Indigenous Varieties of Major Crops

Crop	Local Name	Varietal Characteristics	Potential Yield (kg/ha)	Growth Period (day)
Maize	Milisha	Mixed variety of white & brown grains	4,000	90
Wheat	Lakech	Formally released as improved seeds but no more distribution	2,400	120
Teff	White Brown Mixed		1,600 2,000 2,000	105 105 105
Haricot B.	Round & Fat		2,000	105

6.4 Sustainable Agricultural Production Programs

6.4.1 Objectives and Program Components

(1) Objectives

The lift valley area is often hit by drought and exposed to progressive soil erosion over hilly area and sloping land generated by deforestation, over-grazing and over-cultivation under increase of pressure to land due to growing of human and livestock population. Under recurrent drought, keeping livestock plays a role of security at emergency case and accelerates land-degradation coupled with growing rural population, which pressurizes progressively land use.

Development of this area is only possible when the mixed farming system engaged by the subsistent landholder, who is accounted for majority of inhabitants in the study area is managed in a sustainable way under fragile agro-ecosystem of the rift valley.

In order to support growing rural population and livestock heads continuously, stabilizing and improving agriculture production is most vital issue with formulation of appropriate land use plan. For that purpose, it aims at improving of productivity by developing of appropriate irrigation scheme in the rain-fed farming area and by introducing useful technology to alleviate negative effect of erratic rain on crop production where is out of irrigable area and subject to rain-fed condition.

The study area where is classified as semi arid area with annual rainfall of 700 – 800 mm and is often hit by recurrent drought at reproductive stage of grain crop under rain-fed condition. Seeking for sustainable farming is most prioritized by alleviating drought damage on crop growth caused by erratic rainfall pattern, and by stabilizing and improving crop production, with prevention of on-going desertification under the fragile natural ecosystem. The program is based on the following concept and direction.

(2) Basic Concept

i. This program aims at producing maximum profit by utilizing limited available water resources including irrigation scheme and land resource.

ii. This program aims at stabilizing and improving agriculture production by introducing supplemental irrigation system which is mainly applied to chronic drought prone area during the rainy season.

iii. Most vital issue in the rain-fed farming area is how to alleviate water stress on grain crop growth at emergence and flowering stage during the recurrent dry spell, thus some of useful technologies which have already been verified by the local agriculture research station under the similar agro-climatic condition in the study area should be verified in on-farm level.

iv. Kind of crop and cropping period in the present rain-fed farming system is basically continued and is focused on improvement of land productivity.

6.4.2 Cropping Plan

(1) Irrigation (supplemental irrigation) scheme

Considering the basic strategy of agriculture development in the Program, the following crops are selected for the prospective cropping pattern as main crops.

a. Food grain : maize, wheat
b. Pulse crop : haricot bean, horse bean, field pea
c. Vegetables : tomato, red-onion, chili pepper, cabbage
d. Fruit : papaya

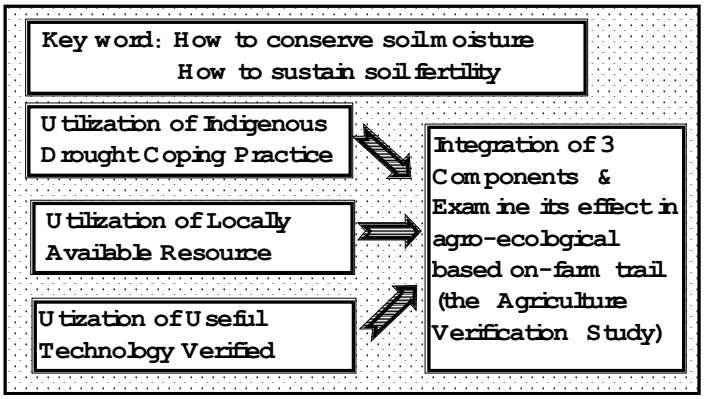
Moreover, considering the below factors, the cropping pattern illustrated in Figure III.6.1 and Table III.6.1 is proposed after construction of irrigation structure.

a. Water requirement based on maximum water requirement and effective irrigation water during the dry season
b. Type of present cultivated crops and method of present farming practice
c. Available family labor
d. Socio-economic condition (profitability, marketability, demand and possibility of seed multiplication)

(2) Rain-fed farming area

The cultivated crops currently are followed as status quo and are focused on improving agricultural productivity based on the three components illustrated below

conceptual figure.



There are two vital factors to be considered for improving rain-fed farming. The first is how to conserve soil moisture and the second, how to keep soil fertility. Approach to improved rain-fed farming is essential for an integration of three components comprising of a) utilization of indigenous drought coping practice, b) utilization of locally available resources and c) utilization of useful technology verified by the local agriculture research station.

Further the integrated approach should be examined in its effect through the agriculture verification study scheme in collaboration with local agriculture research station based on agro-ecological on-farm trial base. The trial subject to be verified in the study area should consider the followings:

a. Tied ridge effect

b. Maize storver mulching effect

c. Intercropping with pulse crop

d. Alley cropping with Leucaena

e. Green manure effect

f. Stone mulching effect

g. Watershed management

APPENDIX III
AGRICULTURE

Tables

Table III.1.1 The Result of Soil Physio-chemical Analyses in the Study Area

No.	Soil Physical and Chemical Properties	Location of Soil Pit								
		Soil Profile No.1			Soil Profile No.2			Soil Profile No.3		
		Ela - Gebre Dalacha (23 Km far from Meki town)			Gusa Elementary School (About 11 Km. far from T.P1)			Bekele Girsa Area(1 Km. far from Meki town)		
		Soil Depth (cm)								
		20	50	150	20	50	150	20	50	150
1	Visial Description	Black silty clay with few sand	Black silty clay with few sand	Brown silty clay	Light brown silty sand with clay and few gravel	Light gray clayey sandy silt with few gravel	White sandy gravel with silt and few clay	Light brown silty sand with few gravel and clay	Light brown sandy silt	Whitish gray silty sand with few gravel and clay
2	Bulk Density (gm/cm^3)	1.95	1.69	1.78	1.76	2.05	1.67	1.76	1.58	1.76
3	Gravel (%)	0.4	0.4	0.5	7.2	5.4	39.2	8.8	0	7.8
4	Particle size distribution Sand (%)	9.8	7.2	7.8	44.9	30.4	58.6	56.4	63.7	54.3
	Silt (%)	38.1	30.8	28.1	36.4	33.2	31.7	34.2	20.9	37.2
	Clay (%)	52.1	61.9	64.0	18.6	36.4	9.7	9.4	15.4	8.5
5	pH(H_2O)	6.2	6.4	6.5	5.2	6.4	7.2	6.6	7.2	8
6	pH(KCl)	5.0	4.5	4.3	4.8	4.6	6.8	6.0	6.4	7.2
7	Electrical Conductivity (EC), mmho/cm	0.28	0.15	0.11	0.03	0.09	0.12	0.06	0.07	0.49
8	Cation Exchange Capacity(CEC) (meq/100gm soil)	45.51	55.15	45.63	16.92	26.33	35.1	25.87	16.95	34.93
		Very High	Very High	Very High	Medium	High	High	Medium	Medium	High
9	Exchangable Sodium (meq/100gm soil)	1.76	2.71	2.7	1.69	1.69	2.61	2.59	2.59	7.97
10	Exchangable Potassium (meq/100gm soil)	0.96	1.08	1.35	0.71	0.78	1.78	1.92	1.87	4.5
11	Exchangable Calcium (meq/100gm soil)	32.95	39.28	33.48	7.07	19.92	39.08	14.58	14.16	40.98
12	Exchangable Magnesium(meq/100gm soil)	9.54	10.48	10.87	4.16	5.51	5.04	3.75	3.34	7.53
	Total Exchangeable Cations (meq/100gm soil)	45.21	53.55	48.4	13.63	27.9	48.51	22.84	21.96	60.98
	Saturation Percentages (%, Total Ex-Cations / CEC)	99.3	97.1	106.1	80.6	106.0	138.2	88.3	129.6	174.6
13	Organic Carbon (%)	1.12	1.2	0.25	0.93	0.45	0.28	1.00	0.77	0.37
	Organic Matter Content (%) (= Org.C % x 1.724)	1.93	2.07	0.43	1.60	0.78	0.48	1.72	1.33	0.64
		Low	Low	Very Low	Low	Very Low	Very Low	Low	Low	Very Low
14	Available Phosphorous(mg/Kg P_2O_5)	4.778	4.81	3.74	2.011	1.025	2.485	3.023	3.023	3.597
		Low	Low	Low	Low	Low	Low	Low	Low	Low
15	Total Nitrogen(%)	0.087	0.064	0.032	0.084	0.039	0.035	0.063	0.098	0.049
		Low	Low	Very Low	Low	Very Low	Very Low	Low	Low	Very Low

Remarks : 1) Measurement of pH(H_2O) and EC are made using suspension as soil and water ratio of 1:2.5 and pH (KCl) using suspension as soil and 1M-Kcl ratio of 1:2.5.

2) Soil Organic Matter content (%) is calculated by multiplying conversion factor of 1.724 to orgarnic carbon (%).

Table III.1.2 Soil Samples Collected by PA

No.	Peasant Association	Soil Sample Number per Peasant Association												No of Samples
		1	2	3	4	5	6	7	8	9	10	11	12	
1.	Kersa Gambala													0
2.	Abene Kumuro													0
3.	Adie Mirt	246	247											2
4.	Biliti Balewoid	218	220	223	224	238								5
5.	Koto Biliti	222	221	240	239	241	242	243	244	245	248	249		11
6.	Argo Gadilala	271	233	232	270	273								5
7.	Tuchi Denbel	228	229	230	231									4
8.	Weyo Gebriel	227	225	28	29									4
9.	Aboro Gebriel	268	27											2
10.	Dodoti Dembel	26	31	30	236	235	234	226	215					8
11.	Mukiye 1	216	209	208	212	210	205	204	41	40	39	38		11
12.	Birbirsa Guda Sabole	60	62	67	70									4
13.	Birbirsa Gale													0
14.	Eela Gebre Daiech	65	64	63	66									4
15.	Menjegso Weji													0
16.	Joro Reka	71												1
17.	Korke Adama	68	69	74	75									4
18.	Goro Korke	72	73	79										3
19.	Kiltu Ombole	78	80	102	203									4
20.	Doyo Laman	138	140	201	200	199	198							6
21.	Tute Koremtu	137	202	139										3
22.	Koye Jejeba	108	110	112	76	111	77	135	136					8
23.	Hafe Kemale	101	107	113	115	109								5
24.	Weldia Hafa	121	114	123	128	130								5
25.	Beyimogusa	55	103	57	104	105	106							6
26.	Dongorota	59	56	58	61									4
27.	Mukiya 2	42	44	46	43	45								5
28.	Hate Leman	206	37	47	48									4
29.	Tepho Choroke	25	207	155	32									4
30.	Giraba Korke Adi	33	34	35	36	49	50							6
31.	Bekele Girisa	264	24	23	259	260								5
32.	Weldiyo Mekidela	265	266											2
33.	Weldiyo Kelina	261	262	263	86	267								5
34.	Saubi Gamo	82	83	84	2									4
35.	Tuchi Sumeyo	3	156	157	158	161								5
36.	Jawe Bofa	20	21	118										3
37.	Oda Bokota	1	51	52	116	117								5
38.	Sera Wekele	53	54	119	120	122								5
39.	Derara Daiecha	5	7	4	85	88	159	274	275					8
40.	Burka Debrebeg	87	89	90	6	98								5
41.	Jirme Bora	8	9	10	11	160	162							6
42.	Berta Sami	16	17	18	19	124	125	126	154					8
43.	Sori Dolesa	127	129	131	132	134								5
44.	Tuka Largamo	15	151	152	153									4
45.	Gose Korke	133	141	142	143	144	145							6
46.	Tuchi Deko	146	147	148	149	189								5
47.	Elen	186	187	188										3
48.	Kushe Huluko	194	195	196	197									4
49.	Lafesa Germeji	190	191	192	193									4
50.	Gora Leman													0
51.	Dodo Wedera	179	181	182	183	184	185							6
52.	Malema Jere Bera	176	177	178	180									4
53.	Tube Suti	171	173	174	175									4
54.	Dalota Mati	12	13	14	150	163	164	167	169	170				9
	Meki City	22	81											2
Source : JICA Study Team/December, 2000.														245

OTHER AREA(Out of the Study Area)

1.	Arsi Zone	91	92	93	94	95	96	97	99	100	165	166	168	
		172												13
2.	Southern Region	257	258	214	237	211	213	217	219					8
3.	Adami Tulu Wareda	250	251	252	253	254	255	256	269	272				9
														30
										Total Sample No				275

Table III.1.3 Soil Analytical Results (1/4)

No.	Peasant Association	Soil Sample No.	Analytical Results			No. of Samples
			pH	EC	Texture	
1.	Kersa Gambala					0
2.	Abene Kumurc					0
3.	Adie Mirt	246	6.2	167.0	S	2
		247	6.9	99.0	SL	
4.	Biliti Balewoid	218	6.8	194.0	L	5
		220	7.0	180.0	S	
		223	6.4	64.0	LS	
		224	6.7	64.0	SL	
		238	6.4	182.0	S	
5.	Koto Biliti	222	6.4	64.0	LS	11
		221	6.4	82.0	SL	
		239	6.1	88.0	L	
		240	6.4	410.0	LS	
		241	6.1	102.0	CL	
		242	6.6	190.0	SL	
		243	6.2	77.0	S	
		244	6.1	128.0	SL	
		245	6.1	114.0	SL	
		248	6.8	172.0	SL	
		249	7.3	240.0	CL	
6.	Argo Gadilala	232	6.2	38.0	CL	5
		233	6.1	21.0	SiL	
		270	6.2	140.0	CL	
		271	6.4	107.0	CL	
		273	6.1	120.0	CL	
7.	Tuchi Denbel	228	6.2	85.0	LS	4
		229	6.2	163.0	LS	
		230	7.0	138.0	LS	
		231	6.2	77.0	LS	
8.	Weyo Gebriel	28	6.8	78.0	S	4
		29	6.6	94.0	SL	
		225	6.8	300.0	S	
		227	6.8	116.0	SL	
9.	Aboro Gebriel	27	6.5	67.0	S	2
		268	6.9	220.0	S	
10.	Dodoti Dembel	26	6.6	85.0	S	8
		30	6.5	47.0	SL	
		31	7.0	20.0	S	
		215	6.9	330.0	SiL	
		226	6.9	108.0	SL	
		234	7.2	200.0	SL	
		235	6.5	75.0	L	
		236	6.6	88.0	L	
11.	Mukiye 1	38	6.6	78.0	SL	11
		39	6.2	86.0	SL	
		40	6.1	53.0	SL	
		41	6.2	57.0	SL	
		204	6.6	200.0	SiL	
		205	6.5	42.0	SiL	
		208	7.0	220.0	L	
		209	6.4	1,060.0	SiL	
		210	6.7	67.0	SiL	
		212	6.4	96.0	CL	
		216	6.9	54.0	L	
12.	Birbirsa Guda Sabole	60	6.1	46.0	SL	4
		62	6.1	41.0	S	
		67	5.8	84.0	CL	
		70	6.1	78.0	CL	
13.	Birbirsa Gale					0
14.	Eela Gebre Daiech	63	6.4	42.0	SL	4
		64	6.2	73.0	CL	
		65	6.4	46.0	CL	
		66	6.1	46.0	CL	
15.	Menjegso Weji					0
16.	Joro Reka	71	6.1	24.0	SiL	1

Source : JICA Study Team/December, 2000

Remarks :

Soil Texture - S:Sand, SL: Sandy Loam, L:Loam, LS:Loamy Sand, SiL:Silty Loam, CL:Clay Loam, C:Cla

Electric Conductivity -µs/cm

Soil pH 1:2.5 H2O

Table III.1.3 Soil Analytical Results (2/4)

No.	Peasant Association	Soil Sample No.	Analytical Results			No. of Samples
			pH	EC	Texture	
17.	Korke Adama	68	5.9	470.0	C	4
		69	6.3	79.0	C	
		74	5.7	28.0	SiL	
		75	6.9	106.0	SL	
18.	Goro Korke	72	6.9	106.0	SL	3
		73	6.8	112.0	S	
		79	5.7	28.0	SiL	
19.	Kiltu Ombole	78	6.1	37.0	SL	4
		80	5.8	38.0	S	
		102	6.3	56.0	SiCL	
		203	6.2	68.0	SiL	
20.	Doyo Laman	138	6.4	71.0	SL	6
		140	6.6	58.0	SL	
		198	6.3	57.0	SL	
		199	6.6	112.0	SiL	
		200	6.8	360.0	SL	
		201	6.1	35.0	SL	
21.	Tute Koremtu	137	6.2	118.0	SL	3
		139	6.8	45.0	SiL	
		202	6.4	76.0	LS	
22.	Koye Jejeba	76	5.8	51.0	L	8
		77	5.6	102.0	CL	
		108	6.1	52.0	LS	
		110	6.0	46.0	SiL	
		111	6.1	26.0	LS	
		112	5.5	360.0	LS	
		135	6.5	64.0	LS	
		136	6.6	61.0	LS	
23.	Hafe Kemale	101	5.7	128.0	CL	5
		107	6.1	65.0	SL	
		109	5.8	54.0	SL	
		113	5.7	38.0	L	
		115	5.8	56.0	S	
24.	Weldia Hafa	114	5.7	139.0	S	5
		121	6.9	57.0	LS	
		123	6.4	64.0	SL	
		128	6.9	81.0	S	
		130	6.0	81.0	SiL	
25.	Beyimogusa	55	6.5	116.0	SL	6
		57	5.9	290.0	S	
		103	6.1	77.0	SL	
		104	6.0	50.0	LS	
		105	5.6	32.0	SL	
		106	6.2	52.0	SiL	
26.	Dongorota	56	6.1	70.0	SL	4
		58	6.0	44.0	S	
		59	5.8	54.0	SL	
		61	6.1	370.0	C	
27.	Mukiya 2	42	6.8	146.0	SL	5
		43	6.4	72.0	SL	
		44	6.5	88.0	SL	
		45	6.3	43.0	SL	
		46	6.1	38.0	S	
28.	Hate Leman	37	6.7	41.0	SL	4
		47	5.6	37.0	SL	
		48	5.7	61.0	SL	
		206	6.6	36.0	SiL	
29.	Tepho Choroke	25	8.9	5,600.0	S	4
		32	6.3	79.0	S	
		155	6.9	65.0	SL	
		207	6.4	64.0	L	
30.	Giraba Korke Adi	33	5.6	112.0	SL	6
		34	5.7	200.0	S	
		35	6.8	162.0	S	
		36	6.8	88.0	S	
		49	6.1	88.0	SL	
		50	6.4	49.0	S	

Source : JICA Study Team/December, 2000

Remarks :

Soil Texture - S:Sand, SL: Sandy Loam, L:Loam, LS:Loamy Sand, SiL:Silty Loam, CL:Clay Loam, C:Cla
Electric Conductivity -µs/cm
Soil pH 1:2.5 H2O

Table III.1.3 Soil Analytical Results (3/4)

No.	Peasant Association	Soil Sample No.	Analytical Results			No. of Samples
			pH	EC	Texture	
31.	Bekele Girisa	23	6.6	86.0	S	5
		24	8.8	1,040.0	S	
		259	7.8	500.0	SL	
		260	6.3	100.0	SL	
		264	6.1	115.0	C	
32.	Weldiyo Mekidela	265	6.2	76.0	C	2
		266	6.4	94.0	SL	
33.	Weldiyo Kelina	86	5.9	69.0	SL	5
		261	6.1	102.0	SL	
		262	6.6	120.0	CL	
		263	6.9	240.0	SL	
		267	6.6	109.0	SL	
34.	Saubi Gamo	2	6.6	18.0	SL	4
		82	5.8	75.0	C	
		83	6.0	83.0	SiL	
		84	6.3	63.0	C	
35.	Tuchi Sumeyo	3	7.0	62.0	SL	5
		156	6.7	38.0	SL	
		157	5.5	1,550.0	CL	
		158	6.8	92.0	S	
		161	6.8	178.0	LS	
36.	Jawe Bofa	20	6.4	39.0	SL	3
		21	6.4	68.0	SL	
		118	6.9	63.0	LS	
37.	Oda Bokota	1	6.4	17.0	SL	5
		51	6.4	74.0	S	
		52	6.1	49.0	S	
		116	6.4	78.0	SL	
		117	6.8	63.0	SiL	
38.	Sera Wekele	53	6.4	35.0	SL	5
		54	6.9	111.0	S	
		119	7.1	62.0	LS	
		120	6.0	65.0	SL	
		122	6.4	78.0	SL	
39.	Derara Daiecha	4	7.0	62.0	SL	8
		5	6.5	2.0	SL	
		7	6.4	52.0	SL	
		85	6.3	196.0	C	
		88	6.8	89.0	S	
		159	6.3	22.0	S	
		274	6.8	250.0	SL	
		275	6.2	123.0	SL	
40.	Burka Debrebeg	6	6.6	32.0	SL	5
		87	6.8	220.0	C	
		89	5.7	69.0	SiL	
		90	6.3	40.0	SiCL	
		98	6.3	73.0	CL	
41.	Jirme Bora	8	6.5	38.0	S	6
		9	6.4	172.0	S	
		10	6.2	51.0	SL	
		11	5.7	67.0	LS	
		160	6.4	122.0	CL	
		162	6.6	82.0	SL	
42.	Berta Sami	16	6.4	33.0	S	8
		17	6.3	37.0	SC	
		18	6.2	61.0	SL	
		19	6.2	64.0	SC	
		124	6.6	36.0	LS	
		125	6.1	94.0	SiL	
		126	6.2	56.0	LS	
		154	6.4	63.0	SL	
43.	Sori Dolesa	127	6.2	42.0	SiL	5
		129	6.3	44.0	LS	
		131	6.6	74.0	LS	
		132	6.4	46.0	LS	
		134	6.7	62.0	SL	

Source : JICA Study Team/December, 2000

Remarks :

Soil Texture - S:Sand, SL: Sandy Loam, L:Loam, LS:Loamy Sand, SiL:Silty Loam, CL:Clay Loam, C:Cla

Electric Conductivity -µs/cm

Soil pH 1:2.5 H2O

Table III.1.3 Soil Analytical Results (4/4)

No.	Peasant Association	Soil Sample No.	Analytical Results			No. of Samples
			pH	EC	Texture	
44.	Tuka Largamo	15	6.2	49.0	S	4
		151	6.7	83.0	SL	
		152	6.3	42.0	SL	
		153	6.5	71.0	S	
45.	Gose Korke	133	6.7	46.0	SiL	6
		141	6.7	38.0	SiL	
		142	6.7	81.0	LS	
		143	6.6	113.0	LS	
		144	6.5	50.0	SiL	
		145	6.4	60.0	SL	
46.	Tuchi Deko	146	6.1	38.0	SiL	5
		147	6.5	54.0	LS	
		148	6.1	52.0	CL	
		149	5.9	44.0	SL	
		189	6.8	118.0	SL	
47.	Elen	186	6.3	69.0	L	3
		187	6.9	82.0	SL	
		188	6.4	79.0	L	
48.	Kushe Huluko	194	6.2	46.0	SL	4
		195	6.2	42.0	SiL	
		196	6.4	57.0	SL	
		197	6.1	81.0	L	
49.	Lafesa Germeji	190	6.4	111.0	SL	4
		191	6.8	95.0	SiL	
		192	7.0	120.0	SL	
		193	6.7	73.0	SL	
50.	Gora Leman					0
51.	Dodo Wedera	179	6.1	137.0	S	6
		181	6.5	35.0	LS	
		182	6.6	82.0	S	
		183	7.1	88.0	SL	
		184	6.9	2.0	SL	
		185	6.4	54.0	SL	
52.	Malema Jere Bera	176	6.9	132.0	LS	4
		177	6.5	44.0	SL	
		178	6.2	77.0	SL	
		180	6.8	91.0	SL	
53.	Tube Suti	171	6.4	90.0	S	4
		173	6.0	200.0	SL	
		174	6.7	67.0	LS	
		175	6.3	98.0	CL	
54.	Dalota Mati	12	6.1	76.0	SL	9
		13	5.8	58.0	SL	
		14	5.7	45.0	SL	
		150	7.0	188.0	LS	
		163	6.4	80.0	L	
		164	6.3	31.0	SL	
		167	6.0	32.0	SL	
		169	6.5	68.0	S	
		170	7.0	45.0	SL	
	Meki City	22	6.2	55.0	S	2
		81	6.1	61.0	S	
					Total	245

OTHER AREA(Out of the Study Area)

	Name of Zone	Soil Sample Number taken from the area				
1.	Arsi Zone	91	92	93	94	95
		99	100	165	166	168
2.	Southern Region	257	258	214	237	211
3.	Adami Tulu Wareda	250	251	252	253	255

Source : JICA Study Team/December, 2000

Remarks :

Soil Texture - S:Sand, SL: Sandy Loam, L:Loam, LS:Loamy Sand, SiL:Silty Loam, CL:Clay Loam, C:Cla

Electric Conductivity -µs/cm

Soil pH 1:2.5 H_2O

Table III.1.4 Indigenous Trees and Grass Species in the Study Area

(1) Indigenous trees

No.	Local name	Scientific Name	Common Name
1.	Tedecha	*Acacia tortilis*	Acacia albida
2.	Dere	*A. brevispica*	Millia
3.	Bisana	*Croton macrostchys*	Moringa
4.	Zibba	*Podo carpus*	Jacaranda
5.	Shola Spatoda ficus	*Ficus sycomorus*	n.a.
6.	Weira	*Olive tree*	Lusinia
7.	Bora	*Capprris tomentasa Sesbania*	n.a.
8.	Kurkura	*Ziziphus mauritania*	Gravicia
9.	Duckuac	*Cactus spp.*	Eucalyptus tree
10.	Keba	*n.a.*	Neem
11.	Abam	*Carissa edulis*	Turmantuli
12.	Bofefe	*n.a.*	n.a.
13.	Sensec	*n.a.*	n.a.
14.	Berbi	*n.a.*	n.a.
15.	Dodota	*Acacia spp.(myalotica?)*	n.a.
16.	Bedeno	*n.a.*	n.a.
17.	Wacho	*Acacia seyal*	n.a.
18.	Girar	*Acacia mubica*	n.a.
19.	Lafto	*Acacia mellifera*	n.a.
20.	Wanza	*n.a.*	n.a.
21.	Wadesta	*Erythrina melanacantha*	n.a.
22.	Kophim	*n.a.*	n.a.
23.	Kontil	*n.a.*	n.a.

(2) Grass Species

No.	Local name	Scientific Name
1	Senbelet	*Hyparrhenia ruffa*
2	Serdo	*Cynodon dactylon*
3	Muga	*Cenchrus ciliaris*
4	Fila	*n.a.*
5	Akirma	*n.a.*
6	Gicha	*n.a.*
7	Chloris spp	*n.a.*
8	Setaria spp	*n.a.*
9	Paspalum spp	*n.a.*
10	Eragrostis spp	*n.a.*