RLDS

REGIONAL AND LOCAL DEVELOPMENT STUDIES
ADDIS ABABA UNIVERSITY

RLDS-Location:	FBE Campus, Addis Ababa University, Ethiopia
Postal address:	P.O. Box 5563, Addis Ababa, Ethiopia
Phone:	55 39 00 Extn. 237, or 11 34 78
Phone/Fax:	00 - 251 - 1 - 55 22 27
E-mail:	rlds@telecom.net.et

Date: February 12, 1999

To: The School of Graduate Studies
Addis Ababa University

From: Meheret Ayenew (Ph.D)
Program Co-ordinator

Re: Student Zewdie Shite's Graduation

Student Zewdie has successfully completed his studies at the RLDS. He has defended his masters thesis and fulfilled all the requirements for graduation. All information pertaining to his graduation, including minutes of the IDGC, IFGC, grade reports, etc. are attached herewith. Please, take all appropriate steps to finalize his exit..

Thanks.

Attachments.

RLDS

REGIONAL AND LOCAL DEVELOPMENT STUDIES
ADDIS ABABA UNIVERSITY

RLDS-Location: FBE Campus, Addis Ababa University, Ethiopia
Postal address: P.O. Box 5563, Addis Ababa, Ethiopia
Phone: 55 39 00 Extn. 237, or 11 34 78
Phone/Fax: 00 - 251 - 1 - 55 22 27
E-mail: rlds@telecom.net.et

Date: February 12, 1999

To: The School of Graduate Studies
Addis Ababa University

From: Meheret Ayenew (Ph.D)
Program Co-ordinator

Re: Student Zewdie Shite's Graduation

Student Zewdie has successfully completed his studies at the RLDS. He has defended his masters thesis and fulfilled all the requirements for graduation. All information pertaining to his graduation, including minutes of the IDGC, IFGC, grade reports, etc. are attached herewith. Please, take all appropriate steps to finalize his exit..

Thanks.

Attachments.

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
REGIONAL AND LOCAL DEVELOPMENT STUDIES

A STUDY ON AGRICULTURAL PRODUCTION, ENVIRONMENTAL DEGRADATION AND CARRYING CAPACITY IN DEBAY TILATGIN WEREDA, EAST GOJJAM

ZEWDIE SHITIE

ADDIS ABABA
JANUARY 1999

A STUDY ON AGRICULTURAL PRODUCTION, ENVIRONMENTAL DEGRADATION AND CARRYING CAPACITY IN DEBAY TILANGIN WEREDA, EAST GOJJAM

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES ADDIS ABABA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN REGIONAL AND LOCAL DEVELOPMENT STUDIES

BY:

ZEWDIE SHITIE

JANUARY 1999

ADDIS ABABA UNIVERSITY
School of Graduate Studies

A Study on Agricultural Production, Environmental Degradation and Carrying Capacity in Debay Tilatgin Wereda, East Gojjam.

By

Zewdie Shitie Tesgaye
Faculty of Business and Economics

Approved by Board of Examiners:

Dr. Tesfaye Tafesse Advisor	Signature
Dr. Tegegne G/Egziabher Examiner	Signature
Dr. Wolday Amha Examiner	Signature

Acknowledgement

I would like to extend my sincere gratitude to my advisor, Dr Tesfaye Tafesse, who generously devoted his time and knowledge to keep me in the right truck through his hospitable guidance and suggestions. I also appreciate his patience in correcting my routines throughout the preparation of this thesis.

As a self-supporting student, I owe much to my family. I am indebted to Ato Tewabe Tsegaye and his family who hosted me during the study time. Special thank is reserved for Ato Yohnnes Tsegaye, Keleme Getahun and Ato Tilahun Shetie for their financial assistance and morale support.

My heart full thanks go to my friends and relatives who in one way or another shared my pains throughout the study time. Although it is difficult to mention all, I would like to express my sincere gratitude to Ato Bisrat Ashebo, Assaye Tamiru, Kassahun Senishaw, Abebaw Maemer, Kumelachew Indalfer, Berhanu Kiber, Zelalem Tesfaye and Yemaneberhan Kelemework, Mezgebu Biazen, and Ato Gashaye Chekol.

I would also like to extend my appreciation to the staff of the RLDS Project, particularly to Ato Berhane Tareke, Dr. Theo van der Loope, and W/o Genet (RLDS Secretary) for their unreserved assistance through out the study time. My thanks are also extended to the ISS of the Netherlands for granting me financial support to carryout my research.

Finally my deepest gratitude goes to the peasants of sampled PAs (for their willingness to answer my questions) Development Agents (for their field assistance) and Wereda Council and Agriculture office for supplying documents that were useful for my study.

TABLE OF CONTENTS

Acknowledgment I
List of Tables v
List of Figures vi
List of Abbreviations vii
List of Amharic words appearing in the thesis vii
Abstract viii

I INTRODUCTION 1
1.1. Background 1
1.2. The Problem 5
1.3. Objective 7
1.4. Significance of the Study 8
1.5. Scope and Limitation 8
1.6. Research Design and Methodology 9
1.6.1 Working assumptions and methods of analysis 9
1.6.2 Sources of Data 10
1.6.2.1 Primary source 10
1.6.2.2 Secondary Source 11
1.6.3 Sampling procedures 11
1.7. Organization of the Paper 12

II. REVIEW OF RELATED LITERATURE 13
2.1. Population pressure and Carrying Capacity: Global persrective 13
2.1.1. Human Population and Carrying Capacity 13
2.1.2. Livestock Population and Carrying Capacity 16
2.1.3. Ecological and Economic Aspects Livestock grazing land Carrying Capacity 17
2.2. Population Pressure and Carrying Capacity : The Case of Ethiopia 19
2.2.1. Population Size and Growth 19
2.2.2. Determinants of Population Growth 20
2.2.3. Population Density and Distribution 22
2.2.4. Food Production and Cultivated Land 24
2.2.5. The Level of Agricultural Technology in Ethiopia 27
2.3. Effects of Environmental Degradation on Agriculture 29
2.4. The Policy Environment in Ethiopia 32
2.4.1. The land Tenure System 32
2.4.2. Policies Governing Environment and Agriculture 34

III. THE STUDY AREA 40
3.1. Physical Characteristics 40

3.1.1. Location and Size 40
3.1.2. Topography 40
3.1.3. Geology, Soils and Vegetation 45
3.1.4. Climate 46
3.2. Demographic Characteristics 47
3.2.1. Population size and Density 47
3.2.2. Family size, Sex ratio and Age structure 48
3.3. Socio-cultural Aspects of the Study Area 49
3.3.1. Ethnicity and Religion 49
3.3.2. Marital status and Family composition 49
3.3.3. Literacy 50
3.3.4. Settlement Patterns 50

IV. LAND TENURE AND FARMING SYSTEM IN DEBAY TILATGIN Wereda 52
4.1. Land Tenure and Administration 52
4.2. Farm Size and Fragmentation 55
4.3. Farming System 58
4.3.1. Farm inputs 60
4.3.1.1. Labor supply and Composition 60
4.3.1.2. Oxen supply 61
4.3.2. Traditional farm inputs 62
4.3.3. Modern farm inputs 64

V THE STATE OF FOOD AND LIVESTOCK PRODUCTION IN THE STUDY AREA 67
5.1. Land use Patterns 67
5.2. Crop Production 68
5.2.1. Areal Coverage and Yield 68
5.2.2. Variation of Yield IN Agroecological zones 72
5.2.3. Yield and Land use Decision of Farmers 76
5.3. Factors Affecting Yield: Regression Analysis 78
5.3.1. Selection of Variables, Rationale for Selection and the hypothesis 79
5.3.2. Regression Analysis of the Aggregate Data 81
5.3.3. Regression Analysis at PA level 83
5.4. Livestock Production and Grazing Patterns 87

VI. PERCEPTION OF THE PEASANTRY TOWARDS RESOURCE DEGRADATION AND THE ROLE OF DAS 95
6.1. Perception of the Peasantry to Resource Degradation 95
6.1.1. Perception of the Peasantry to Farmland Degradation 96
6.1.2. Perception of the Peasantry to Deforestation 101
6.2 The Role of Extension Services in Resource Conservation and DA-Peasant Relationships 106

6.2.1. The Role and Position of DAs in the Extension Service 106
6.2.2. The Efforts of DAs and response of the Peasantry 108

VII. Population Support Capacity Of The Study Area 112
7.1. Consumption (Level of Gross Calorie Intake in the Study Area) 112
7.2. Population Support Capacity (PSC) Model 115
7.2.1. Cropland Sub-model 115
7.2.2. Livestock Sub-model 119

VIII SUMMARY FINDINGS, CONCLUSION, AND POLICY IMPLICATION OF THE STUDY 124
8.1. Summary Findings 124
8.2. Conclusion 134
8.3. Policy Implication of the Study 135
REFERENCE 137
Annexes 143

LIST OF TABLES

Table 1 Population and Household Size of Sample PAs 12
Table 2 Annual Population Projection Of Ethiopia by Rural and Urban area from 1978-2015 . 20
Table 3 Age Category of Sample PAs 48
Table 4 Land holding by Category 55
Table 5 Family Size and Land Holding 56
Table 6 Land Fragmentation and Number of Plots 57
Table 7 Ownership of Oxen by Sampled Households 61
Table 8 Patterns of Crop Rotation IN the Study Area 63
Table 9 Fertilizer application In Debay Tilat Gin Wereda for three Years 65
Table 10 Fertilizer application In Sampled PAs (1997) 65
Table 11 Summery of Methods applied to maintain Soil Fertility 66
Table 12 General Land use Pattern of the Study Area 67
Table 13 Cultivated land and Average yield of Crops in the Sampled PAs 69
Table 13a Area Coverage and amount of production of major Crops 71
Table 13b Areal Coverage and Yield of Crops in agroecological zones 72
Table 14 Variation of crop yield 75
Table 15 Areal Concentration of main crops in sampled PAs 77
Table 16 Relative Average Yield Index of Crops 78
Table 17 Summary of the Regression analysis for the Aggregate Data 83
Table 18 summery of the Regression analysis in Debate 84
Table 19 Summery of the Regression Analysis in Asendabo 84
Table 20 Summery of the Regression Analysis in Yebabat 85
Table 21 Summery of the Regression Analysis in Debre Iyesu 86
Table 22 Summery of the Regression Analysis in Nabra 87
Table 23 Summery of the Regression Analysis in Inekoy 87
Table 24 Number of animals owned by Sampled Households 88
Table 25 Summery of the view of the Peasantry to Pasture availability and Management 90
Table 26 Summery of Grazing Patterns In the Study Area 99
Table 27 Summary of farmers perception towards farmland degradation 99
Table 28 Farmers views on level of Erosion, farmland stoniness and decline of farmland productivity 99
Table 29 Major uses of Trees in Sampled PAs 101
Table 30 The views of the Peasantry about trees and forests 103
Table 31 Major causes of Deforestation 104
Table 32 Principal sources of fuelwood in the study area 105
Table 33 Major problems to plant trees 105
Table 34 The responses of the sampled household heads about the assistance they received . . 109
Table 35 Summary of the view of peasants on pasture land management and area closure . . . 110
Table 36 Gross Calorie Production from Food Crops in the Sampled PAs 113

Table 37 Annual Consumption of Meat and Milk/milk products ... 114
Table 38 Gross Calory yield form food crops, meat and milk in the sample PAs ... 114
Table 39 Size of net arable land in the Sampled PAs ... 116
Table 40 Annual Calorie requirement of an average family in the sampled PAs ... 117
Table 41 Land requirement of sampled households ... 117
Table 42 Population Support Capacity (PSC) of net arable land of Sampled PAs ... 118
Table 43 Balance between cropland and the requirement of sampled PAs ... 119
Table 44 Number of animals owned by Sampled households and its equivalent in TLU ... 120
Table 45 Number of TLUs in the Sampled PAs 120 ... 120
Table 46 Total Forage Supply by PAs (tones) ... 121
Table 47 Annual forage requirement By PAs ... 122
Table 48 The balance between forage requirement and available resources in the Sampled PAs ... 122

LIST OF FIGURES

Figure 1 Relative position of the study area ... 42
Figure 2 Relief map of the Study area ... 43
Figure 3 Location of Sampled PAs ... 44

List of Abbreviations

ADB	African Development Bank
CCI	Crop Concentration Index
CSA	Central Statistics Authority
CSO	Central Statistics Office
DA(s)	Development Agent (s)
ECA	Economic Commission for Africa
EHRS	Ethiopian Highlands Reclamation Study
ENI	Ethiopian Nutrition Institute
FAO	Food and Agriculture Organization
ILCA	International Livestock Center for Africa
ITCZ	Iter Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature
LUPRD	Land Use Planning and Regulatory Department
MOA	Ministry of Agriculture
ONCCP	Office of National Committee for Central Planning
PA(s)	Peasant Association (s)
PSC	Population Support Capacity
RAYI	Relative Average Yield Index
RRC	Relief and Rehabilitation Commission
TLU	Tropical Livestock Unit
UN	United Nations
UNDP	United Nations Development Program
GDP	Gross Domestic Product
FDRE	Federal Democratic Republic of Ethiopia

List of Amharic Words Appearing in the thesis

Belg	Small rainy season (April- May)
Birr	Ethiopian Currency
Gote	A small village in a peasant Association
Gotta	Grain store, made of mud
Guaro	Homestead
Gudguad	A hole prepared to store grain especially of barley
Arera	Butter milk
Dega	Agro-ecological zone ranging between 2400-3200 meters a.s.l.
Wurch	Agro-ecological zone ranging above 3200 meters a.s.l.
Kiremt	Rainy season (June- August)
Meher	Main harvest season
Gemed	Rope
Timad	Land holding that can be ploughed in a day with a pair of oxen
Terara	Hill

Abstract

The general objective of this study has been to investigate the relationship between the population ands resource base of Debay Tilatgin Wereda, East Gojjam. Specifically, this study was concerned with the assessment of food production, resource degradation and examination of peasant's perception towards their environment. The data for the study was obtained from the survey of 250 sampled households through questionnaire, group discussions, field observation and consultation of various documents and personal communication with concerned officials both at the Wereda and PA levels.

The methods of data analysis applied in this study are both descriptive and inferential statistics. Linear Regression Model has been applied to identify the major factors affecting yield of crops in the study area. Population Support Capacity (PSC) Model, in turn, has been used to assess the carrying capacity of the study area. The results are interpreted and presented in the form of tables.

Although the area is in high potential cereal zone, the analysis of the available data has paradoxically revealed that poor natural resource base as compared to the requirement of the present human and livestock population characterize the study area. The current agricultural density in the study area is about 3 persons per hectare. On the bases of household survey, the average cultivated land per farming household is about 1.5 ha (with an average household size of 6.4). The holding is fragmented indicating an average of four parcels for each household.

The fact that farming tools and production techniques are traditional best manifests the rudimentariness of farming technology in the study area. The application of farm inputs is very low with an average oxen possession of 1.8 per household. Fertilizer application too is very low and is limited to the lower Dega. All these aspects taken together accounts for the low yield per unit area, which characterizes the study area. This is best illustrated by average production per household, which is about 12 quintals of all crops with an average yield of 7.9 qt/ha.

The analysis of variation of yield using Coefficient of Variation (C.V) index has indicated that variation of yield between different crops is not high in the study area. The dominantly grown crops are wheat, barley, teff and pulses respectively. The analysis of Crop Concentration Index (CCI) and Relative Average Yield Index (RAYI) have indicated that peasants in the study area are not efficient in their land use decision. The regression analysis, on the other hand, has indicated that the major factors affecting yield are oxen possession, size of cultivated land, labor input, soil erosion, and stock density. All of them taken together have explaining about 79% of the variations in yield in the study area.

The PSC assessment has shown that the current level of agricultural technology, available arable land and forage resources are enough only for 78% and 49% of human and livestock population respectively. A surplus (about 20.3%) is observed in cropland requirement when allowing an anticipated 50% increment. The carrying Capacity of forage resources is at critical stage both at the present level of farming technology and at an anticipated 50% increment in yield. In general, there is an overall resource deficit in the study area indicating population pressure.

The effects of population pressure is manifested in the expansion of cultivation to ecologically fragile areas, deforestation, overgrazing and accelerated soil erosion resulting in subsequent decline of yield per unit area. The response of peasants for declining production and ever worsening resource degradation is not encouraging. The problem lies somewhere else and is related to policy issues such as security problems.

I. INTRODUCTION

1.1 Background

The relationship between population growth and socioeconomic development is one of the crucial issues of various discussions these days. Since the appearance of man on earth, the size of human population has been increasing regularly. The growth has become much more conspicuous after the introduction of agriculture. There are two general explanations for this: (a) It has reduced the risk of death by allowing human beings to settle in one place, and (b) since farming families attached high economic value to children they started to give more birth (Ehrlich, 1977).

The other important period that has accelerated population growth is the period between 1650-1850, a period where commercialization of agriculture, improvements in crops and farming techniques came into existence. During this period, population grew so rapidly that it began to threaten the resources available on earth. So, people started showing concerns about the earth's ability to support the growing population. Prior to that period the relationship between population and resources was imperfectly understood and has rarely been considered worth of an academic study (Hutchinson, 1969).

Concern about the earth's ability to support growing population on a sustainable basis has been widely discussed ever since the publication of Thomas Malthus's essay on population in 1878. He was the first person who expressed his concern about the imbalance between population growth and resources. He indicated that man could increase his subsistence (production of food) only arithmetically whereas his number tends to increase geometrically. Malthus concluded that population growth, if left unchecked will be beyond the growth in food production and ultimately the balance will be maintained through war, famine, pestilence, self-restraining, etc.

After Malthus, many writers began expressing their feelings and one of these persons was David Ricardo, who supported Malthus's idea and tried to answer the question of how the growth in food production trails after the growth in population. He argued by saying that it is because the unit of labor that is successfully added to fixed supply of land would lead to diminishing increments of output. Therefore, the increasing population will not be associated with the same rate of growth in food production.

Boserup (1965) has expressed contrary views to that of Malthus and Ricardo basing her argument in relation to agriculture. Simon (1987) too argued in relation to industrial societies with a view that more people contribute to the generation of new technologies. Boserup saw the introduction of new technologies that are impelled by the need to replace long fallow as population increased. She also viewed population growth as ultimately leading to cheaper transport, easier marketing and more specialization. This would lead to the growth of local towns and more interactions with the existing large stock of ideas and technologies, which in turn, would spark off new technologies and improvements, so that resources could be improved, substituted, or economized.

Although the debate for or against population growth is still on- going, it is, however, believed that the presence of too many people in an area without any change in the production system will end up in the degradation of resources which will finally lead to the decline in production. A rapid increment in population is expected to exert disproportionate pressure upon the natural environment. Very often, physical problems are the results of human intervention and are exacerbated by human factors which mainly include population pressure and farming practices, the land tenure system and the polices governing the environment and agriculture (Bounder, 1987; Campbell, 1991)

When we come to the Ethiopian condition, long ago, when there were relatively fewer people in the country, indigenous farming systems and technology enabled them to make a living without seriously depleting the natural resources base. In the past, environmental degradation occurred around settlements, where communities could always move to new land, which was abundant. It was a time when there was little need for conservation, the landscape was generously covered with trees, bushes and grasses, and a higher proportion of rain was percolating into the soil. Erosion was, therefore, held in check and fuel wood was abundant, easily obtained and cheap.

In the present century, however, population growth increased and new land is no longer easily available with the consequence being the shortening of the fallow period and the continuous cultivation of the land. This has, in turn, caused the ever increasing and perhaps irreversible environmental damage. Only a massive investment in environmental reclamation can reverse this process. The common peasant is unable to make this investment because he/she is too poor to forego the present for future income or to provide for their children (Abebe, 1994; Abi, 1995; Hoben, 1995).

The increasing scarcity of firewood has forced peasants to use cow-dung as a household fuel instead of using it as manure. Similarly, steeper hillsides have been cleared and denuded of vegetation. Cultivation and overgrazing have left the soils exposed to heavy rainstorms causing severe soil erosion, reducing the nutrients available to crops and letting water run freely into the streams and rivers. Increasing livestock pressure had led to overgrazing and the deterioration of the ever-shrinking pastureland. According to Stahl (1990), the densely settled regions of Wello, Gonder and Northern Shoa are on the frontier of serious degradation.

In Ethiopia, especially in the highlands, rapid population growth has already created critical land scarcity, a lower pasture and fuel wood resources per capita. A combination of rapid population growth, improper land use practices, technological stagnation and poverty have brought about environmental degradation, retarded agricultural growth and thus contributed to the decline in per capita income. Moreover agricultural production is highly weather dependent and fluctuates from time to time. For instance, at national level, in the peasant sector, production has fallen by 22.5 percent from 69.4 million quintals in 1979/80 to 53.8 million quintals in 1987/88 and the estimates of C.S.A. for the year 1994/95 was about 67.4 million quintals (CSO/CSA, 1987/1988, C.S.A. 1996).

High population densities, as indicated by many scholars in various disciplines, have accelerated deforestation and brought about shortage of fuelwood. The demand for fuelwood is increasingly replaced by animal dung and crop residue. This, in turn, has led to progressive deterioration in soil quality (Hurni, 1988, Daniel, 1990). The other scholar, (Wood, 1990), has estimated that these problems have probably reduced the nation's crop production capacity by about 10 to 20% below the potential. Put in a nutshell, population increase and growing land scarcity, shortening of fallow period and the relative stagnation of land use technology have aggravated agricultural problems. As a consequence of all these and other problems, food production at the national level has long failed to keep pace with population growth.

Deforestation and soil degradation have reached catastrophic levels in the country. Though controversial yet, it is believed that about 40 percent of the country was forested at the turn of the century (ONCCP, 1984). To date, the forest reserves of the country are estimated to be less than 3 percent, of which, about 100,000 hectares of forests are lost annually (World Bank, 1986). About one billion tons of topsoil is also believed to be eroded annually from Ethiopia (Lester et al, 1985). The depletion of forests, which do have a remarkable capacity of preserving the land from degradation, coupled with factors such as civil war, drought and misguided socioeconomic policies have placed the country in a position where its people fail to feed themselves.

As human and livestock populations increase, the cultivation of fragile /marginal lands would take a commonplace. This would, in turn, disable the basic natural resources (soil, wood and grass) to regenerate themselves. With little or no input in agriculture, crop yields decline and living standards fall. When climatic aberration such as drought sets in, it makes the already precarious conditions in rural areas worse. With little or no employment alternatives in non-agricultural sectors in rural areas and little or no cash savings or grain reserves, the rural population succumbs to hunger and confronts famine.

1.2. The Problem

Environmentally sustainable development is a global concern today. Countries are striving to follow environment friendly policies in their development endeavors. Such a strategy is heavily advocated in countries whose livelihood is entirely dependent on agriculture. Sustainability of agriculture is basically dependent upon well-managed environment. This issue deserves much more attention in traditional agrarian societies such as Ethiopia where rapid population growth and stagnant economy remained a norm than exception.

Needless to say, the main stay of the Ethiopian economy is agriculture. The nature of agricultural practice and concern for sustainability are points that must draw national attention. Though Ethiopia is relatively well endowed with natural resources (by African standards), its landscape shows a sign of degradation interpreted by many experts as an indicator of impending environmental crisis (IUCN, 1990:2-28, Hoben, 1995:1009). Propitious conditions for indigenous agriculture are concentrated in the highlands that are elevated above 1500 meters, which comprise 43 percent of the country. Here a combination of favorable rainfall and soils have fostered the development of a variety of farming systems that have supported major concentration of population and complex societies for several millennia.

Natural resources are the foundation of the economy. Small holder peasant agriculture is the dominant sector accounting for about 45 per cent of the GDP, 85 per cent of the exports and 80 per cent of the total employment (FDRE, 1997; Tesfaye, 1994). Renewable natural resources, i.e., land, water, forests and trees as well as other forms of biodiversity, which are sources of food, water, clothing and shelter have now deteriorated to a low level of productivity. In many parts of highland Ethiopia, the present consumption of wood is in excess of unaided natural sustainable production.

The burning of dung as fuel, instead of using it as a soil conditioner, is considered to cause a reduction in grain production by some 550,000 tones annually. In 1990, accelerated soil erosion caused a progressive annual loss in grain production by about 40, 000 tones, which unless arrested, will reach about 170,000 tones by 2010. Notwithstanding the role of livestock in the rural and national economy, some two million hectares of pastureland have been destroyed by soil erosion between 1985 and 1995. Land degradation is estimated to have resulted in loss of livestock production in 1990 equivalent to 1.1 million Tropical Livestock's Units (TLUs), and, unless arrested, it will rise to 2.0 million or to 10 per cent of the current national cattle herd by 2010 (FDRE, 1997:1).

A greater proportion of Northern Ethiopia has a dissected and slopping terrain, fragile soils and is subject to highly erosive rainstorms during the main agricultural season. The region has little natural tree cover; its soils are low in organic matter content and are subjected to severe soil erosion. Mesfin (1991) has succinctly described this aspect by stating that flux, crisis and calamity rather than harmonious balance have characterized the relationship between man and nature in northern Ethiopia.

In a subsistence economy, it is obvious that human beings depend heavily on the exploitation of natural resources for the production of basic needs such as food, fiber, energy, building materials and transport. In these endeavors, the basic natural resource is land itself, which is farmed, grazed and logged. The plough-based mixed farming system contributes to soil erosion through fine tillage, mono-cropping and lack of vegetative cover at times of heavy rains. All these problems are typical of the study area under consideration.

In the study area, the terrain is steep, agricultural land is very scarce, there is little or no vegetative cover and grazing land is scarce. On the other hand, there is a high density of human and livestock population, which brought about a scramble for farm and grazing lands. The absence of enough fodder is frequently forcing peasants to feed their existing cattle population with crop residue and/or let the cattle on the existing grazing land and land cover. The acute shortage of forest products is also causing shortages in fuel wood, which again persuades the entire population to rely on animal dung and crop residues.

Since there is no enough grazing land and fodder in the area, the livestock population is undernourished. As a result, the physical strength of farm animals, especially of oxen, is weak. This problem coupled with the ruggedness of the terrain has created hardships to the peasant population to eke a living out of the existing meager and fragmented farmland. The existing surface configuration, the use of animal dung and crop residues for fuelwood and animal feed, which would otherwise have been used to maintain the fertility of the soil, led to the deterioration of the environment beyond its capacity to support the existing human and livestock population. Moreover, because of the size of farming population land is fragmented, fallow period is very short and the economic strength of farmers to use modern agricultural inputs is limited.

The paradox lies in the fact that research and rehabilitation attempts are usually directed to the already devastated areas, ignoring regions or localities vividly leading to degradation till the problem sets in. All these and related issues have stimulated the author to undertake this study. Attempts will generally be made to analyze the population and resource base of the Woreda and to find possible ways of intervention to combat the problems.

1.3. Objectives of the study

The general objective of this study is to show the direct consequences of population pressure on resources, especially on issues related to the sustainability of the environment and food production. The specific objectives include: -

I) To show the current level of food production in relation to the size of the population of the Woreda,

II) To estimate the human and livestock carrying capacity of the area under consideration,

III) To assess the perception and responses of the local population to environmental degradation, especially to soil erosion and vegetation loss

1.4. Significance of the Study

This study is designed with the expectation that its findings could serve the following organizations: -

1. The Amhara Regional Bureaus of Agricultural Development and Planning and Economic Development could benefit from this study and can use the findings to implement their polices in the Woreda under study in particular and to rural areas of similar demographic and environmental conditions in general.
2. The study may give general information about the natural resource base and population characteristics of the Woreda. By so doing, the study will render basic data bases for project proposals, relief and rehabilitation efforts and other development endeavors and,
3. The findings of the study would give concerned authorities some possible ways of combating environmental degradation and increasing agricultural production.

1.5. Scope and Limitations of the Study

Though there are a number of factors related to population and resource base of an area, it is very difficult to analyze all of them in this piece of work. This study will, hence, have its own specific scope. It will be confined to the analysis of issues that revolve around the formulated objectives. Thus, the scope and limitations of the study will appear as follows:

1. Geographically, the study will be limited to a specific Woreda. The findings of the study could possibly be inferred to similar Weredas in Region Three. Due to time and financial constraints, the author of this paper is forced to select only six PAs and 250 sample households, which would have some limitations in making inference to the general population.

2. In order to estimate human and livestock population carrying capacity one has to obtain the net calorie yield from a certain unit of cropland. Yield data can be derived from estimates based on land suitability assessment, which is expensive, multi disciplinary and

time-consuming. As a result, yield data for this particular study is obtained from household and field surveys.

3. The respondents are generally very suspicious and highly reluctant to give actual figures in connection to the amount of agricultural products and number of livestock. For one reason or another, respondents seem to inflate or deflate the yield of their farmland. This may cause elements of subjectivity in the study.

Despite the above-stated constraints, the author has taken the maximum possible care to keep the comprehensiveness of the study.

1.6. Research Design and Methodology

1.6.1 Working Assumptions and Methods of Analysis

On the basis of the objectives of the study the following working hypotheses are formulated

1. Crop yield per unit area is significantly affected by the amount of inputs, demographic and institutional settings of the Wereda. This will be tested using multiple regression analysis (for the selection and justification of variables see the part dealing on the regression analysis).
2. The productivity of an agricultural land varies from area to area in the Woreda. Coefficient of Variation will be used to test whether there are agricultural land productivity variations between Peasant Associations.
3. Owing to their long stayed traditional wisdom, farmers are expected to be efficient in their land use decisions. Examining areal concentration and relative average yield of crops is designed to test this.
4. The current size of human and livestock population is beyond the carrying capacity of the resource (land) available at the current level of input and land use practices. Human and livestock carrying capacity will be tested by the assessment of population support

capacity of the study area. To achieve this, "cropland sub Model" and "livestock grazing sub model" (for details see Annexes II and III) will be employed.

5. The response of the local population to environmental degradation especially to soil erosion and vegetation loss is very low. The low concern of the local population to natural resources management is related to tenure problems i.e. land insecurity. The local people simply maximize their benefits before they are dispossessed. This will be tested by descriptive methods.
6. There are severe soil erosion problems and intensified deforestation in the Woreda. This will be tested by descriptive techniques on the basis of the interviews and field observation.

1.6.2 Sources of data

Data for the study are obtained both from primary and secondary sources. The primary data is generated through questionnaire, field observation and personal conversation with local people and development agents.

1.6.2.1. Primary Sources

Household head questionnaire was designed to generate data on population characteristics, land holding, land use patterns, crop production and consumption patterns in six different areas (PAs) of the study area. Ten enumerators and the author filled in the questionnaire. The enumerators were selected on the basis of their educational standards, knowledge of the locality and familiarity with the habits and customs of the local population.

Sufficient orientation was given to the interviewers for three days before they were sent to interview the randomly selected respondents. Informal interviews and group discussions were conducted with elderly peasants and community leaders to generate data on population and land dynamics as well as on migration and informal activities.

1.6.2.2. Secondary Sources

The Secondary data sources include research papers, publications, unpublished materials and other related literature. These are obtained from governmental and/or non-governmental organizations, which include official documents and records of the Woreda office of MOA and Peasant Associations.

1.6.3. Sampling Procedure

Stratified sampling method has been used to determine Sample PAs. Since the size of the human and livestock population cannot be uniform in all Peasant Associations in the Woreda, this method is believed to be more appropriate. The household head questionnaire was administered by taking 250 household heads (3.1%) in 6 Peasant Associations, which comes to 30 percent of the total number of PAs. The six Peasant Associations have been selected based on their agro-climatic characteristics and altitude.

As it is defined by MOA/UNDP/FAO (1987), the agroecological zones of the study area range from lower Dega to Wurch. The bulk of the population is concentrated in the lower Dega (2400-2600 meters a.s.l.) and the middle Dega (2600-2900 meters a.s.l) agroecological zones. As a result, two PAs each have been picked from both and one has been taken from upper Dega zone (2900-3200 meters a.s.l). The remaining one has been taken from Wurch (3200-4000 meters a.s.l) zone. The number of households that were taken from each sample PAs was dependent on the population size of the PAs.

Accordingly, Nabra and Inekoy PAs were selected from upper Dega and Wurch Dega zones respectively. From the Middle Dega Zone, Debre Iyesus and Yebabat were selected. The remaining two PAs, namely Asendabo and Debate, were selected from the Lower Dega Zone.

Sampled households were randomly selected from membership lists of sampled PAs. As a result there were no landless (for details refer to Table 1).

Table 1 Population size and number of households of the sample PAs

Name the PA	Population Size	Household Size	Number of Sampled HHs.	Percentage of HHs.*
Debate	5520	1226	38	3.1
Asendabo	5686	1263	39	3.1
Yebabat	5356	1407	44	3.1
Debre Iyesus	9829	2184	69	3.2
Nabra	2879	640	20	3.1
Inekoy	5856	1301	40	3.1
Total/average	35126	8021	250	3.1

Source: Tabulated by the author based on the household survey undertaken in 1998

* Households

1.7. Organization of the Study

This paper is organized in to eight parts. The first part of the paper deals with background, the problem and objective of the study, research design and sampling procedures. Review of related literature is presented in the second part. The third part is devoted to the brief description of the study area. Land tenure and farming system of the study area is discussed in the fourth part of the paper. The states of food and livestock production, Perception of the peasantry to resource degradation and the role of DAs in resource conservation are analyzed in part five and six respectively. Part seven deals with thee analysis of the population supporting capacity of the study area. The last part of the study is about summary findings, conclusion and policy implication of the study.

II. REVIEW OF RELATED LITERTURE

2.1. Population pressure and Carrying Capacity: Global Perspective

2.1.1. Human Population and Carrying Capacity

The concept of carrying capacity is familiar to biologists and wild life managers that are concerned in assessing the ability of ecosystems to support animal life. It is defined, for a particular region, as the maximum population of a given species that can be supported indefinitely, allowing for seasonal and random changes, without degradation of the natural resource base that would diminish this maximum population in the future. With some modifications, carrying capacity can also be used as a measure of a region's ability to support human population (Kirchner, 1985). As it appears, carrying capacity of a region can in simple terms be defined as a maximum ratio value of population to food production (Muscat, 1985:6).

A renewable resource base cannot sustain population beyond its carrying capacity indefinitely for it will suffer a reduction in its inherent productivity as a result of being overexploited. Managing these resources is difficult because the decline in the carrying capacity is usually evident only some time after the damage has been done and because in the short term the productivity of the resource will actually increase (Kessler and Laban, 1994; Kirchner, 1985).

To date, as elaborated by Kirchner et al (1984), little effort has been spent on defining and measuring the human carrying capacity of natural systems. Applying the carrying capacity concept to human population is also complicated by several factors. One of these factors indicates that per capita natural resource's consumption by humans is often extremely variable whether within the same society or among different societies competing for the same natural resource. Another complicating factor is people's ability to control the natural resources on which they depend.

Unlike other species, human beings can expand the carrying capacity of their environment by using technological innovation and trade (Simon, 1987; Boserup 1965; Kahn, 1982). However, human population can also diminish the carrying capacity of a region through various forms of environmental mismanagement leading to long-term natural resource's degradation. Such human-induced degradation often results from various short-term human pressure, which occur largely in response to rapid population growth. People pressing against their carrying capacities are likely to have a low standard of living and slim prospects for substantial socioeconomic improvement.

When people press relentlessly against the limits of their local or national carrying capacity, the development process can be crippled. Economic development depends upon the successful reinvestment of surplus resources. When population increases to a level of the carrying capacity of a region, the whole production would be devoted to immediate consumption needs. Thus, surplus will not be available for investment in the future. Since population size and per capita consumption are ultimately constrained by the availability of natural resources no population can be supported sustainablly over and above the carrying capacity provided by the available resources. In most cases, resource degradation is observed because it is much easier to allow population to grow than to force it to contract.

Through technological change, human beings can increase the productivity of natural resources, thereby expanding the carrying capacity of a region. Technology can increase the carrying capacity of a given region in two ways. Firstly, it can allow people to substitute, albeit to a limited extent, a natural resource that is abundant for the one that is scarce. Secondly, technology can increase the efficiency of conversion of natural resources into economic goods thereby allowing people to squeeze more economic value from a given natural resource base.

While technological advances can expand the carrying capacity of a region to a considerable extent, they ultimately reach a point of diminishing returns and fail short of supporting an unlimited population growth possible (Kirchner et al, 1985). For example, at high application levels, fertilizers exhibit sharply declining marginal returns and cause serious environmental complications. At some point, increased fertilizer use will result in nutrient "poisoning" of crops that ultimately brings about an actual drop in yields.

Moreover, technology cannot increase the total quality of natural resources that are available on this planet. It can neither create more raw materials nor increases the efficiency of conversion of these materials into economic goods beyond the constraints imposed by the physical laws of thermodynamics. Therefore, no technological advance can eliminate natural resource constraints entirely.

Another means of pushing back natural resource constraints is through trade. Trade can expand local carrying capacity by exchanging resources that are locally plentiful for those that are scarce. For example, countries in the Persian Gulf can support population far in excess of their local agricultural carrying capacity by trading oil for food. Trade can, however, expand local carrying capacity only under certain conditions. The resource that is scarce in one region must be available in surplus elsewhere and simultaneously the regions' plentiful resources must also be in high demand elsewhere. Trade cannot alleviate global scarcity, as there is no other "globe" nearby with which to trade. The difference in value between the exported and imported goods must be enough to pay the costs of transportation both ways, which for small, remote, or landlocked countries can be enormous.

It should be stressed that rapid population growth is by no means the only threat to the natural environment. According to Repetto and Holmes (1983), to view the problems of environmental deterioration in developing countries as a consequence of growing population and rising subsistence requirements is to oversimplify matters. The above-mentioned scholars argue that if this was true, very little environmental degradation would have been expected in low population-growth industrialized countries. Policies governing certain socioeconomic systems are also important factors to influence the resource base of a region.

2.1.2. Livestock population and Carrying Capacity

The preeminent management problem on communal African rangeland i.e. the control of excessive livestock number has been perceived for some considerable time both by the public at large and by many rangeland professionals. The scientific basis for this concern has been the concept of grazing land carrying capacity defined and measured according to the assumptions about the impact of stocking and plant successions.

The conventional notion of carrying capacity in range management rests on theories of plant succession defined as the orderly and directional processes whereby one association or community of plant species replaces another (Behinke and Scoones, 1993:2). Both succession theory and range management practice assume that in a single, persistent and characteristic vegetation, the climax would dominate a particular site, depending on the soil and climate of that site. If this climax vegetation is disturbed, the vegetation could return through a succession sequence to climax. An obvious example of a disturbance and subsequent succession back to climax is provided by the clearing of a forest area for agriculture, the abandonment of the area and the eventual reestablishment of forest through a predictable sequence of intermediate vegetation stages.

According to Behinke and Scoones (1993), range management adapted these ideas to grazing systems. It is assumed that the effects of grazing on vegetation paralleled the effects of clearing fields for crop agriculture; that is, grazing will push the succession sequence back to some form of subclimax. The task for the stockowners is to balance grazing pressure against the natural regenerative power of the plants thereby maintaining a stable sub-climax, which yields a steady and profitable flow of animal products. The concept of carrying capacity is important because it marks the stocking density at which this balance could be achieved.

Pushed beyond the threshold carrying capacity, the balance between grazing pressure and the inherent regenerative powers of the range is destroyed and its progressively deteriorates. This deterioration is reflected in a process of regression back through the succession sequence. In practical terms, experienced range managers have found out that they were often able to estimate range condition by referring to plant species, which were particularly sensitive to the effects of grazing. The indicator species either increased, decreased or invaded a range depending on the intensity of grazing pressure thereby proving a convenient measure of the extent to which grazing had altered and is continuing to alter the climax vegetation. This botanical approach to the assessment of range deterioration was defended on the grounds that vegetation change preceded both reduced livestock's production and increased levels of soil loss serving as a valuable 'early warning' of the declines in other parts of the range land system [Behnke, Scoones and Kerven (1993:2-3)].

2.1.3. Ecological and Economic Aspects of grazing land carrying capacity.

Caughley (1979), and later, Bell (1985) have expressed their views about the relationship between plant herbivore and grazing population at alternative stocking densities. As the animal population increases, the edible plant biomass declines. In undisturbed grazing system, the increase in animal number will eventually be checked by the declining availability of natural forage. This will occur when the production of forage equals the rate of its consumption by animals and when the livestock population ceases to grow because limited feed supplies produce death rates equal to birth rates. At this point there is no surplus production either of individuals or biomass.

This point of equilibrium routinely designated as "K" in ecological literature is termed as ecological carrying capacity. Bell (1985) has speculated that at ecological carrying capacity livestock may be plentiful but they will not be in good condition; neither will the vegetation be dense nor will the plant communities necessarily be composed of the same species as they would be in the absence of animals.

If range managers want denser vegetation and healthier animals then they must maintain fewer animals. This can be done either by hunting in the case of wild herbivores, or by culling in the case of domestic stock. However, culling may not be accepted in the case of owners for the very reason that the number of livestock is taken as a measure of status.

If carrying capacity must be defined relative to economic objectives, there would appear to be different stocking densities associated with and appropriate to different forms of production. If there is consumer demand for high-grade meat, some ranchers may find it profitable to sell relatively few animals in excellent condition raised on a relatively abundant forage supply. These ranchers will need to hold their stocking densities well below economic carrying capacity.

On the other hand, there is the case of subsistence oriented production as well as other forms of livestock husbandry which seek to harvest animal output in the form of live animal products such as milk, blood, traction power and transport. Offtake for these producers does not require animal slaughter and when they can profitably exploit a large standing crop of animals (Payne, 1990). At the same cost, in terms of output, these producers may be capable of maintaining high levels of aggregate output at stocking densities approaching ecological carrying capacity.

The erratic and variable rainfall in many areas poses a further fundamental challenge to standard conceptions of carrying capacity. Any notion of carrying capacity, be it ecological or economic, is predicated on the notion that herbivore numbers are controlled through the availability of forage that are controlled by the number of animals as a pattern of negative feedback, which eventually produces a stable equilibrium between animal and plant population.

This pattern of interaction between plants and herbivores presumes, in turn, that conditions for plant growth are relatively constant. If physical factors, such as rainfall and temperature, fluctuate widely it is likely that these non-biological variables will have a greater impact on plant growth than marginal changes in grazing pressure caused by different stocking densities. During bad seasons, therefore, livestock population will be depressed to the point where the impact of their grazing on the vegetation is minimal. In this condition it is the availability of rainfall and not forage that acts as an ultimate factor liming population growth (Behnke and Scoones, 1993).

If disturbances are intermittent, it may be useful to analyze a grazing system as if it were at equilibrium and to treat outside perturbations as 'noise' which confuses and obscures an underlying pattern. Noisy or event-driven grazing systems require a different approach to and understanding of carrying capacity. Ellis and Swift (1988) illustrated plant-livestock interaction under the influence of frequent drought perturbation in a fluctuating climate. Single year drought constitutes a minor and very temporary set back for the animal population and a some what greater but nonetheless temporary set back for the plants, while multi year droughts precipitate population crashes of both plants and animals.

In such a system, livestock population may decline because of lack of fodder, which becomes scarce, as there is too little rain rather than too many animals. Moreover, when major droughts are frequent enough and herd recovery is low livestock number would be given little or no opportunity to approach ecological carrying capacity. In sum, Ellis and Swift (1988) have concluded that the condition of this grazing system at any particular time is determined more by the chance occurrence of non-biological events than by interaction between the biological components of the system itself.

2.2. Population Pressure and Carrying Capacity: The Case of Ethiopia.

2.2.1.Population size and Growth

Currently the Ethiopian population is growing at the rate of 3.2 percent per annum. Such a growth rate is unaffordable when compared to the present state of food production in the country. The population is rapidly increasing and is doubling itself in a very short period of time. Based on the 1994 census, C.S.A.'s projection indicates that the population would double itself by the year 2105(see Table 2 below).

(a) The level of Fertility

Fertility, as one of the major components of population change, results in an increase in the total population of a given country. It is a dynamic element that determines the demographic characteristics of the population. The level of fertility in Ethiopia is considered as very high. The estimates from C.S.A. do show us that the total fertility rate, i.e., the number of children a woman would bear during her reproductive time increased significantly from 5.2 children per woman in 1970 to 7.7 in 1990. The trends in fertility show continuous increments in rural areas than urban areas. It was 5.8 children per woman in 1970 and 8.1 and 8.2 in 1984 and 1990 respectively. As opposed to rural areas, in urban areas it was 4.7, 6.3 and 5.7 in 1970, 1984 and 1994 respectively.

In general, all the figures show that fertility is very high and the present rapid population growth will continue for decades to come. So, there is no doubt that this high level of fertility will affect the socioeconomic as well as environmental situation of the country and some even argue that because of continuing rises in fertility the country may experience a baby boom in the coming few years.

(b) The level of Morality

Mortality decreases the total size of the population of a given country. The three important indicators of the levels of mortality are crude death rate, infant mortality rate and life expectancy at birth. Between the period 1970 and 1990, significant improvements in the level of mortality have been observed in Ethiopia. Crude death rate has declined from 20 deaths per thousand population in 1970 to 16.4 in 1990 while infant mortality rate from 153 deaths per thousand live births in 1970 to 110 in 1990. Similarly, life expectancy at birth increased from 44 years in 1970 to about 53 in 1990 (C.S.O 1994).

Just like fertility, there is also a high difference in a mortality rate among the rural people. It varies between an infant mortality rate of 12 per 100 live births in Borena Zone of Oromia region to 195 in Bench Maji Zone of Southern Ethiopia. Life expectancy at birth varies between 38.1

Table 2. Annual Population Projection of Ethiopia by Rural and Urban Areas from 1978-2015 (in thousands)

Area	Year							
	1978	1984	1994	2000	2005	2010	2015	2020
Rural	24016.1	36825.8	46716.1	55002.2	63415.7	72845.6	82514.6	91995.0
Urban	3096.3	4210.1	8222.0	11753.6	15952.8	21400.4	29069.2	39530.1
Total	27112.4	41035.9	54938.1	66755.8	79368.5	94246.0	111583.8	131485.1

Source: C.S.A. Statistical Abstract 1978, 1984, and 1995.

As shown in the above table, the rural population has doubled itself in almost 26 years. According to the 1994 census, the rural population is estimated to reach 55 million by the year 2000 showing an increase of almost 1.4 million people each year on the average. At the same time, the C.S.A. has projected the rural population to reach 72.8 million by 2010. Even assuming that fertility would decline, the population is expected to reach about 92 million by the year 2020. Moreover, under the conditions where the share of the rural population is expected to decline in the future due to urbanization, the proportion will still become significant for decades to come. This indicates us that the country's dependency on the agricultural sector will continue for the unforeseeable future.

2.2.2. Determinants of Population Growth

Generally, the growth of population is determined by the conditions of fertility, mortality and migration. The source of population growth is the interplay between a crude birth rate, which is the product of fertility, a crude death rate which is the product of mortality and crude migration rate, which is the product of mobility (WB 1994). The difference among the first two components gives us the natural increase of population and if a crude migration rate is added to the natural increase, it will give us the rate of population growth.

years in Bench Maji Zone and 59.7 in Borena Zone. In contrast to fertility, the trend in mortality for both areas (urban and rural), especially the infant mortality rate is declining. However, since the decline has not been accompanied by rapid fall in a fertility rate, a higher growth rate is observed in the country (CSO, 1995).

(c) The Level of migration

Migration is another important demographic factor that affects the magnitude and directions of population size. It either increases or decreases the size of population depending on whether net migration, which is a difference between in-migration and out-migration, is positive or negative. Data on migration is not sufficiently available in Ethiopia. The available data has shown that there were 1,483,029 migrants in to the Amhara region, about 2,598,645 to Oromia, 1,011,986 to Southern Ethiopia and 551,660 migrants to Tigray regions (C.S.A. 1995). So, one can deduce from the figures that migration is important in influencing the distribution of population in Ethiopia.

Migration, in addition to changing the distribution of population, can also influence the use of resources in a region. Since the movement of people is usually from low potential to high potential regions, it results in concentration of people in few areas creating pressure on the resources available in that particular area. Therefore, all the above factors determine population growth and the interplay among them in Ethiopia is the cause for high population growth.

2.2.3. Population Density and Distribution.

The settlement pattern of Ethiopian population in general and the rural population in particular is uneven. This is to say that a high concentration or cluster of population is found in some areas while in other areas population is found to be sparser. When we consider the distribution of population based on altitudinal difference, about 50 percent of the Ethiopian population lives at an altitude of 2200 meters or above, 11 percent live at altitudes of 1400 meters and the remaining

40 percent live between 1400 and 2200 meters (Assefa, 1994). This shows that there is a high concentration of people in the highlands, i.e., about 80 percent of the total population reside in only 37 percent of the total land areas.

The lowlands, which account for about 63 percent of the total land area of the country, are occupied by only 20 percent of the total population. This testifies the facts that certain areas are densely populated while others are sparse. The highlands are definitely 'over-populated' while the lowlands are 'under-populated'. There is also a regional difference in population density. It ranges from 6.97 persons/km^2 in Gambella Region to 5281.85 in Addis Ababa. The variation is more significant when we go down and compare the densities at the Zonal and Woreda levels. It ranges between 10-20 persons per squire kilometer in Eastern highland Weredas to 500-800 persons in the Inset growing areas (Taddese, 1989).

The reason for the differences in the spatial distribution of populations could be ecological factors like soil, climate, rainfall, availability of water and disease pattern (i.e., availability of disease such as malaria, rinderpest, tsetse fly etc.). Historical and development factor such as patterns of trade, agricultural development, communication and the like could as well act as important factors (WB, 1994). Whatever the cause may be, population pressure will no doubt result in over exploitation of resources in countries like Ethiopia, where technology is at the lowest level. This excessive exploitation of resources would consequently result in reducing the capacity of resources available to sustain life. This is much more serious in densely populated areas, where the pressure already is a serious one with the condition being aggravated by high fertility rate. This has a negative repercussion on land stock mainly because more and more people are being added to the constant supply of land.

As population grows rapidly, the pressure on land will increase and fallow period will be reduced. In most developing countries, since the land is not treated with biological and chemical inputs, the soil will be depleted. Another consequence of population pressure is its result in migration. People, as a result of high population pressure, move to some other places where they can sustain their life. As indicated by Seyoum (1991), people usually move from environments of declining carrying capacity to those that are perceived to be relatively intact and therefore offering good survival possibilities. Historical evidence shows that there used to be massive migration of peasants from such areas like Wello, Gonder and Gojjam to the Southwest and Eastern parts of the country to work as daily laborers. The push factor as such would be the exhaustion and fragmentation of the land caused by population pressure.

Population pressure is also believed to cause the use of marginal lands for farming. Vertisols and steep lands which were previously used for perennial crops and fuel productions are cultivated in areas of heavy population pressure (Tegegn, 1995). However, using these areas for farming without proper technology will cause severe soil degradation in which the effect will be observed by low yield in production.

2.2.4. Food Production and Cultivated land

Declining per capita production, low caloric consumption and increasing food insecurity and resource exploitations are the likely consequences of population pressure. In an African context in general and in Ethiopia in particular, the growth in food production has failed to keep pace with population growth. In Sub-Saharan Africa, for example, the growth of per capita food production is 2% while the population is growing at 3% per annum (Abbi, 1995:68); in Ethiopia, however, the former is less than 2% while the latter more than 3.2% per annum (Tegegn, 1995:29).

Empirical evidences on Ethiopian agriculture and population growth do show us that there is a wide gap between population growth and the corresponding growth in food production. As elaborated by Abbi (1995:70-71), although the arable land increased from 14 million hectares in 1981 to 15 million hectares in 1992 (might be due to encroaching the closed forests and the grazing lands, expansion of potentially cultivable lands, marginal lands, watersheds, and reserves), the growth of rural population from 33 million in 1981 to 44 million in 1992 was much greater than the proportionate increase in arable land. This has resulted in a generally declining per capita agricultural production and food consumption per head that indicates the existence of food shortages in the country.

According to Tegegn (1995: 23-26), Ethiopia's currently cultivable land is 30.2 million hectares (or 27% of the total land). Of this, the already cultivated land is only 26.6 million ha (or 24% of the total land) that includes land under fallow, cropped land, and grazing land. Vertisols and steep lands, which are classified as potentially cultivable land, together account for 11% of the total land. Such types of areas, however, require special management and intensive conservation measures if we opt to use them for agricultural purposes.

It is argued that a combination of factors have created the present problem of environmental degradation and declining agriculture, the most important of which are population pressure and the present traditional farming practices. Ethiopian agriculture is, hence, confronted with a challenging task of supplying food requirements for the growing population and also to meet its expected contribution to the Ethiopian economy. The expansion of the agricultural land through the application of modern technology is proposed as the way out to this problem.

The expansion of agriculture in to the currently uncultivated but potentially cultivable land seems to be practically possible. According to Tegegn (1995:25), it requires the systematic use and management of the land as well as the application of intensive conservation measures as the cultivated land expands to areas with heavy black soils and steep lands. Srivstavo and Alderman (1993:47) have also argued that it is even possible to expand the agricultural land through extensive cultivation of marginal lands, pastures, water shades and reserves. Reducing fallow

periods and practicing the annual cropping system as opposed to production of perennial and root crops that takes long periods to give yields is the other method that is suggested.

The above measures, however, require initially high capital investment, which is hardly possible for countries like Ethiopia. Moreover, the majority of the measures in one way or another lead to deforestation, increasing soil erosion, reduction of the extent of permanent ground cover (disappearance of grass lands), loss of soil fertility and bio-diversity. Thus, care must be taken in expanding the agricultural land size and the cost-benefit analysis must be carried out before the expansion decision is met.

The growing population demand for food usually leads to more intensive use of land by using modern inputs (such as improved seeds, fertilizers, insecticides, and herbicides), applying improved soil and water management techniques and using irrigation water very effectively. The research undertaken on the impact of water on different varieties of maize have come out with the following findings [Redd and Kidane adopted by Tegegn (1995:35-36)]:

(a) With the conservation of water resources, maize yields, on the average, can increase by 51.2%.

(b) By using improved seeds, fertilizers, and water management techniques, crop yields in dry land can increase at least by 100%.

(c) By using fertilizers alone, crop yields in dry land areas can increase significantly.

An agricultural intensification that is achieved through the use of commercial fertilizers has a negative impact on agricultural output and natural resource conservation in the long run. Instead, what is important and trustworthy is to expand agricultural land through the introduction of irrigation schemes with which Ethiopia has a high potential (only 4.6 % of the potential is so far utilized). Besides, the increased use of manure, animal dung and crop residues as fertilizers, cultivating leguminous crops, cover crops, and perennial (tree) crops that will enrich the soil are also recommended (Ibid. 995:36). Relying on the time-tested techniques such as inter-cropping, multiple cropping, bunding, grass strips, terracing practices can bring about a greater agricultural output that will meet immediate future food requirements of the growing population.

2.2.5. The level of Agricultural Technology in Ethiopia

Because of modern farming techniques, artificial fertilizer, High Yielding Varieties (HYVs), pest control and agricultural research activities, the world's agricultural production has shown dramatic increases in output during the last 50 years. Such a growth has, however, been not observed in the case of Ethiopian agriculture. Although the great majority of the population earns its living from the sector, the performance of agriculture was and is so poor that it cannot provide the population with adequate food. The reason is partly related to the poor state of agricultural technology in the country.

Since modern inputs have not been practiced, the small farmers' agricultural production has not shown the expected increase in output. The common response to increasing population in rural Ethiopia has so far been to expand the cultivated land into marginal areas, without being accompanied with efficient technology. As a result it failed to yield better output. Agricultural tools that are used to produce agricultural output are rudimentary and had remained the same for millennia. Moreover, agricultural inputs that are considered to increase production, if properly used, are not much applied in the country. Fertilization of soil is inadequate and very little is done to control pests. Irrigation is not widely used, due to this; agricultural practices are dominantly rain-fed. An appraisal on the level of utilization of agricultural inputs will be given hereunder.

1. Improved seeds

The use of improved seeds is one of the most important factors that could raise agricultural production. However, the use of improved seed varieties by small holder of Ethiopia is very small. As indicated in the C.S.A. reports, in 1994/95 out of the total cultivated land, which was 7687.84 thousand ha, improved seed was applied only to 66.20 thousand ha or 0.86 percent of the total land under crops. The figure had been 0.62 per cent in 1991/92 and 0.90 per cent in 1990/91. All the figures indicate that peasant agriculture in Ethiopia is inherently tied to the use of traditional seeds rather than improved ones .The latter are assumed to adapt to various growing conditions, give high yield and resist diseases. Improved seeds are not sufficiently applied because of the high cost involved in obtaining it and less availability (C.S.A. 1996).

2. Irrigation

Irrigation is another important input that could increase agricultural output. When it comes to Ethiopia, its contribution is negligible. Out of the total potentially irrigable land, i.e. 3,495,795 ha, only 161,010 ha (4.6 percent) is irrigated (Tegegne, 1995:35). The record of C.S.A for the harvest year of 1990/91indicates that the irrigated land for that particular year was only 53.62 thousand ha (or 0.99% of the total cultivated land). The irrigated land has, however, increased to 71.23 thousand ha in 1994/95 (0.93 per cent of the total land cultivated). This indicates that the use of irrigation for farming is very low. Put differently farmers are dependent upon rain-fed agriculture.

3. Pesticides

The use of chemicals and biological controls against diseases and pests in Ethiopia is still very low. Of the total 5410.30 thousand hectares of cultivated land in 1990/91, pesticides was applied on only 213.37 (4% of the total) thousand hectares of farmland and increased to 345.93 (6.5%) thousand ha in 1991/92 and 562.79 (7.3%) thousand ha in 1994/95 (C.S.A. 1996)

4. Fertilizer

Fertilizer is one of the very important agricultural inputs that are used to facilitate the growth of crops and increase productivity. According to C.S.O., about 1844.96 (34.8%), 1771.51 (32.3%) and 2129.79 (27.7%) thousand hectares of land was assisted by fertilized in 1990/91, 1991/92 and 1994/95 respectively.

Besides, the contribution of agricultural research and extension services has been limited due to policy, institutional, technical and other socioeconomic constraints. Therefore, the level of agricultural technology in Ethiopia is at its lowest level. This condition, together with rapid population growth, keeps the sector unable to respond to increasing demand for food.

2.3. Effects of Environmental degradation on agriculture.

Most of the countries of the Horn of Africa have recently suffered natural as well as man made disasters and Ethiopia is no exception. In addition to drought and famine, the country has also been ravaged by war, leaving few resources available to deal with environmental problems that are endemic to the region. An acceptable working definition of degradation is the decreasing of biological productivity expected of a given area of land. The most important manifestation of environmental degradation is desertification. Desertification takes place when desert conditions appear where they did not appear before and yield decreases progressively (Abebe, 1994:173).

The term ' desertification' has been controversial until recently. This, of course, is not a simple semantic problem, but is concerned with theoretical and methodological explanations. Desertification is understood as a process of ecological degradation in arid, semi-arid, and sub-humid lands where which the productivity of the land is lost or substantially diminished; grazing land ceases to produce palatable pasture, dry land agriculture fails and irrigated fields are abandoned due to salinization, water logging and other forms of degradation (EMA, 1981:17). Bio-climatic zones or regions are a synthesis of major climatic factors (such as heat, sunshine, humidity, saturation, annual rainfall, evaporation, and evapor-transpiration) and the distribution of vegetation.

Although the unavailability of complete human activity data on a spatial basis is a limiting factor, empirical evidences from the recent catastrophic drought indicate that the areas that are claimed to be 'hazard free zone' are seen in secular environmental deterioration. Unplanned and uncontrolled human actions (agricultural practices and land use strategies) are assumed to be the basic causes of the problem.

Supporting the above statement, one writer argues that "drought is clearly not simply a natural disaster nor 'an act of God'. It is largely an act of man or rather the outcomes of a long period of cumulative acts of man" (Fassil, 1990:7). According to the writer, the acts of man, which led to reduction of vegetation, are deforestation, over grazing, and generally inappropriate land use practices.

Leaving other things normal (constant), failure of the soil to retain moister and increasing vulnerability to the effects of reduced rainfall leads to low yield over time. Where the degradation of land resources is intensified, a process of desertification sets in, reducing once productive land to a virtual desert. According to current scientific thinking, the elimination of vegetation cover and the creation of a desert like conditions can eventually lead to the reduction of rain fall due to the so called increased albedo or reflectivity of solar radiation (Glantz et al, 1985).

Total soil loss from different land use and cover type in Ethiopia is estimated at between 1.5 and two billion cubic meters a year (Abebe, 1994). The most erosion prone land type is in the currently unproductive areas (3.8% of the total area), with an annual soil loss of 70 tones per hectare which is equivalent to 22% of the soil loss. The annually cropped areas are the second most erosion prone areas having a soil loss of 42 tones per hectare per year. The rate of the loss varies considerably depending on slope, soil type and vegetation cover, but it can be as high as 400 tones per hectare per year (IUCN, 1990).

Some 11 million hectares, 8.9% of the total area of the land in Ethiopia, are classified as degraded area. The largest one is in the Woina Dega climatic zone, where 72% of agricultural land is concentrated. IUCN (1990) estimates that in the highlands of Ethiopia 25% is seriously degraded (54 million hectares), 24% is moderately eroded and 3.7% has suffered irreversible degradation.

The areas of rain-fed agriculture most under pressure from environmental degradation lie in the central highlands of Ethiopia. Their thick volcanic soil is inherently fertile and once supported a large forest with diversified flora and fauna. A cool climate with ample rainfall attracted early human settlement and mixed agriculture and stock keeping in the past. The highlands have been settled for more than five thousand years and wide spread deforestation started about 2500 years ago in the northern highlands of Ethiopia (Hurni, 1985).

In the recent past, accelerated population growth that has been accompanied with little or no change in the traditional land use practices coupled with the recurrent drought in many parts of the highlands have led to serious land degradation and low productivity accentuating misery. E ecologically fragile environments, especially steep slopes and marginal lands, such as water logged plateaus and basins have been brought under cultivation. Vast areas of forest and woodland have been cleared. In most parts of the highlands, no soil protection measures were practiced. As forest and woodlands were cleared for cultivation wood became a scarce resource, particularly in the northern and central highlands of Ethiopia. Animal manure came to be used as fuel instead of an organic fertilizer and, as a result, soils became much more impoverished.

The total estimated soil loss in Ethiopia as a whole is 1,493 million mt/year or 12 mt/ha/year; while the estimated soil loss from cropland is 672 million mt/year or close to 40 mt. /ha /year (Hurni, 1986). Part of this loss is deposited in the foothills or on valley floors and may be reclaimed. These figures, therefore, indicate that the soil loss from cropland, which is less than 15% of the total area of the country, account for 45% of the total loss.

About 63% of the total area of northern Ethiopia is covered by shallow soils (less than 35cm), accounting for about 50% of the total area of the highlands covered by shallow soils in the country (Daniel, 1990). In 1986, the FAO study has estimated that more than 1900 million tones of soil are lost from the Ethiopian highlands annually. According to the study, if this trend continues, by the year 2010, some 38,000 square km area will be eroded down to bare rock and a further 60,000 square km will have a soil depth of 10 cm or less, making it too shallow to support cropping. The report concluded by stating that approximately 10 million people of the population living in the highlands will become destitute by the year 2010 (FAO, 1986).

Accelerated devegetation, intensification of cultivation and mismanagement of land without modern inputs and basic changes in technology combined with rugged topography and torrential rainfall have led to environmental degradation due to soil erosion (Mesfin 1984, FAO 1986, Kebede 1989, Tadesse 1989, Daniel 1990. Teshome 1994). The economic implications of the progressive impoverishment of the resources bases are indeed multifaceted and cumulative in nature. The recurring and chronic food shortages in Ethiopia are caused partly by soil degradation (RRC 1985, Desalegn 1987,and FAO 1986).

Generally, low labor productivity, declining food production, growing ecological degradation on the one hand and rapid population growth on the other are the major factors that reduce the population support capacity of the country. That is why Ethiopia figures as one of the 14 Sub-Saharan African countries where present population pressure exceeds the carrying capacity of the land (ADB/ECA 1988:63).

2.4.The Policy Environment in Ethiopia

2.4.1. The Land Tenure System

Land tenure system, as defined by Dejene and Teferri (1995:314), is the various forms and rights of access to land such as free-hold, lease-hold, share-cropping, on a village or customary use rights. Thus, the type of land tenure system determines the efforts towards the conservation of environmental resources, which concomitantly affects the socioeconomic development of a country in many ways. According to the same authors (1995:315), the land tenure system determines the distribution of incomes among users of the land, the type of land use, power, social attitudes and social satisfaction and national traditions and character.

Different countries have experienced different forms of ensuring land access rights to their population at different times. Some provide temporal land ownership for the purpose of political stabilization and to diffuse social tension while others give more security to meet the interests of the capitalist class in order maintain a high rate of profit in the industrial sector. Still others prefer to give the land to peasants based on efficiency and equity arguments while some others leased the land to small farmers either on an individual or on a cooperative base (Ibid, 315-316).

In Ethiopia, land has been under state ownership since 1975 where the peasants appropriate the land from the state. They have usufractory right but lack the ultimate right of ownership (the ability to sell, mortgage or transfer) for a particular piece of land. According to Thomas (1984:5), before the 1974 revolution, about 60% of the high lands of Ethiopia were under feudal system of ownership whereby individuals had been granted exclusive rights by the emperor or by the church. Individual tenants had no right to clear the forest without the permission of the owner. After the 1974 revolution, private ownership of land was abolished and it became the collective property of the Ethiopian people. After the reform, agricultural land is held by three major groups, namely: Peasant Associations', Producer's Cooperatives, and by state farms (Thomas, 1984:5). These groups of landowners have only usufructory rights over land and land was distributed among farmers based on family size.

Bounder (1987:246-251) has identified many problems that might arise from tenure insecurity. Activities such as indiscriminate felling of trees for fuelwood, intensive grazing in forestland, conversion of forests for agriculture, poor efforts for forest regeneration etc. became evident. This, will, in turn, result in a complex environmental problems manifested by land degradation and extinction of genetic diversity.

Despite the fact that the 1975 land reform has been appreciated for its merits, there have been acute problems related with it. Landholders were only provided with usufructory rights, resulting in bad land use practices. Large-scale deforestation and land degradation have been observed after the 1975 land reform. The combined effects of these problems have been manifested in declining natural productivity of the land.

The land tenure system also determines the type of crops grown on a specific plot of land. In situations where the peasant makes a short-term contract with the landowner, the farmer usually prefers to harvest annual crops that would enable him/her to maximize agricultural output in the short run. However, when the individual owner cultivates own land himself, the types of crops grown would be perennials, conservation-based types of crops or plants that have been increasing rates of return on investment in the long run. The Ethiopian rural survey data released by the Department of Economics, Addis Ababa University (1995:345) has illustrated the fact that excepting few areas where permanent crops occupy the bulk of the land, all other sites were used for the production of annual crops.

Thus, it is possible to make an inference that individual farmers are motivated to grow perennials (which is more sustainable and highly productive) than annuals if they are given not only temporary usufructory rights but also guaranteed private ownership to the land. Due to this, the land tenure system determines the type of investment to be made on the land.

2.4.2. Policies Governing Environment and Agriculture

Together with many other macro-economic policy reforms, environmental and agricultural policies play a significant role in the development of a nation's economy particularly in agrarian countries like Ethiopia. The Ethiopian government and donor agencies have formulated one policy after another to combat these extensively debated issues of ecological degradation, often based on an impressionistic view about the nature and magnitude of the problem. This is done in the absence of village level data that could identify the socioeconomic forces that could mitigate or exacerbate the process of environmental degradation.

With a program of environmental reclamation the Ethiopian government, supported by donors and NGO's, implemented the largest food-for-work program. This enabled the construction of about 600,000 km of soil and stone bunds and 470,000 km hill side terraces, the planting of 500 million seedlings, closed 80,000 hectares of steep slopes for natural regeneration, built thousands of kilometers of check dams in gullies between 1976 and 1985 (Hurni, 1986).

As a result of the 1985 famine, peasants have constructed more than one million-kilo meter of soil and stone bunds, almost half a million kilometer of hill side terraces and planted considerable hectares of trees (much of it was a community wood-lot), closed-off more than 80,000 hectares of hill sides after 1985(Hoben, 1995:1007). Hoben has, however, argued that none of the programs and activities was successful and productive. As has been identified by Gills and Repetto (1984: 11-16), and Hoben (1995), the failure of conservation programs and activities especially the irrational utilization of resources are explained by the following three reasons:

First, government polices undervalue the wisdom of traditional resource uses and the value of local traditional resource management practices. Peasants' view of the environment is often misunderstood and ignored without due consideration to the predicaments he or she faces between survival and environmental exploitation. After all, environmental degradation, is ultimately a place-specific process and the policy makers should understand peasants' problems, consider their knowledge and practice of the environment and realize the vicious circle of survival and environmental degradation (Watts, 1985:19). Experts and policy makers often have limited understanding about the peasants' environment. This lack of access to representation contributes to the denigration of peasant knowledge and practice.

Second, government polices undervalue the continuing flow of benefits from natural resources, specifically to natural forests. Gills and Repetto (1984) have elaborated the failure of policies to consider the continuing flow of benefits from natural resources. They have argued that natural

The government has granted peasants the right to sell their products at places of their choices based on the principles of market competition and profitability. Prices are liberalized, export subsides and import controls are eliminated by the policy. The policy encourages the participation of the private sector in the marketing and distribution of seeds and fertilizers. The role of the state is restricted to helping farmers in obtaining fair prices for their products, provide agricultural extension services, promote distribution and use of fertilizers and improved seeds, regulate the harmful effects of price fluctuations on producers and consumers, etc.

The policy gives due consideration to the expansion of peasant agriculture and allocation of a greater share of budgetary and manpower resources to the sector. The government has to focus on the expansion of infrastructure particularly on the introduction of small-scale irrigation and the use of modern technological inputs as a strategy for ensuring sustainable agricultural development. Moreover, to stimulate the performance of pastoralists, it is intended to organize and form cooperatives so as to help them lead a sedentary life. They will be assisted by extension services, credit and infrastructural facilities and the freedom to use traditional grazing areas along with the practice of conserving soil and water resources.

To encourage large-scale commercial agriculture, the policy promotes the provision of fertile lands in uninhibited and unused areas to private entrepreneurs on concessionaire basis with full guarantees, provide incentives in the form of creating access to bank credit, tax benefits, and expanding infrastructure. This encourages the development of modern farming. Thus it is a strategy designed to improve agricultural productivity as well as create employment opportunities for the expanding rural labor force.

The expansion of large-scale commercial farms, however, has a contradictory impact on the natural environment through its destructive effects of deforestation and clearing of bush covers. Unless an efficient land use policy is adopted, it is tempting to conclude that the prevailing policy environment will not respond to the problems that it is designed to address.

- The first point that is seldom assessed is peasants' view of their environment and their proposals for effective resolution to the problems.
- Policies and strategies are usually designed without sufficient village level study. This study would therefore contribute to this end.
- The relationship between peasants and development agents is fundamental in resource conservation and utilization. There are no sufficient studies in this area and this study would attempt to examine the interaction between the peasantry and the near-by government agents.
- There are very few studies on carrying capacity of land resources.
- Most of the studies (research and development activities) are usually confined to the already devastated areas. Those areas that are apparently good or are located in relatively better regions but would in the near future face a serious problem are usually ignored. The study area is one of such kinds.

III. THE STUDY AREA

Population settlement and agricultural activities are largely dependent upon the physical and social environment. In an attempt to create a general impression about the study area some of the basic physical and socio-cultural characteristics will briefly be described below.

3.1. Physical Characteristics

The most important environmental factors that influence human activities include climate and its elements such as temperature and rainfall, latitude and altitude, topography or relief, soil and vegetation. Thus, a brief description of the study area with reference to these factors is given hereunder (for relative position, relief and PAs of the study area refer Fig1-3).

3.1.1. Location and Size

Debay Tilatgin Woreda is one of the 14 Woredas in East Gojjam (Regional State of Amhara) that is found some 300-km north of Addis Ababa. Astronomically the study area is located between 10° 5'20''N-10° 15' 42''N and 37° 45'E-38° 00'E. The Woreda covers about 69995 ha. (CSA, 1992) and is located in the foothills of Choke Mountain. As it is part of the north-central highlands, its physical and socioeconomic characteristics are more or less similar to the northern highlands. According to the Ethiopian agroecological zoning system, the study area is dominated by Wurch and Dega zones. The slopes of Mount Choke and the Plateau are the major physiographic regions.

3.1.2 Topography

The three major topographic influences that may usually act as limiting factors to agriculture are altitude, aspect and relative steepness of slopes. Although the influence of aspect is negligible, the role of altitude and relative steepness of the slope is considerable in the study area. It is generally believed that air temperature decreases and rainfall increases with an increase in altitude. These changes in temperature and rainfall conditions result in the occurrence of different climatic zones at different altitudes along the slopes of highlands.

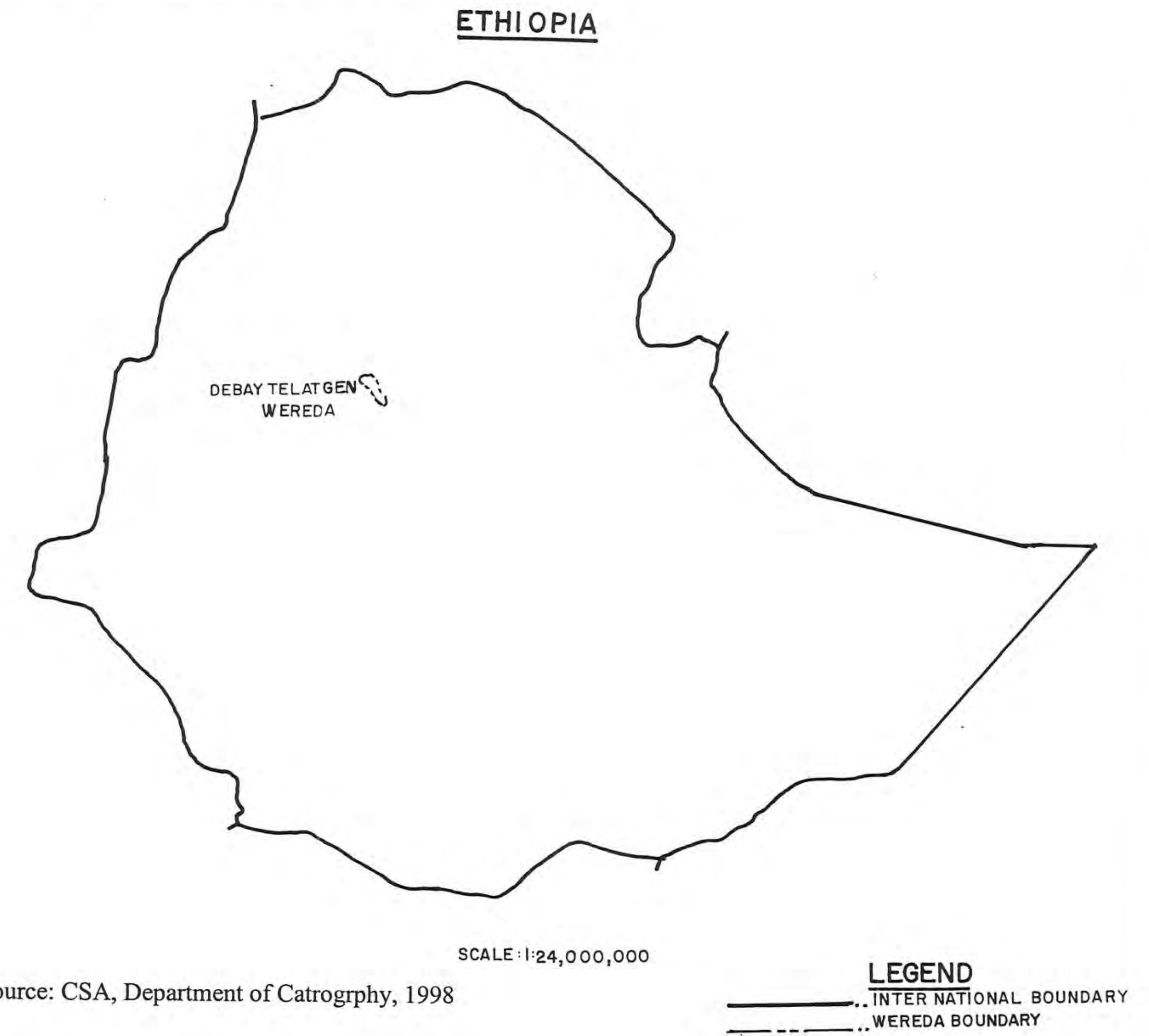
The above conditions are responsible for the well-known development of altitudinal zonation patterns in plant communities. Besides, at higher altitudes, solar radiation during clear weather is intense, winds are strong, soil temperature is lower, and the atmosphere is less dense with a decrease in carbon dioxide than at lower altitudes. This lowers the capacity of plants in absorbing and retaining much heat, in turn, slowing and stunting the growth of vegetation. This is vividly seen in the northern extreme of the study area where the altitude is above 3600 m.

According to the Woreda Agriculture office, the land configuration of the study area is characterized as 40% mountainous, 25% plain, 20% undulating and the remaining 15% is regarded as valley. As to the distribution of the land in ecological zones, 25% of the area is under Wurch and the remaining 75% under Dega ecological zones.

The relative steepness of the slope also affects drainage and run off. The depth as well as the water and nutrient content of the soil is also affected by the slope (IUCN 1990). As a general rule, steeper slopes in mountainous areas are drier than the relatively gentle ones and, as a result, the vegetation communities developed upon them can be expected to be of a more xerophytic nature than elsewhere. Besides, owing to the higher degree of slopes, water and soil nutrients are easily removed. Thus, the steep slopes, unlike the gentle ones, are usually covered with stunted and short vegetation.

In the study area, 30% of the total area has 11-25 % slope gradient and is characterized by plateaus and undulating type of landform. The area that accounts for about 25% of the total area has the lowest slope where the gradient ranges between 1-10 %. About 20% of the total area have a gradient ranging between 26-50%. The remaining 25% fall within the slopes of Choke Mountain ranging between 52- 100%.

Figure-1 Relative Position of The Sudy area in Ethiopia



Source: CSA, Department of Catrogrphy, 1998

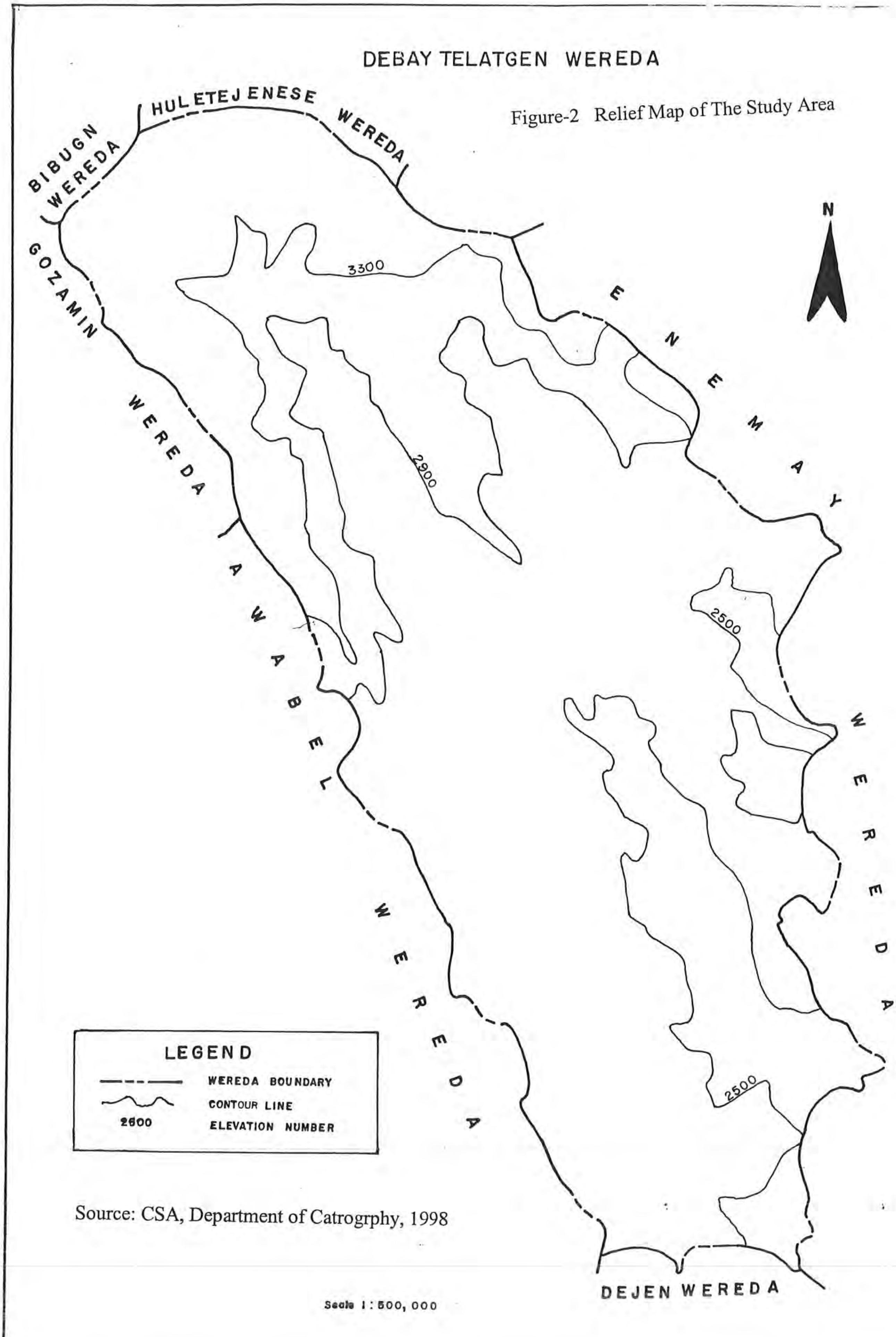
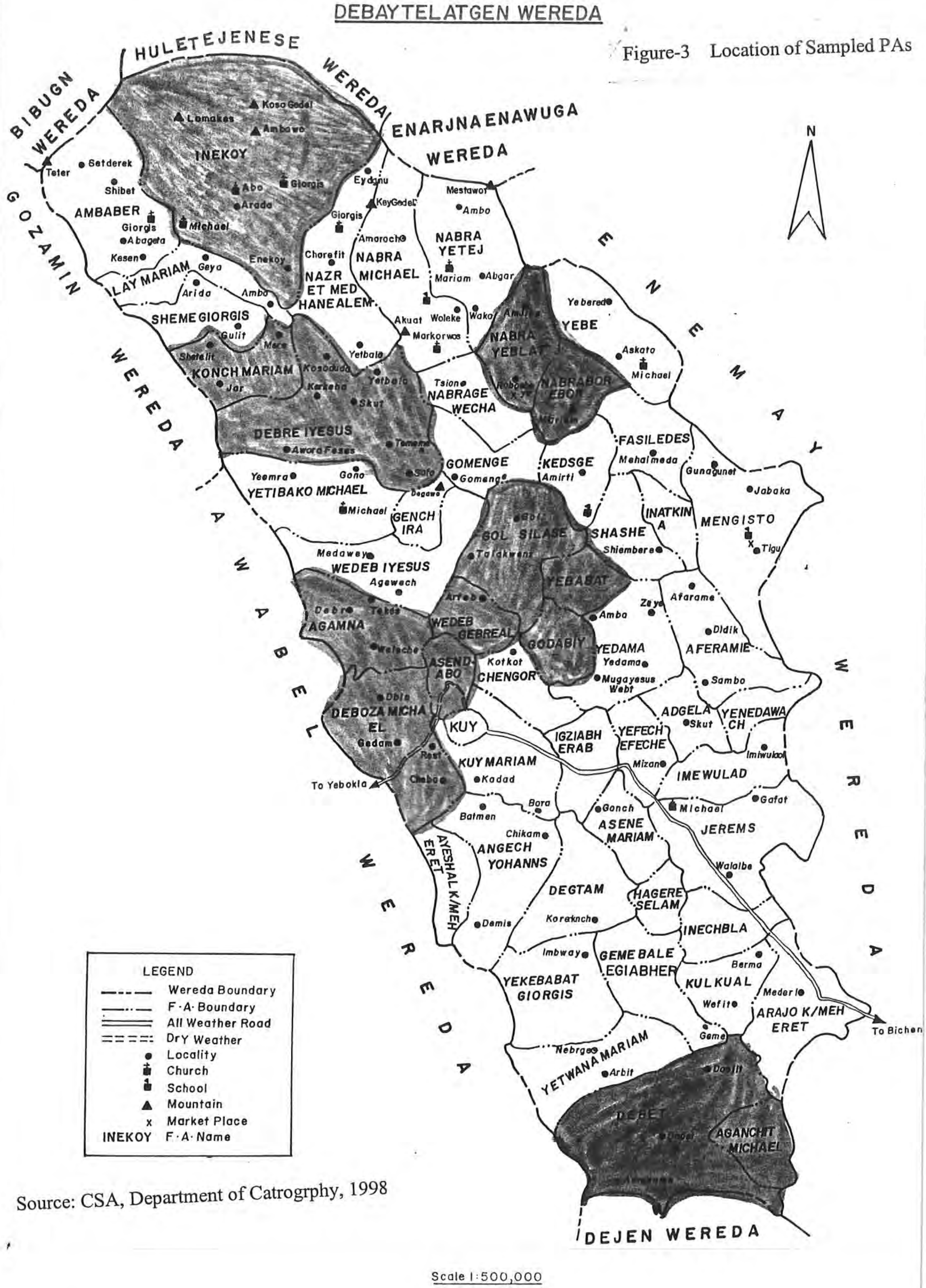


Figure-2 Relief Map of The Study Area

Source: CSA, Department of Catrogrphy, 1998

Figure-3 Location of Sampled PAs



Source: CSA, Department of Catrogrphy, 1998

Scale 1:500,000

3.1.3 Geology, Soil and Vegetation

The study area is underlain by tertiary basaltic lava, which is covered by Quaternary deposits at higher altitudes. As to the type and distribution of soils, the higher slopes of Mount Choke are dominated by Andosols and Cambisols developed on pyroclastic parent materials. The plateau area is dominated by Vertisols whereas the flatter and gently sloping areas with Cambisols, Luvisols and Nitosols on moderate slopes (FAO/UNDP, 1987). The color-based classification of soil by the Woreda Agriculture Office indicates that 25% of the soil is red, 12% is reddish brown, 60% is black soil and about 3% gray.

Edaphic factors are the other environmental factors, which seriously influence agricultural practices. Soil may be defined as a natural body developed in profiles from a mixture of broken and weathered minerals and decaying organic matter, which cover the earth in a thin layer and which supplies, the proper amount of air and water; mechanical support; and sustenance for plants (Hurni, 1985).

Soils provide plants with essential conditions such as anchorage for plant roots, supply of water, supply of an adequate amount of chemical elements in nutrient form and providing enough space for air circulation. Variation in the supply of each of these elements may lead to restrictions in the development of both individual plant and whole community. These edaphic controls tend to have their greatest effects in areas, which are dry or cold or in regions where there are prominent relief forms where soils may only be formed very slowly.

As has been previously stated, the study area lies within the Choke Mountain range. As a result, besides the influence of human and livestock population, the nature of relief might be responsible for the presence of little vegetative cover on the steeper slopes. It must be borne in mind, however, that there is a two-way interaction between vegetation and soil. While certain soil types may exert considerable restraints on the growth of plants and vegetation communities, the type of vegetation present in an area can in turn act as important direct influence on the formation of soil as any other factor. Paradoxically, it may lead to restrictions on the development of specific plants by inducing complicated reactions within the soil.

With the exception of few hillside closures, there is no observable forest in the study area. The lower and middle Dega areas are totally dominated by eucalyptus trees with occasional bushes. In the upper Dega and Wurch zones eucalyptus ceases its importance and gives way to some high altitude plants such as 'Tid' and 'Asta'.

3.1.4 Climate

Climate is by far the most important environmental factor that influences agricultural activities. Climatic changes are the most common and serious problems that are beyond the control of man (Adedoyin, 1987:1). Of the elements of a climate, the influence of temperature and rainfall on agriculture is of paramount importance.

Temperature is an important climatic element that affects the process of photosynthesis and plant growth. The intensity and duration of solar radiation influence plant growth. As articulated in the works of Clave (1974), outside a fairly well defined temperature limit plants' growth ceases together. As indicated in the works of FAO/UNDP (1987), temperature shows a strong correlation with altitude in the study area. In the lower Dega zone of the study area, temperature is mild and pleasant. Whereas, in the upper Dega and Wurch zones it is harsh. Its influence is clearly observed in crop restriction and stunted growth of plants.

Rainfall, just like temperature, is another climatic element influencing agriculture. The main factors that affect the distribution and variation of rainfall are the direction and extent of marine winds, which are, in turn, governed by the north-south movement of the sun and altitude. Variation in the movement and seasonal distribution of rainfall not only affects the length of the growing period and crop yields but also the rate of land degradation in various agro-climatic zones.

Since the area is located in the sub humid tropics and is influenced both by the Intertropical Convergence Zone (ITCZ) and by the subtropical high pressure cells, most of the annual precipitation falls in the main rainy season ('Kremt') which normally spans June to September. Annual rainfall in the study area ranges from 1100-1250 mm for Wurch, 1150-1250 mm for upper Dega, 1050-1350 mm for middle Dega and 950-1300 mm for lower Dega. Because of the absence of meteorological station in the Wereda, the study can not present accurate and time series data on temperature and rainfall.

3.2. Demographic Characteristics

3.2.1. Population size and Density

According to the 1984 population and housing census, the total population of Debay Tilatgin Woreda was about 74, 407. Of the total population, 51.06 % were males and 48.94% females. The crude population density of the Woreda was about 106 p/km2 whereas it was about 53 and 33.7 p/km2 for Gojjam administrative Region and Ethiopia respectively. The population of the study Wereda has grown to nearly 100,000 in ten years. According to the 1994 population census, the total population was 99,840, of which 50,591 (50.7%) were males and 49,249 (49.3%) females. Of the total population, 97,678 (97.8%) were rural. The estimated population size of the Woreda for 1998 is 111310, of which 56207 will be males and 55103 females. The population has increased by about 33% between 1984 to 1998. The population of the Wereda has been growing at 2.9% on the average between these years

The average fertility rate for East Gojjam, where the study area is a part, is estimated at 5.8 children per women, which is one of the highest in the Amhara Region. The crude density of the study area, according to the 1998 estimated population, is about 1.6 Persons per hectare whereas agricultural density about 3 persons per ha. The population of the Woreda, however, is not evenly distributed. The density varies according to the productivity and physical characteristics of the argoecological zones. The data generated based on the recently undertaken land distribution indicates that there are about 24,212 farm households in the Wereda with an average family size of 4.6 persons. Of the total population of the Woreda, urban Population accounts for only 5326 (4.8%) and the remaining 105,984 (95.2%) is rural population.

3.2.2. Family Size, Sex ratio and Age Structure.

Table 3 shows that the average household sizes in the investigated PAs are six persons per household. This is larger than the average rural household size of the region that is about five persons per household. The size of household members in each family varies from two in households formed by some newly formed couples to twelve in extended families. The sex ratio of the study area according to the 1998 estimation is almost one to one. There is, nonetheless, a considerable variation in age structure

Table 3. Age Category of Sampled Peasant Associations.

Sample Peasant Associations	Age Category of Households.						
	0-4	5-9	6-14	15-60	>60	Total	Average
Debet	20	33	96	89	11	249	6.5
Asendabo	19	33	76	85	20	233	5.9
Yebabat	23	52	106	105	23	289	6.6
Debre Iyesus	40	78	157	168	29	472	6.8
Nabra	11	19	36	42	–	108	5.4
Inekoy	20	35	87	82	22	246	6.2
Total	133	230	558	573	105	1597	6.4

Source: Computed by the author based on the household survey undertaken in 1998

The study area has a pyramidal age structure with a very wide bottom and narrow apex. Examination of age structure of the study area based on the 1994 census reveals that the greater proportion of the population is below the age of 20 (about 57 %). Assuming the age group of 15-59 years to be economically active and the population less than 15 and more than 59 years as economically dependent, the dependency ratio accounts for about 108.12%. This indicates that a single economically active person is expected to feed him/herself and more than one person. Such a high dependency ratio is common in many developing countries. This could partly explain why agriculture is so weak in those countries where there are many dependents. It reduces the ability of farmers to produce surplus mainly because most of the produce is devoted to immediate consumption.

3.3. Sociocultural Aspects in the Study Area

3.3.1. Ethnicity and Religion

The population is totally homogenous in ethnic and religious compositions with the entire population being classified as Amhara and the follower of Orthodox Christianity. The peasants in the Woreda are bound by religion devoting more than sixteen working days in a single month as holidays.

Moreover, engagement in cottage activities such as weaving, tanneries, blacksmith etc. is despised by the community, which otherwise could have contributed for the generation of additional income for the farming households. Peasants that are engaged in these activities are not recognized as efficient farmers and are ostracized. They are, hence, excluded from social ties with other members of the community through marriage and other social undertakings.

3.3.2. Marital Status and Family Composition

The survey result shows that the marital status in the area is predominantly monogamous. The household survey in this study has never come across cases of divorce and households headed by women. The composition of family is almost the same and involves husband, wife and children. It is not the habit to have more wives at the same time or to extend the family by integrating distant relatives. Mostly the elderly people have independent households. The present legislation for land distribution, in allowing every individual more than 18 years a right to have farmland, leads to the formation of many small independent households.

3.3.3. Literacy

The level of literacy for the Woreda is generally low. Of the 250 respondents, 98 (39%) of them stated that they can read and write. Most of the respondents, however, had never attended formal education. Household heads were also asked whether they send their children to school or not for which more than 70% responded by saying 'Yes'.

Although farmers are willing to send their children to school the demand for child labor is very difficult to ignore or to compensate. According to the Woreda office of education, it is the propagation and persuasion of teachers that persuades reluctant families to send their children to school. This kind of persuasion is, however, effective only at the beginning of the academic year and is usually followed by massive dropouts during the harvest period.

3.3.4. Settlement Patterns

Settlement in the study area is not diversified. Villages in the upper Dega and Wurch zones are mainly clustered along the top of a hill, on rigs and spurs. In the relatively plain areas of Debet and some parts of Asendabo, the settlement pattern created by the former government's villagization program is still prominent. In high altitude and steep slope areas such as Debere Iyesus, Nabra, Inekoy and some parts of Yebabat, peasants were forced to evacuate their original settlement during the villagization program. The new settlement sites are flat and mainly agricultural lands. Some farmers went back to their original place while others are still occupying the most fertile land in the newly formed villages.

The houses in the study area are mostly traditional tukuls, with cone-shaped, thatch roofed and circular walls made of wood and plastered with mud. Currently, modern style tin-roofed (corrugated iron) houses are replacing these traditional housing units. This situation is largely observed especially in the low-lying teff growing areas.

IV. LAND TENURE AND FARMING SYSTEM IN DEBAY TILATGIN WEREDA

4.1. Land Tenure and Administration

Prior to the 1975 land reform, land in the study area was held communally; i.e. it was owned by the kinship groups and distributed to members for cultivation. However, land became a collective property of the state following the 1975 land reform proclamation. After the proclamation land eased be sold, leased, inherited, exchanged or transferred to other persons. Article 4 of the 1975 proclamation states that land should be distributed as equally as possible within an area in such a way that no household would have more than 10 hectares.

The nationalization of land in the study area thus necessitated redistribution of land among farmers, which involved a readjustment in the size and allocation of individual households and in some cases the accommodation of landless peasants. Land distribution according to elderly people and the Wereda Agriculture Office was not a 'once only ' phenomenon. In most of the investigated PAs, land was redistributed every two years.

The recurrent redistribution of land since 1975 has, among other things, resulted in fragmentation of farms. The system also exacerbated tenure insecurity among peasants, which culminated in loss of incentives for land improvements. As a result, the government itself has put an end to this generalized reallocation in most parts of the country, including the study area, in 1989. This system was allowed to continue even after the government change in 1991. The only change that came into effect through the new economic policy of the Transitional Government was allowing landholders to inherit, transfer and lease their holdings.

In 1997, however, the Amhara National Regional State had initiated land redistribution in most of the Weredas in the Region including the study area. According to the information from the official sources at the regional and the Wereda levels several factors were responsible to undertake the new land redistribution in the region. The basic reasons given are related to the unjust land distribution which benefited the former pro-government elements and the growing land demands that came as a result of ever increasing newly married couples.

It is widely argued by regional authorities that land was dominantly owned by what they called 'bureaucrats ' and 'remnants of the former feudal system '. These 'bureaucrats ', such as former PA leaders, had absolute authority to take the law into their hands as a result of which land was concentrated under their possession and their relatives. The remnants of the former feudal system were also active to possess land through bribe and the support of corrupt PA leaders. Thus, authorities in the region strongly argue that these two groups have had marginalized the bulk of the peasantry and undertaking the land redistribution had been a necessity.

In this study, an attempt has been made to assess the attitude of the population towards the recently undertaken land redistribution. The assessment was done in two ways; through household head interview and group discussion with elderly farmers. The majority of the population in the sample PAs', including former PA leaders, were not against the distribution but almost all of the respondents in the interview and participants in the group discussion were against the mechanisms and the process of the new redistribution. They did not oppose the idea of redistribution with the expectation that the distribution would be fair and just.

In principle, two major criteria have been followed for the allotment of land in the study area: family size and the quality of land. First, farm size allotment has been assumed to consider the size of the family, i.e., households with small size would receive relatively small size of land and those with larger family more land. The other criterion was the principle that the land should be composed of good and poor land. The greatest discontent of the farmers in the study area lies in measures pertinent to this principle. Peasants are openly speaking that the fertile land is no more accessible to poor and marginalized farmers. It is taken from the former holders and given to the others. According to the information gathered from the group discussion, peasants are feeling helpless in the face of the present PA leaders that are not different from the former ones. The new leaders do also have insatiable appetite in snatching the fertile land.

In order to gather information about the land distribution from the other group, discussions were made with some of the PA leaders during the fieldwork. They seem satisfied by the entire process and for them it was just and fair and, above all, it was a great victory over 'bureaucrats ' and 'feudal remnants' that ensured peace and stability in their locality. In the study area, PA leaders are mostly young and educated with some of them finishing junior secondary school and some others senior secondary school level. Besides, they have a mix-up of rural and urban life styles. They consider themselves as if they are well educated and denigrate the peasantry. They neither follow the customs of the local population nor respect their moral value. Their sole existence in the PA administration is primarily for their economic advantage, so as to appropriate fertile land at the expense of the innocent and voiceless peasants.

It is, hence, tempting to draw a general conclusion that land holding and its administration in the study area is no more in good condition. Clearly, the peasantry is not in absolute opposition about the redistribution but blame the way it has been administered. The group discussion was also important to learn that hopelessness is escalating among the peasantry by the inconsiderate and egoistic acts of the PA leaders. The outlook of the government officials at the Woreda level towards the performance of the PA leaders is inconclusive. It looks evident that those young individuals with relatively good educational status, but unpopular within the peasantry, would continue to attract the eyes of officials to be recruited as leaders of Peasant Association. Thus, suffice is to say neither prudence nor competence is observed in leadership at the grass root level. Hence, the impact of such a poor leadership is certainly reflected in the land administration of the study area and accentuates tenure insecurity.

4.2. Farm Size and Land Fragmentation

In the study area land is measured using a rope locally known as 'Gemed. One 'Gemed' covering an area of 50m by 50m and is called 'Timad'. 'Timad' is defined as a farmland that can be ploughed by a pair of oxen in a day. The 250 sample household heads were asked to state the total area of land they owned and the amount they cultivate. Based on the responses of the sample household heads the land holding, only the farmlands or fallow, is summarized in Table-4. Since there is no standard classification of land holding in Ethiopia an attempt has been made to categorize land holdings of sampled PAs based on the upper limits (3 ha.) and lower limits (0.5 ha. for unmarried young): Small holding (<1ha); medium holding (1-2ha) and large holding (>2ha).

Care must be taken in this classification not to associate that the economic return of the land with size. Some households may possess a relatively small size of land but this does not mean that the yield generated from this holding is always smaller than a certain holding regarded as medium, or even in same cases large. According to the responses of household heads and information gathered from group discussion, if a household possesses a relatively smaller size of land, say less than one-hectare, but a relatively fertile one size would be compensated by fertility. Thus, the purpose of this classification is only to show what proportion of the households fall in which size category.

Table 4 Land size Distribution of Sampled Households.

Sample PAs	Small <1 hectare	Medium1ha 2ha hectares	Large > 2 hectares.	Total households
Debet	2	26	10	38
Yebabat	5	22	17	44
Asendabo	_	26	13	39
Debre Iyesus	5	45	19	69
Nabra	1	12	7	20
Inekoy	-	34	6	40
Total	13	165	72	250

Source: Computed by the author based on the household survey data, 1998

As it is evident from Table 4, about 5.2% of the households have small farm holdings and claim about 6.9% of the total cultivated land. It means, small holders support 5.2% of the total population. The medium farm size holders occupy 64.8% of the farmland and support about 66.1% of the sample population. Large holders, on the other hand, account for 28.3% of the farmland.

Simple correlation analysis has been employed to see the relationship between farm size and family sizes. The result has indicated a direct but weak relation (0.+4). Looked at PA level, the relation is stronger in the case of Debre Iyesus indicating (r= + 0. 7) and it is weak in Debate and Asendabo (r=+ 0.4). This indicates that land distribution has taken family size into consideration in those PAs with strong correlation coefficient and the role of family size has been weak in the allocation of farmland in those PAs with low correlation coefficient. In one of the PAs viz. Nabra no association between these two variables has been found (for details refer to Table 5).

Regarding the cultivated land per head, which shows relative pressure on land, a direct relationship is observed between farm size and family size in all sampled PAs, i.e., the higher the family size the higher the farm size and vice versa. Pertaining to the variation in average farm size per person per hectare among PAs, no significant variation has been observed. The aggregate average land holding per household in the sampled PAs is about 1.5ha. PAs such as Debre Iyesus (1.4 ha) and Nabra (1.4 ha) have below average holdings whereas PAs such as Debate (1.6), Asendabo (1.6) and Yebabat (1.6) posses above the average land holdings

Table 5 The association between household size and land size.

Sample PAs	HH Size	Family size	Produc. labor	Land Size	Ave.land Holding	Agri. Density	Labor Density	Corr. land and family si
Debate	38	249	89	61.5	1.6	4.05	1.45	0.4
Asendabo	39	233	85	62.500	1.6	3.73	1.36	0.4
Yebabat	44	289	105	72.125	1.6	4.00	1.45	0.5
Debre Iysus	69	472	168	99.750	1.4	4.73	1.68	0.7
Nabra	20	108	42	27.750	1.4	3.89	1.51	-
Inekoy	40	246	82	58.500	1.5	4.21	1.40	0.6
Total	250	1597	571	382.12	1.5	4.18	1.49	0.4

Source: Computed by the author based on field survey

Similar to farm size land fragmentation too has an important feature in the study area. Fragmentation occurs when a household holding is divided into a number of small parcels in far apart areas. The major cause for land fragmentation is the need to balance the distribution of poor and fertile land stocks amongst the population. The data collected from 250 farmer indicate that they altogether cultivate 1081 plots with each farmer having an average of four plots. Of the sample households, about 34% of them possess less than four plots while the remaining 66% above four plots. The degree of land fragmentation is not the same in all sampled PAs (refer to Table 6).

Fragmentation is relatively higher in lower Dega and middle Dega zones and smaller in upper Dega and Wurch zones. Accordingly, the majority of the sample households in Debet, Asendabo and partly in Debre Iyesus possess more than four plots of land where as 90% and 78% of sample households in Inekoy and Nabra possess less than four plots of land respectively (refer Table 6). The intra-PA variation in land fragmentation is not as strong as inter-PA variation. The inter-PA variation is most probably caused by physical factors such as climate, altitude, slope and soils. These physical factors determine the type and number of crops grown. Therefore, crops are more diversified in the lower and some parts of middle Dega zones than in the upper Dega and Wurch zones. Thus farmers usually try to make use of this opportunity. In the upper Dega and Wurch zones, the types of crops grown are limited to cool-weather crops such as barley, wheat and in some case pulses. Hence, there is no need to compete for different lands to grow different crops.

Table 6. Land Fragmentation and number of plots owned by a household.

Sample PAs	Number of farm plots owned by a household								
	1	2	3	4	5	6	7	>8	HH
Debet	_	2	3	15	7	6	2	3	38
Yebabat	-	5	3	16	11	5	2	2	44
Asendabo	-	-	7	12	10	4	3	3	39
Debra Iyesus	-	5	10	27	23	2	2	-	69
Nabra	-	8	10	2	-	-	-	-	20
Inekoy	-	10	21	8	1	-	-	-	40
Total	-	30 (12)	54 (21.6	80 (32)	52 (20.8)	17 (6.8)	9 (3.6)	8 (3.2)	250 (100)

Source: Computed by the author based on the household survey data, 1998.

Fragmentation is higher in those holdings that are relatively considered as large (>2 ha.). Farmers were asked to tell the average travel time required to cover the distance between their dwellings and their farthest plots. In all cases, the average time required is not more than 30 minutes. This indicates that travel time is not as such a problem in the sampled PAs, which neither influence the farmer to manage his/her plots nor shares the working time. The major problem posed by the farmers is not land fragmentation as such but shortage of land. In some cases farmers are interested to possess plots in different areas so as to diversify their cropping. Security is the other reason given by farmers favoring fragmentation. When a crop failure happens in a certain area, the other plot will be used to support households.

4.3. Farming system

Generally, the farming system in the study area is characterized by subsistence farming of annual rain-fed crops and animal husbandry at a low level of technology. There are no 'Belg' crops in the study area and the farmland is used once a year. A family farm is supposed to produce enough food to satisfy the family's consumption requirement plus a little surplus to meet its cash needs. Management practices are traditional with a low level of capital intensity (using hand implements and oxen drown plough). The nature and combination of each of these activities depends upon several factors. The agroecological factor under which a farm operates determines the choice of the crops to be grown and the kinds of animals to be raised.

Like in many parts of rural Ethiopia, agricultural practices in the study area are absolutely traditional. The commonly used farm implements in the study area include oxen; the plough, sickle, axe and other materials usually made by the farmer him self. Oxen are used as main traction power and the utilization of other animals such as equines, as traction power to pull the traditional plough is rarely practiced. Digging tools are used to prepare a farmland in areas that are too steep to use oxen power and, obviously, by oxen-less farmers.

The farmers in the study area are little exposed to new technologies and including new crop varieties. A number of local activities exist which seem to be well adapted to the prevailing conditions. Farmers are reluctant to adapt new technologies since their traditional technology has developed over centuries of trials and experiments. This condition is strong especially in the upper Dega and Wurch zones that are relatively remote. To sum up, access and exposure to new technology to the people in the study area are limited.

Despite centuries of farming in rural Ethiopia, agricultural technology has remained virtually unchanged. The lands for cropping is prepared by the ' Maresha', plough-drown by a pair of oxen. This implement does not invert the soil and the major crops such as teff and wheat require a very fine seed- bed that is usually achieved after five to six rounds of tilling. Pulses require three rounds of tillage. Seed is generally broadcast and covered by the final pass of the 'Maresha'. Weed control is done entirely manually.

The crops are harvested using the sickle. In this operation care is taken while collecting both the grain and the straw, as the latter is used for purposes such as animal fodder and fuel. This is followed by threshing, which is done by animals trampling the grains on purposely-prepared threshing floor. The grain is winnowed using the traditional shovel like implement made of wood. The produce is stored in a traditional container made of mud locally known as 'Gotta'. Although 'Gotta' is commonly used in the study area, barley is also stored in a special hole known as 'Gudguad' prepared around the homestead. This type of storage is commonly practiced in high altitude areas such as in Nabra, Inekoy and Debre Iyesus PAs.

The mode of production is essentially private, but an important system of cooperation within the group exists. Share cropping is one of the widely practiced cooperation in the study area. Arrangements are made when the owner of a certain farmland is not able to work himself while a friend/neighbor is with little or no farmland but possesses oxen, labor and other farm implements they make a share deal. These kinds of arrangements are usually undertaken between female-headed households and young unmarried peasants.

Another form of share arrangement is struck when a farmer that possesses no oxen borrows the neighbor's to work on his land. This is compensated in the labor of farmers (mostly one-day oxen power to two-day human labor) or in a stated share of the harvest obtained. There is also a share arrangement between farmers when one possesses only an ox and the other with one or more ox (en) to form a pair of oxen. The pair of oxen so tied would work for a day on one of the peasant's plot and the next day on another's plot. Cooperation also exists in the form of labor. For certain operations, particularly during weeding and harvesting, a family might not have enough labor and might appeal to outsiders to assist in the work. Although this is a common practice in the study area, it should not, however, be associated with labor shortage for it is a seasonal pressure on a family.

4.3.1. Farm Inputs

4.3.1.1. Labor Supply and Composition.

Family labor is the most important input in the study area. All family members, including children aged above 6 years, are active participants in one way or another. The major farming activity namely tilling the land is exclusively the duty of males. Children are usually assigned in household activities. This does not, however, mean that children are free from agricultural activities. Food preparation, fetching water, firewood and dung collection, on the other hand, are the duties of women.

According to the household survey carried in the sampled PAs, there are on the average 2.3 persons per household falling in the working age category (15-60 years). The size of the household labor force depends upon family size. The number of agricultural workers was found to range between two workers in smaller households, usually formed by newly married young couples, to six in long established families. In this study, it was also found that the numbers of agricultural workers are higher in those families with relatively high holdings.

Although shortage of labor has not been reported in the household survey, it is evident that its supply is greatly influenced by the culture and religion of the people in the study area. The entire population follows the Ethiopian Orthodox Church. As a result the population has to devote up to 16 day a month for religious duties. Thus, the annual working days in the study area are not more than 169. It is, hence, clear from this perspective that the labor force in the study area is under utilized. Though the household survey confirms that there is no labor shortage in general terms, seasonal shortage of labor especially during the times of weeding and harvesting is a common feature in the study area. Undertaking special cooperation arrangements, as mentioned earlier in this study, usually solve this seasonal problem.

4.3.1.2. Oxen

Household heads had been asked to indicate the number of oxen they own (Table 7). The number of oxen per household is related with the size of land holding. In the sampled PAs, households with a relatively larger land holding are the owners of more than two oxen. The number of oxen owned by a household could also be used a proxy to the economic strength of peasants. The data from the household survey reveals that a relatively higher number of oxen per household are found in the lower Dega zones namely in Debet and Asendabo PAs. The least number of oxen are found in Nabra. As indicated in the table below (Table 7), about 34% of the respondents had one and 43% two Oxen. Households with three and four oxen are 12% and 5 % respectively. Four percent of the households were with no oxen.

Table 7. Ownership of oxen by sampled households.

PAs	Household	No. Of oxen	Ave/ No. of Oxen	Number of households with oxen					
				no ox	1 oxen	2 ox	3 ox	4 ox	> 5
Debate	38	79	2.0	2	8	19	4	4	1
Yebabat	44	87	1.9	3	15	11	11	3	1
Aendabo	39	84	2.2	1	11	15	6	5	1
D/Iyesus	69	108	1.6	3	30	31	4	1	-
Nabra	20	31	1.6	1	9	8	2	-	-
Inekoy	40	71	1.8	-	13	23	4	-	-
Total	250	460	1.8	10 (4)	86 (34.4)	107 (42.8)	31 (12.4)	13 (5.2)	3 (1.2)

Source: Household Survey, 1998

Simple correlation analysis has been made to see whether the relations between family size and oxen, farm size and number of oxen are statistically significant or not. The finding reveals that the correlation between family size and oxen is moderately positive association ($r=+0.5$) whereas and the correlation between farm size and oxen is strong ($r=+0.8$).

4.3.2. Traditional Soil Recuperation Techniques

Long term continuous cultivation of land would lead to the depletion of soils. A lower fertility of soil, in turn, lowers crop yield. Being cognizant of these realities, farmers in the study area, somehow, practice traditional soil management measures on their fields.

The survey data and the group discussion were helpful in indicating the traditional methods of maintaining soil fertility in the study area. As part of the north central highlands, traditional methods of maintaining soil fertility in the study area are similar to that of the methods adopted by highlanders. Thus, crop rotation, fallowing, intercropping and manuring are the major methods practiced by the farmers.

1. Crop Rotation

Crop rotation is the leading traditional method that is dominantly practiced by farmers in the study area. Though the system exists in all of the investigated PAs, its application is more pronounced in the middle and lower Dega zones. The summary of crop rotation as responded by farmers in the group discussion and recommended by the Woreda agricultural experts are given below (see Table 8). S the table indicates farmers are well aware of the importance of rotating crops as a natural mechanism to maintain the fertility of the soil. Cereals are rotated by pulses such as horse bean, field pea or chickpeas in the middle and upper Dega zones. In the lower Dega zones, vetch and chickpeas are rotated with teff and wheat.

Table 8. Patterns of Crop Rotation in the Study Area

Name of The PA	Type of Crops and Their Rotation			
	First round	Second round	Third round	Fourth round
Debate	teff	Teff	Vetch	vetch
	Niger seed	Vetch	Teff	wheat
Asendabo	Wheat	Wheat	Teff	Check peas
	teff	Teff	Chickpea	vetch
	Check pea	Wheat	vetch	teff
Yebabat	barley	Barley	Pea/bean	barley
	wheat	Teff	teff	vetch
	wheat	Pea	barley	bean
Debre Iyesus	barley	Barley	pea	barley
	wheat	Bean	barley	lentil
Nabra	Barley	Fallow	barley	fallow
Inekoy	Barley	Fallow	barley	Fallow

Source: Group discussion with Selected Farmers In the study area, 1998

2. Fallowing

Because of the increasing land scarcity, which has been induced by rapid population growth, the use of fallow is currently confined in the upper Dega and Wurch zones of the study area. As has been gathered from the group discussion held with elder farmers, in order to attain good yield the land should be left fallow at least for a year after two successive years of cultivation or in some cases, after a year of cultivation. Currently, however, this system is no more practiced even in those areas where the land must be under fallow. They simply cultivate the land and collect what the land gives them. In the lower Dega zones such as in Debate, Asendabo and Parts of Yebabat PAs fallow is not at all practiced.

3. Intercropping

Though not widely practiced as crop rotation, intercropping is one of the traditional method that is applied to maintain soil fertility in the study area. This method of keeping soil fertility is mostly practiced in the steeper farmlands of the middle and lower Dega zones. The primary objective of using this method is to reduce soil erosion in such away that long stemmed and farther apart groups are intercorpped by short crops such as teff and vetch where by the eroded soil is trapped by the mulching effects of these short crops.

4. Manuring

The use of manure to maintain and replenish soil nutrients is limited to the homesteads. None of the respondents in the sample PAs apply manure in their farmlands. The occasional drop of cow dung on farmlands is frequently collected to satisfy the demand for fuel. Dung is not even used as manure in homesteads in such areas as Asendabo and Debate PAs where acute shortage of fuel wood is prevalent. Animal dung forms the principal source of energy for the majority of the respondents. The utilization of animal dung as a source of energy is much more prominent in the lower Dega areas than that of the upper Dega and Wurch zones.

The distance between dwelling area and farmlands has sometimes been considered as a factor influencing the application of dung on farmlands. This is not the case in the study area. First, cow dung is not only the principal source of energy but also important source of cash to a farming household, especially in those localities that are found the in vicinity of the Wereda capital-Kuy. Utilization of dung as a source of energy is common in both urban and rural household. Secondly, the group discussion has revealed that peasants are not well aware of about the importance of dung in maintaining the fertility of the soil.

4.3.3. Modern Farm Inputs

The application of modern inputs is not common in the study area and is limited to the areas where teff is growing. Chemical fertilizers are not used in upper Dega and Wurch zones. It is only in the lower Dega and some parts of the middle Dega zones that fertilizers are applied to a limited extent and on limited type of crops. Table 9 gives the general impression of fertilizer application in the study area for three years (1985/86-1987/88 E.C.)

Table 9. Application of Chemical Fertilizers in Debay Tilatgin Woreda For the Year 1985/86-1987/88 E.C

Year	Area in ha	Type of Artificial Fertilizers		
		DAP	URIA	Total Fertilizer
1985/86	14696	129.5	296	425.5
1986/87	14791	838.5	659.5	1498
1987/88	15554	3304.5	2534	5838.5
Total	45041*	4272.5	3489.5	7762**

Source: Debay Tilatgin Woreda Agriculture Office, Agricultural Statistics Compiled By the Office, 1997.

*- Total only for cultivated land under Cereals in three years.

**- Total for fertilizer inputs in three years.

As it is indicated in the above table, there is a low level of the application of modern inputs in the study area. However, the application of fertilizers is increasing from time to time. With regard to the application of fertilizers in the sampled PAs, farmers, especially in the lower Dega zone are well aware of the importance of fertilizers. Thus, it is neither ignorance nor the supply problem that precludes farmers to use fertilizers but their weak purchasing capacity.

Table 10 summarizes the responses of interviewed household heads on the application of fertilizers. About 36% of farmers in the sampled PAs responded by saying that they apply modern fertilizers, albeit to a limited extent. Attempts have also been made to find the relationship between fertilizer application and crop yield. The correlation analysis result has shown that there is a strong positive relationship between the two variables in Debate (r=+0.9), Asendabo (r=+0.8) and Yebabat (r=+0.8). Out of the 250 respondents, not a single farmer responded to have used improved seeds, pesticides or weed killers

Table 10. Application of Fertilizer in Quintals Per hectare in the sampled PAs

PAs	Cultivated Land	Total yield	Fertilizer Appl/qt.	Application/ha	Correlation (yi/fer)
Debate	61.5	474	26	0.42	0.9
Asendabo	62.5	507	23	0.37	0.8
Yebabat	72.125	554	28	0.39	0.8
D/Iyesus	99.750	791	-	-	
Nabra	27.75	207	-	-	
Inekoy	58.5	485	-	-	
Total	382.125	3018	77	0.20	

Source: Computed by the author based on the household survey data

The role of irrigation as farm input is very low in the study area. According to the Woreda office of Agriculture there are about eleven rivers could irrigate 685 ha of area. This potential is not, however, fully utilized. So far the only 292 ha (about 43% Of the total potential) have been irrigated. Ironically, none of the sampled respondents reported of irrigating their farmlands. There was no report of farming through irrigation in the household survey.

The response of sampled peasants on the utilization of traditional methods of maintaining soil fertility and the application of modern inputs is summarized in the table below (Table 10). As has been indicated in the table, about 94% of sampled peasants apply crop rotation, 39.2% intercropping and only 13% have used manure to replenish soil in their farmlands. With regards to the application of modern inputs only 37.6% are users of fertilizers.

Table 11. Summary of Methods applied to maintain soil Fertility

PAs	Crop rotation		Intercropping		Manuring		Fertilizer		Others	
	yes	No	yes	no	yes	no	Yes	no	yes	No
Debet	38	-	18	20	4	34	31	7	-	38
Asendabo	39	-	23	16	3	36	30	9	-	39
Yebabat	44	-	32	12	6	38	32	12	-	44
D/Iyesus	69	-	25	44	-	69	1	68	-	69
Nabra	20	-	-	20	-	20	-	20	-	20
Inekoy	25	15	-	40	-	40	-	40	-	40
Total	235 (94)	15 (6)	98 (39.2)	152 (60.8)	13 (5.2)	237 (94.8)	94 (37.6)	156 (62.4)	-	250 (100)

Source: Computed by the author based on the household data gathered in 1998

V. THE STATE OF FOOD PRODUCTION IN DEBAY TILATGIN WEREDA

5.1. Land Use Pattern

The data about the general land use patterns in the study area are obtained from the Woreda Agriculture Office. As indicated in Table 12, cultivated land accounts for about 52% (36300ha) of the total area of the Woreda (69,995 ha). Of the total cultivated land, the area covered by annual crops was about 26427 ha (73%), leaving the remaining 9873 ha (27%) to perennials. Grazing land covers about 8949 ha or 12.8% of the total area. The areal coverage of forests, bushes and shrubs is about 6283 ha or about 9% of the total area. Land under settlement and other occupation is estimated to occupy 3752ha, accounting 5.4%. Water bodies claim 8528 ha (12.2%) whereas currently unusable land occupies about 6183 ha (9%).

Table 12 General land use Patterns of the Study area, 1998

Type of land use		Area (ha)
Cultivated land		36300 (51.9)
Area covered by Annual Crops	26427	
Area covered by Perennial crops	9873	
Grazing land		8949 (12.8)
Forest, bush cover and shrub land		6283 (8.9)
Currently unusable land		6183 (8.8)
Water bodies		8528 (12.2)
Settlement and others		3752 (5.4)
Total		69995 (100)

Source: Wereda Agriculture Office, 1998

5.2. Crop Production:

5.2.1. Areal coverage and Yield of Crops.

In the study area there is only one cropping season that which is confined to 'Kremt' season in summer. With the exception of some occasional cultivation such as of potato in higher altitudes areas of the upper Dega and Wurch zones, 'Belg' cropping is not practiced in the study area. The 'Meher' season, hence, accounts for almost100% of the cropped area and the total crop production in the sampled PAs. There are no reports of double cropping in all of the investigated PAs.

On the bases of the household survey conducted in the sampled PAs and information gathered from the Woreda agriculture office, cultivated land in the sample PAs accounts for about 34% of the total cultivated land in the Woreda. The average cultivated land per household for the study area is about 1.49 ha. There were about 24212 households in the Wereda in 1998. The average cultivated area per household for the sampled PAs (1.55ha) and sampled households (1.53) were not that different from the Wereda aggregate average. The total cultivated area of the sampled PAs was about 14771.4 ha, of which 382.125 ha were cultivated by the sample households (see Table 13). The remaining area is either considered as grazing land, especially in the flat lower Dega or severely eroded slopes that are occasionally used for grazing in Wurch, upper Dega and some parts of the middle Dega areas.

According to the data generated by the household survey, the total crop production in all the sampled households was about 3018 quintals. This output indicates that the average annual production was about 12.07 quintals per household. Cereals are the predominant crops both in terms of areal coverage and production. Of the total area under major crops, about 65% (250 ha) was occupied by cereals in1997/1998 harvest year. Pertaining to production, cereals claim about 64% of the annual production (1922 quintals). There was little variation between PAs i.e. crop production was invariantly dominated by cereals (refer to Table 13 b). Among cereals, however, there exists a well-defined variation between the sampled PAs.

Table 13 Sumary of Area coverd by Major Crops and Yield Per hectar in Sampled PAs

Crop	Debet			Asendo			Yebabat			D/Iyesus			Nabra			Inekoy		
	area	yield	ave.	area	yield	ave	area	yield	ave	area	yeild	aver	area	yield	ave	area	yield	ave
Teff	34	230	7.6	27.125	212	7.8	9	74	8	.500	4	8	-	-	-	-	-	-
Wheat	10.875	90	8.3	14.750	117	7.9	16.875	124	7.3	28.125	213	7.6	9.75	69	7.1	13.500	114	8.4
Barley	-	-	-	-	-	-	11.625	69	5.9	33.250	264	7.9	11	83	7.5	26.000	224	8.6
Maize	3.250	32	9.8	-	-	-	0.375	3	8	-	-	-	-	-	-	-	-	-
Bean	2.750	28	10.1	4.125	35	8.5	9.500	75	7.9	14.250	129	9.1	3.25	25	7.7	7.875	64	8.1
Field pea	-	-	-	-	-	-	3	21	7	13	94	7.2	2.75	22	8	4.875	36	7.4
Chick pea	-	-	-	7.000	60	8.6	9	81	9.0	-	-	-	-	-	-	-	-	-
Lentil	-	-	-	0.375	3	8	2.875	23	8	4.250	37	8.7	0.75	6	8	2.875	22	7.6
Vetch	8.875	79	8.9	9.000	79	8.8	6.375	55	8.6	.125	1	8	-	-	-	-	-	-
Niger seed	1.750	15	8.6	0.125	1	8	3.500	29	8.2	-	-	-	-	-	-	-	-	-
Lin seed	-	-	-	-	-	-	-	-	-	6.250	49	7.8	.25	2	8	3.375	25	7.4
Total	61.50	474	7.7	62.500	507	8.1	72.125	554	7.7	99.750	791	7.9	27.75	207	7.5	58.5	485	8.3

Source: Household Survey By the Author, 1998.

Teff is the most important crop in lower Dega zone (Debate and Asendabo PAs). Thus, it accounts for about 65% of the total production of cereals and 68% of the area under cereals. When we see the middle Dega zone, wheat and barely are much more important than teff. Hence, in Yebabat and some parts of Debre Iyesus PAs a greater area is devoted to wheat and barley, i.e., 90% of the area under cereals and 89% of the output. In the upper Dega and Wurch zones wheat ceases its importance and barley takes its place. Thus, in Inekoy and Nabra PAs 61% of the cropland under cereals is covered by barley and 63% of the total production of cereals is the share of barley.

The second important groups of crops grown in the study area are pulses. They account for about 31% of the total area under crops and 32% of the total crop production. Though pulses are secondary in terms of importance in all of the investigated PAs, (see Table 13 b) similar to cereals, one finds variations in the relative importance of different types of pulses between PAs. For instance, the production of vetch is more important in Asendabo PA than other crops in this category. Horse bean and field peas are important in the middle and upper Dega zones. Lentil is commonly grown in the upper Dega zone.

Oilseeds are the third group of crops that are grown in the study area. There are two types of oilseeds commonly cultivated in the study area with niger seed being cultivated in lower and parts of middle Dega zones and linseed in middle and upper Dega zones. In comparison to cereals and pulses, the relative importance of oilseeds in both area coverage (4%) and size of production (4%) is minimal (refer Table 13a).

Production of vegetables such as potato, onion and others is limited to homesteads. Of these garden products, potato is exceptional mainly because it is sown in a fallow land with minor preparation of the land in Wurch and some parts of upper Dega zones. Otherwise, farmland is not as such allocated for vegetables.

As it can be inferred from the above discussion, the relative importance of crops shows clear spatial patterns. In the study area, one of the major physical factors affecting spatial patterns of crop production is altitude. By its impact on climate, soil and slope, altitude plays a major role in determining the relative importance of crops. In the lower altitude area the climate is mild, the slope is gentler and the soil is deeper. With an increase in altitude firstly the climate will get harsher thereby limiting the variety of crops grown and secondly the slope will get steeper causing severe soil erosion.

Table 13 (a) Areal Coverage and amount of Production of major crops by sample households

Type of crops		Area (ha)	Production (qt.)	Average Yield (qt/ha)
Cereals	Teff	70.625 (18.5)	520 (17.2)	7.4
	Wheat	93.875 (24.6)	727 (24.1)	7.7
	Barley	81.875 (21.4)	640 (21.2)	7.8
	Maize	3.625 (0.9)	35 (1.2)	9.7
	Sub total	250.00 (65.4)	1922 (63.7)	7.7
Pulses	Bean	41.75 (10.9)	356 (11.8)	8.5
	Field pea	23.625 (6.2)	173 (5.7)	7.3
	Chick pea	16.000 (4.2)	141 (4.7)	8.8
	Lentil	11.125 (2.9)	91 (3.0)	8.1
	Vetch	24.375 (6.4)	214 (7.1)	8.8
	Sub total	116.875 (30.6)	975 (32.3)	8.3
Oilseeds	Niger seed	5.375 (1.4)	45 (1.5)	8.3
	Linseed	9.875 (2.6)	76 (2.5)	7.7
	Sub total	15.250 (4)	121 (4.0)	7.9
Total		382.125 (100)	3018 (100)	7.9

Source: Computed from Table 13,

Figures in parenthesis represent percentages

Table 13 (b) Areal Coverage and Yield of Crop Categories by agroecological Zones

Agroecological Zone	Cereals		Pulses		Oilseeds		Total	
	Area	yield	area	yield	area	Yield	Area	yield
Lower Dega	90	681	32.125	284	1.875	16	124	981
Middle Dega	99.75	751	62.375	516	9.750	78	171.875	1345
Upper Dega	39.50	338	15.625	122	3.375	25	58.5	485
Wurch	20.75	152	6.75	53	.250	2.0	27.750	207
Total	250 (65)	1922 (64)	116.875 (31)	975 (32)	15.250 (4)	121 (4)	382.125 (100)	3018 (100)

Source: Computed from Table 13
Figures in parenthesis indicate percentages.

5.2.2. Variation of Yield of Crops Per unit Area

The variation of yield for all the sampled PAs is analyzed through the calculation of standard deviation (SD) and coefficient of variation (C.V.). The result of the analysis is summarized in Table 14 and is interpreted at three levels; for all sampled Pas; between agroecological zones and within agroecological zones.

a). Variation of yields for all PAs

The aggregate variation of the yield of crops per unit area is generally low. The highest variation of yield is observed in the production of barley (3.0 S.D. and 36.6 C.V.) whereas the lowest in field peas (1.5 S.D. and 21.1 C.V.). With the exception of field peas the variation of the yield for pulses is more or less the same. Oil seeds also show lower variation on the aggregate level (2.5 S.D. and 30.1 C.V.). Generally, the variation is greater between agroecological zones than on the aggregate level.

2. Variation of yield between agroecological zones

The highest variation of yield In the production of teff is observed in the middle Dega zone(3.4 S.D. and 42.5 C.V.). The least variation is observed in the lower Dega (1.4 S.D. and 18.2 C.V.). When it comes to wheat, the highest variation is observed in the upper Dega (2.6 S.D. and 30.2 C.V.) and the lowest in the middle Dega and Wurch zones (1.8 S.D. and 23.4 C.V.). Similarly the yield of barley shows the highest variation in the middle Dega (2.8 S.D. and 37.3 C.V.)and the lowest and uniform variation in the upper Dega and Wurch zones (1.5 S.D. and 19.8 C.V.). Although maize is not widely cultivated in the study area, the highest variation of yield for this crop is observed in the lower Dega (refer to Table 14)

Within the group of pulses, the highest variation of yield is observed in the lower Dega. Horse bean is one of the crops cultivated in all of the sampled PAs and shows the highest variation in the lower Dega (3.4 S.D. and 36.1 C.V.) and the lowest is observed in upper Dega zone (0.6 S.D. and 7.8 C.V.). Similarly, the highest variation of yield in field pea is observed in the upper Dega (1.5 S.D. and 21 C.V.) and the least in the Wurch zone (1.3 S.D. and 16 C.V.). Chickpeas are crops cultivated only in the lower and middle Dega zones and do have the highest variation of yield in the lower Dega zone (2.7 S.D. and 32 C.V.) and the lowest in the middle Dega Zone (1.6 S.D. and 17.6 C.V.). Although lentil shows its highest variation in the middle Dega (3.6 S.D. and 42.4 C.V.), yield of this crop has shown no variation in the lower Dega zone (Asendabo PA). Vetch is cultivated in the lower and middle Dega zones showing the highest variation of yield in the lower Dega zone (2.8 S.D. and 31 C.V.) and the lowest the middle Dega zone (2.3 S.D. and 27.1 C.V.). Generally, with the exception of lentil, yield of pulses is observed to greatly vary in lower Dega than in any other agroecological zone (refer to Table 14).

Oilseeds show their greatest variation of yield in the lower Dega (4.2 S.D. and 48.8 C.V.). This is the greatest variation of yield in all the PAs. The second highest variation of yield of oil seeds is found in the middle Dega zone (2.2 S.D. and 26 C.V.) The lowest variation of oilseeds is observed in the upper Dega zone (1.2 S.D. and 15 C.V.) and Wurch Zone (1.3 S.D. and 17 C.V.).

3.Variation of yield between PAs of the same agroecological zone

In the lower Dega zone, the highest variation is observed in the production of oilseeds (4.2 S.D. and 48.8 C.V.), which is higher than the general variation observed in all of the PAs. The lowest variation of yield is observed in the production of teff (1.4 S.D. and 18.2 C.V.) and wheat (2.0 S.D. and 24.4 C.V.). Although horse bean shows the highest variation (3.4 S.D. and 36.1 C.V.), the variation of yield for pulses in the lower Dega is more or less similar.

In the middle Dega zone, unlike in the lower Dega, teff (3.4 S.D. and 42.5 C.V.) and lentil (3.6 S.D. and 42.4 C.V.) show the highest variation of yield. The lowest variation is observed in the production of chickpeas (1.6 S.D. and 17.6 C.V.). Barley also shows a relatively high variation (2.8 S.D. and 37.3 C.V.). With the exception of lentil, yield of pulses and oilseeds is almost the same for this zone.

In the upper Dega zone, wheat shows the highest variation (1.8 S.D and 23.4 C.V.) and yield of lentil exhibits the lowest variation (0.5 S.D. and 6.3 C.V.). In the Wurch zone crop diversity and the variation yield of crops are both low with the highest variation being observed for wheat (2.6 S.D. and 30.2 C.V.) and the least variation for horse bean (0.7 S.D. and 8.6 C.V.).

Although the variation of yield on the aggregate is very low, disparities in the yield of crops per unit area are relatively higher within the same agroecological zone. The highest yield per unit area is observed for bean and maize in the lower Dega zone. Maize, however, is not a major crop both in size of production and areal coverage. It is mostly grown on homesteads and the relatively good yield should be accounted for this reason. The other important figure that come into sight is the production of barley in the middle Dega zone. Yield of barley in Yebabat PA is very low being only 5.9 qt/ha, while the mean yield of barley in the middle Dega zone is 7.5 qt/ha. The area devoted for this crop in this PA was about 44% of the farmlands under cereals. Thus, it appears irrational to grow this crop while the yield of other crops is much better off.

Table 14 Variation of Crop Production in agroclimatic Zones

		Teff	Wheat	Barley	maize	bean	field pea	Chick pea	lentil	vetch	Oil seed
Lower	Debt	6.8	8.3	-	9.8	10.1	-	-	-	8.9	8.6
	Asendao	7.8	7.9	-	-	8.5	-	8.6	8	8.8	8.0
Dega	Mean	7.7	8.2	-	9.9	9.4	-	8.5	8	9.0	8.6
	S.D	1.4	2.0	-	3.4	3.4	-	2.7	-	2.8	4.2
	C.V(%)	18.2	24.4	-	34.1	36.1	-	32	-	31.0	48.8
Middle	D/Iyesu s	8.0	7.6	7.9	-	9.1	7.2	-	8.7	8.0	7.8
	Yebabat	8.0	7.3	5.9	8.0	7.9	7.0	9.0	8.0	8.6	8.2
Dega	Mean	8.0	7.7	7.5	8.0	8.8	6.8	9.1	8.5	8.5	8.4
	S.D	3.4	1.8	2.8	-	2.6	1.4	1.6	3.6	2.3	2.2
	C.V(%)	42.5	23.4	37.3	-	29.5	20.6	17.6	42.4	27.1	26.2
Upper	Nabra	-	7.1	7.5	-	7.7	8.1	-	8	-	8.0
	Mean	-	7.7	7.6	-	7.8	8.0	-	8	-	8.0
Dega	S.D	-	1.8	1.5	-	.6	1.3	-	.5	-	1.2
	C.V	-	23.4	19.8	-	7.8	16.3	-	6.3	-	15
Wurch	Inekoy	-	8.4	8.6	-	8.1	7.4	-	7.6	-	7.4
	Mean	-	8.6	8.6	-	8.1	7.1	-	7.5	-	7.6
	S.D	-	2.6	1.7	-	.7	1.5	-	2.0	-	1.3
	C.V (%)	-	30.2	19.8	-	8.6	21.0	-	26.7	-	17.1
All	Average	7.4	7.7	7.8	9.7	8.5	7.3	8.8	8.2	8.8	7.9
PAs	Mean	7.8	8.1	8.2	9.7	8.7	7.1	8.8	8.3	9.0	8.3
	S.D	2.2	2.0	3.0	3,2	2.6	15	2.8	2.6	2.8	2.5
	C.V	28.2	24.7	36.6	32.9	29.9	21.1	31.8	31.3	31.1	30.1

Source: Computed by the author based on Table 13.

5.2.3. Yield and Land use Decision of Farmers

As can be inferred from the above discussion and a simple observation of the previous tables, there seems to be some unwiseness on the parts of the peasants in land use decision (e.g. yield of barley and land allocated for this crop in Yebabat PA). It would, hence, be pertinent to examine the efficiency of farmers in land use decisions. To attain this objective two indices, Crop Concentration Index (ICC) and Relative Average Yield Index (RAYI), are employed in this study.

The figures from the crop concentration index and relative yield suggest that some peasants are making rational land use decisions while others are not (refer to Tables 15 and 16). Farmers in Debate PA (lower Dega) are typical examples of those that make unwise land use decisions. The crop concentration index here is higher for teff (3.4) while the relative average yield index is (91) and is the lowest of all crops. Although farmers in Asendabo PA are much better in their decision, they could have also concentrate lentil instead of check pea.

Tadesse (1989:140) quoting Mandal (1982) has indicated that, RAYI values well above 90 indicates a relatively high yields; i.e. efficient in the production of a particular crop. In this perspective, therefore, crops with high RAYI such as horse bean, are given the minimum share of the farmland. The interest of farmers towards this practice could be attached to two reasons. Firstly, teff is the staple food of the people particularly in the lower Dega. Secondly, though the yield per unit area of teff is low compared to other crops, the unit price of teff is higher than most other crops.

Just like those farmers in the lower Dega farmers in Yebabat (middle Dega) can also be labeled as inefficient in their land use decisions. Although CCI values below 1 are considered as no concentration, barley (0.8) is the second most concentrated crop in Yebabat PA. The RAY for this crop (75.6 which is much lower than the indicated level of efficiency) is, however, the lowest of all crops. The crop with the highest RAYI in Yebabat is teff (108.1) the CCI (0.7) is even lower than the crop with the lowest RAYI.

The other surprising observation almost in all of the PAs is the case of oil seeds. All of the PAs are efficient in the production of oilseeds but show no concentration of the crops. Oil seeds are crops with the highest unit price in the study area. The factor, which might be traced to this case, could be the fact that the seed prices for these crops are too high for the majority of the peasants to afford.

Farmers in Inekoy PA (Wurch/upper Dega) are more efficient in their land use decision. Barley and wheat are not only concentrated but also are crops with high RAYI. The other observation in the Wurch zone indicates that the peasants are highly concentrating wheat and barley, while the relative average yield for these crops compared to other crops such as field peas and linseed is very low. Thus, farmers in Nabra PA could have substituted barley and wheat for linseed and field peas. Barley however is the staple food of the people in the upper Dega and Wurch zones.

Table 15 Areal Concentration of main crops in the Sampled PAs.

	Debate	Asendabo	Yebabat	D/Iyesus	Inekoy	Nabra
Teff	3.4	2.6	O.7	0.2	-	-
Wheat	1.1	1.4	1.2	1.1	1.5	4.9
Barley	-	-	0.8	1.3	2.9	5.4
Maize	0.3	-	-	-	-	-
Bean	0.3	0.4	0.7	0.5	0.9	1.6
Field Pea	-	-	0.2	0.5	0.5	1.4
Check Pea	-	0.7	0.7	-	-	-
Lentil	-	0.1	0.2	0.2	0.3	0.4
Vetch	0.9	0.9	0.5	-	-	-
Niger seed	0.2	-	0.3	-	-	-
Linseed	-	-	-	0.2	0.4	0.1

Source: Field Survey, 1998 (based on Table 13)

Formula for Crop Concentration Index

$$CCI = \frac{\%\ \text{of area of each crop in a PA}}{\text{Total field crop in a PA}} \times \frac{\text{Total Area of each crop in all PAs}}{\%\ \text{area of each crop in all PAs}}$$

NB. < 1 = No Concentration
1-2= Low Concentration
2-3 medium concentration
> 3 high concentration

Table 16 Relative Average Yield Index of Crops

	Debet	Asendabo	Yebabat	D/Iyesus	Inekoy	Nabra
Teff	91.9	105.4	108.1	108.1	_	_
Wheat	107.8	102.6	94.8	98.7	109.1	92.2
Barley	-	-	75.6	101.3	110.3	96.2
Maize	101.0	-	82.5	-	-	-
Bean	118.8	100.0	92.9	107.1	95.3	90.6
Pea	-	-	95.9	98.6	101.4	109.6
Chick peas	-	97.7	102.3	-	-	-
Lentil	-	98.8	98.8	107.4	93.8	98.8
Vetch	101.1	100.0	97.7	90.9	-	-
Niger seed	103.6	96.4	98.8	-	-	-
Linseed	-	-	-	101.3	96.3	103.9

Source Household Survey, 1998

Formula for Relative Average Yield Index

$$RAYI = \frac{\text{Yield per hectare of each crop in a PA}}{\text{Average yield of each crop in all PAs}} \times 100$$

5.3. Factors Affecting Yield: Regression Analysis

It can be observed from the discussion in part 5.2.2. that yield varies between PAs and agroecological zones. This part of the paper is devoted to the identification of factors affecting yield. Attempts have been made to see the degree of association between the sets of paired variables. But neither the correlation nor its significance test can tell the way in which the two sets of variables are related. Regression analysis is applied when the objective is to estimate a functional relationship for predicting the values of a variable from one or more variables.

The objective of this part is to examine the functional relationship between variables. This study, therefore, has employed a linear regression model. Two separate regressions were run to identify the major variables affecting yield. The first regression is for all the sampled PAs while the second one for individual sample PAs.

5.3.1. Selection of variables, rationale of selection and the hypotheses

1. Dependent Variable

   Yield of crops per unit area: - Total out put per unit area (in quintals per hectare) for all considered crops for the year 1997 was calculated from the data collected in the survey.

2. Independent Variables: - Based on physical and socioeconomic considerations the following ten explanatory variables were selected:

   X_1 Cultivated Area (ha): - the data on cultivated area for each sampled household for the year 1997 were obtained from the household survey conducted by the author.

   X_2 Labor input (members of a household between 15-60 age): - This is the ratio of agricultural workers (15-60) in each household to the cultivated area owned by the household.

   X_3 Oxen supply - This refers to the ratio of the total number of oxen owned by a household to the cultivated area.

   X_4 Modern inputs: - Refers to the total quantity of fertilizer input in quintals per hectare of cropped area (applied only to the lower Dega zone mainly because the use of fertilizers in other zones is not common).

   X_5 Livestock Pressure: - This refers to the ratio of the total number of animals owned by a household to the cultivated area.

   X_6 Risk of erosion (dummy): - This is measured using dummy variable. Thus the respondents scored 1 if they face erosion in their farmland and 0 if they did not.

   X_7 Population Pressure: - Refers to man –land use ratio, obtained by dividing household size by cultivated area.

   X_8 Exposure to Extension Services: - This is measured using the weekly contact hours of farmers with extension agents.

   X_9 Land Insecurity: - This is measured using dummy variable. Hence respondents scored 1 if they feel secured with their holding and 0 if they are not.

   X_{10} Number of Plots: - This refers to the division of the farmland owned by a household into separate plots.

As stated above, nine explanatory variables depicting various characteristics of the farming practice of the 250 sample households were used. The variables were selected to represent levels of input, institutional and demographic conditions. Six explanatory variables were selected to represent various characteristic of farming systems that are likely to have significant effect on yield of crops per unit area. These are variable X_1, cultivated area; variable X_2, labor input; variable X_3, oxen supply; variable X_4 modern inputs; variable X_5, livestock pressure; variable X_6, risk of erosion.

Variables X_2, X_3, and X_4 are assumed to positively relate to yield because they are inputs. Whereas variables X_5 and X_6 are expected to be negatively related to yield as erosion is the major factor affecting soil depth and stock density is the other factor exposing the soil for various forms of erosion through overgrazing.

The remaining three variables X_7 (population pressure); X_8 (exposure to extension services); X_9 (land security) and X_{10} represent demographic and institutional characteristics of the selected Peasant Associations. The first two variables are expected to positively relate with yield. Based on the works of Boserup (1965, 1981) high population is associated with high yield per unit area. Therefore, X_7 is expected to be one of the positive correlates of yield. Variable X_8 is selected to see how important is the on- going extension service in increasing yield of crops per unit area.

Variable X_9 is included as explanatory variable on the idea that insecurity of ownership is one of the major factors affecting the management and wise exploitation of basic resources. Based on the results obtained from the group discussion with selected farmers and being cognizant of the frequent land redistribution, the attempt is made to finding a statistically significant association between yield and land insecurity. Thus, this variable is expected to negatively correlate with the yield of crops. Variable X_{10} (number of plots) is incorporated to see the effects of land fragmentation on the yield. Thus it is expected that fragmentation will have a negative impact on yield.

Hence the linear regression model used in this study has the following functional form: -

$$Yield = B_o + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + B_8X_8 + B_9X_9 + B_{10}X_{10} + Ui$$

Where B_0 - a constant

B_1-B_{10} - regression coefficients

X_1-X_{10} - selected variables (regressors described above)

Ui - Error term

5.3.2. Results of the Regression Analysis (Aggregate)

Before running the regression analysis, the associations of those selected variables were observed in the correlation matrix. The correlation matrix indicated some cases of multi colinearity between variables. This has been minimized using multicolinearity diagnosis and dropping some of the independent variables. Stepwise regression analysis has been applied to screen out the most important variables.

The multiple regression model-using yields of crops per unit area as the dependent variable indicated that four independent variables were not retained in the regression equation. In applying this model, it was predicted that exposure to extension service would be shown to make a significant contribution to the explanation of variation in aggregate crop yields in the sampled PAs. This variable, however, did not emerge in the regression as one of the significant correlates of yield of crop per unit area. Although it is found statistically unrelated, the role of extension services with respect to the relationship between DAs and farmers is discussed descriptively and some striking results have been observed (See chapter 6).

Variable X_7 (the ratio of family size per cultivated land), is drooped because of two reasons. First, it has shown colinearity with the independent variables such as cultivated land (X_1), labor input (X_2) and oxen density (X_3). Secondly, since the role of family size is already incorporated in labor input dropping this variable sounds appropriate. Land insecurity and number of plots as independent variables were incorporated in the regression analysis. Unexpectedly, however, these variables have failed to be statistically significant. Though the coefficients are of no analytical value, these two variables signal a negative relationship with yield. The possible reason that could be forwarded for rejection of insecurity form the regression may be related to the problem of subjectivity since it is incorporated in the regression as a dummy variable.

Given the above aspects, the remaining six independent variables were retained in the linear regression model. The most influential variable in the aggregate data is oxen supply (X_3). The regression result indicated that there is a strong positive association between oxen supply and yield of crops per unit area. The second variable that is strongly and positively correlated with yield is modern input (X_4). Although the role of fertilizer, on the aggregate, is minimal and its application is confined to only three PAs in the lower Dega zone the variable has emerged as one of the most important factors affecting yield.

In line with the formulated hypothesis, stock density (X_5) and the risk of erosion (X_6) have shown a strong negative association with yield. It should, however, be stated that the influence of stock density is, however, important only in the aggregate data. This is because of the varying characteristics of pasture availability, stock density and the total size of sample PAs. The risk of erosion is not only influential in the aggregate data but also in the individual sample PAs of middle/upper Dega and Wurch zones (See 5.3.3.)

The other variable that showed a moderate influence on yield yet statistically significant is labor-input (X_2). Since amount of labor input determines the nature of farm processing, it was hypothesized that labor will show a positive association with yield. As can be inferred from the summary of the regression analysis (Table17), the result confirms the hypothesis. The size of cultivated land (X_1) has also shown a positive association with yield. The possible reason for this kind of relation could be associated with the personal characteristics of individual holders, i.e., in the study area strong and efficient farmers possess more holdings. This was confirmed in the informal discussion that was held with some selected strong farmers and extension agents. Thus, it is the management of the land, which influence yield though it is directly related with size.

Generally, the strong positive relation between yield and those four influential variables confirms that oxen supply, fertilizer input, labor and, to some extent, size of cultivated land are important variables influencing yield of crops in the study area. The two variables, which are negatively associated with yield, are equally important in affecting yield in the study area. The adjusted R^2 (i.e., 0.79) indicate that the above stated variables explain about 79% of the variation of yields in the study area. Moreover, the F value of the regression equation is significant at 0.01 level.

Table 17 Summary of the regression analysis between independent variable (yield) and six regressors for all the sampled PAs

	Constant	X_1 Farm Land	X_2 labor input	X_3 Oxen density	X_4 Modern inputs	X_5 stock density	X_6 Risk of Erosion	Adj. R Square	F Stat.
All PAs	6.635 (6.103)	1.586 (4.411)	1.409 (6.717)	1.179 (3.548)	1.026 (6.202)	-0.120 (-2.967)	-2.143 (-6.277)	.79454	161.48
$Yield = B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4+B_5X_5+B_6X_6+Ui$									

Numbers in bracket indicate T values

Where B_0 is Constant

B_1-B_6 is Regression Coefficients

X_1-X_6 are explanatory variables (regressors)

Ui -indicates Error Term.

5.3.3 Regression Analysis at PA Level

The influence of those variables retained in the aggregate equation are not equally important when treated at individual PA level. The regression analysis was also run to examine yield of crops and the influential variables at individual PA level. Examination of regression result indicates that independent variables retained in each equation were relatively successful as predictors of yield in all of the sampled PAs. The results should, however, be considered with caution because of the small sample size involved in some of the PAs.

In Debate and Asendabo PA (lower Dega) four independent variables were found to be significant correlates of yield. These are cultivated land (X_1), labor input (X_2) oxen supply (X_3) and modern inputs (X_4). They are relatively strong predictors of yield in Asendabo (Adj. R^2= .82848) than in Debate PA (Adj.R^2 = .78526). The F value of the equation for both of the PAs is significant at 0.01 level. Two independent variables viz. X_5 and X_6 failed to appear as significant predictors of yield in these two PAs (for details refer to Tables 18 and 19).

The risk of erosion (X6) is, of course, very low in the lower Dega areas where the two PAs are located. This is because farmlands are commonly found in plain areas and the slope of the area is not as steep as in PAs located in upper Dega and Wurch zones. Stock density (X5) was expected to be significant predictor of yield in the lower Dega. But failed to be so in statistical terms. The influence of stock density is usually reflected on its impact on the farmland through over grazing. The latter is usually severe when attached with steep slopes. It may probably be due to the slope of the land that its role remained minimal in these PAs.

Table 18 Summary of the regression analysis between Yield and four significant variables in Debate

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.R Square	F Stat.
Debate	1.874 (1.850)	1.844 (2.016)	1.088 (2.285)	2.519 (2.394)	1.775 (2.337)	-	-	.78526	34.826
$Yield = B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4+Ui$									

Source: Computed by the author

Table 19 Summery of the regression analysis between Yield and four significant variables in Asendabo

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.R Squar	F Stat.
Asendabo	1.999 (.884)	2.379 (2.138)	1.500 (2.133)	1.788 (1.958)	1.404 (2.303)	- -	- -	.82846	46.880
$Yield = B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4+Ui$									

Source: Computed by the author

In Yebabat and Debre Iyesus (middle Dega) five variables are retained in the regression equation (refer to Tables 20 and21). It was assumed that stock density in the middle Dega zone would have a significant impact on yield. The variable, however, does not appear as determinant of yield in Yebabat PA. The reason for this state of affair could be attached to the fact that the proportion of the cultivated land to the total area of the PA is small when compared to the PA with in the same agroclimatic zone. The other possible reason that could be stated regarding this situation is similar to our observation in those PAs in the lower Dega zone. Although the altitude is higher, the surface configuration of Yebabat is similar to the PAs in the lower Dega zone.

The impact of livestock on farmland is minimal in Yebabat PA than in Debre Iyesus where stock density is significantly and negatively associated with yield. In Debre Iyesus PA, modern input (X_4) does not emerge as an important predictor of yield. This is because the amount of fertilizers applied in this PA was very small to affect yield. Conversely, the importance of fertilizers is well understood in Yebabat PA and the application is much better. Therefore, this variable has emerged as one of the major factors that affect yield positively.

The remaining four variables X_1, X_2, X_3 and X_6 are retained in the regression as significant predictors of yield in both PAs with varying degree of influence (see Tables 20 and 21). The retained variables in Yebabat PA are more successful in explaining the variation in yield than that of Debre Iyesus PA. The adjusted R^2 in Yebabat with a value of 0.82 indicates that about 82% of the variation in yield is explained by the retained variables. In Debre Iyesus the role of those five variables in explaining yield variation is moderate with the adjusted R^2 value being 0.64 indicating 64% of the variance in yield. The F value of the regression equation for both PAs is significant at 0.01 level.

Table 20 Summary of the regression analysis between Yield and four significant variables in Yebabat.

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.RSquar	F Stat.
Yebabat	3.023 (1.286)	1.934 (2.415)	1.494 (2.263)	1.934 (2.014)	1.202 (2.782)	- -	-2.454 (-2.206)	.82268	40.901
Yield = $B_o+B_1X_1+B_2X_2+B_3X_3+B_4X_4+B_6X_6+Ui$									

Source: Computed by the author

Table 21 Summary of the regression analysis between Yield and four significant variables in Debre Iyesus

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.RSquar	F Stat.
D/I	6.649 (3.669)	1.454 (2.53)	1.665 (4.417)	.939 (1.690)	- -	-.155 (-2.592)	1.576 (-2.501)	.64859	26.102
$Yield = B_o+B_1X_1+B_2X_2+B_3X_3+B_5X_5+B_6X_6+Ui$									

Source: Computed by the author

In Nabra PA, only three variables are retained in the regression. The most important variable, which is significantly and negatively related with yield is X_6 (risk of erosion). As Nabra is one of the PAs characterized by rugged topography, the result is as expected (see Table 22). The other variable, which appears as significant correlates to yield in this PA, is labor. Since the slope of farmlands is the major factor that affect the use of draft power, the farmland is often processed through human labor. Therefore, the significant and positive association of labor with yield could not be surprising. Land size is also retained as one of the factors affecting yield. The justification for this association is the same as that of the reason given in the interpretation of the regression in the aggregate data.

Probably owing to the surface configuration of Nabra PA the role of oxen supply (X_3) is minimal. It, therefore, does not appear as an important predictor of yield. Modern input are not applied at all, therefore, this variable is not incorporated in the regression. Stock Density (X_5) is the other variable which has no significant association with yield. The possible reason for this could be traced to the relative abundance of pasture in upper Dega and Wurch zones. Uncultivable hills are important sites of grazing in the PA and there is no need to compete for the farmland.

The three variables retained in the regression equation appear to explain about 73% of the variation in yield in Nabra PA. The value of F is significant at 0.01 level (refer to Table 22). The result should, however, be interpreted with caution because of the small sample size involved particularly in this PA.

Table 22 Summary of the regression analysis between Yield and four significant variables in Nabra.

PA	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.RSquar	F Stat.
Nabra	6.704 (3.505)	2.370 (2.261)	1.704 (2.739)	- -	- -	- -	-4.205 (-3.255)	.73961	18.998
$Yield = B_o+B_1X_1+B_2X_2+B_6X_6+Ui$									

Source: Computed by the author.

Lastly, the regression equation in Inekoy PA has retained four variables as statistically significant predictors of yield. Similar to Nabra PA, the risk of erosion (X_6) in Inekoy PA has emerged as the most influential and negative correlates of yield. In this case, however, oxen density (X_3) has appeared as a positive correlate of yield. The variance explained by the four retained variables is about 75% at 0.01 level of significance (refer to Table 23).

The role of stock density and modern inputs has no statistical relationship with yield. The reason for this condition is similar to the explanation given in the case of Nabra PA. Inekoy is the largest of all sampled PAs in total area. The proportion of cultivated land to the total area is the lowest of all sample PAs. Therefore, the size of gazing land is relatively higher in Inekoy than any other PA. Hence, stock pressure on the farmland is relatively minimal. With regard to X_4 (modern inputs), the variable is not incorporated in the regression analysis because it is not applied in this PA.

Table 23 Summary of the regression analysis between Yield and four significant variables in Inekoy.

PA	Constant	X_1	X_2	X_3	X_4	X_5	X_6	Adj.RSquar	F Stat.
Inekoy	2.233 (1.057)	2.440 (2.561)	2.236 (3.798)	1.774 (1.727)	-	-	-2.759 (-3.863)	.75365	30.829
$Yield = B_o+B_1X_1+B_2X_2+B_3X_3+B_5X_5+B_6X_6+Ui$									

Source: Computed by the author

5.4. The State of Livestock Production and Grazing Patterns in the study area

Ethiopia has one of the largest livestock population in Africa. The bulk of the livestock population of the country is found in the highlands. The study area is part and parcel of the Ethiopian highlands where both cultivation and livestock production (mixed farming) are practiced simultaneously. The peasant sector, using and managing almost 100% of the land, is conducting subsistence farming. Oxen are the only source of traction power in the study area. Livestock products such as milk and meat are both consumed and sold. Small flocks of sheep and goats are used mainly as sources of cash for the majority of the peasantry.

More often, livestock rearing is generally regarded as a major activity in the lowlands and is commonly viewed as of secondary importance. In the study area, however, the role of livestock production is as equally important as cultivation. According to the information generated through group discussion, the ever-increasing shortage of cultivable land is forcing the local people to pay attention to the production of livestock mainly of sheep and goats. Indeed, cattle production is the preferred one but the availability of grazing land is discouraging.

The livestock population of the sampled households for the year 1998 consisted of 949 cattle (including oxen); 1159 sheep and goats and 236 equines. As shown in Table 24 there is no significant variation between PAs in the average number of animals per households. The average number of livestock owned per household ranges from 6.9 in D/Iyesus PA to 11.8 in Yebebat.

Table 24 Number of animals owned by sampled households

PAs	Cattle	Sheep/goat	Equine	Total	Average
Debate	186	107	30	323	8.5
Asendabo	165	137	42	344	8.8
Yebabat	198	273	50	521	11.8
Debre Iyesus	157	268	56	481	6.9
Nabra	81	138	15	234	11.7
Inekoy	162	236	43	441	11.0
Total	949	1159	236	2344	9.4

Source: Household survey by the author, 1998

A comparison of animal density with farm size reveals that density tends to be relatively higher in PAs where farm size is relatively small. For instance, Nabra PA has the highest animal density but about 60% of the farmers cultivate farmland ranging between one to two hectares. Conversely, Debre Iyesus has the lowest animal density but the number of farmers with large holdings is almost equal to that of farmers in Nabra where animal density is higher.

One of the major reasons given by the respondents about the problems attached to livestock was shortage of pasture. Of the sampled household heads in this study, 205 (82%) of them indicated that they are facing a serious shortage of greasing land. In spite of acute shortage of grazing land, nearly 75% of the respondents indicated a desire to increase their stock. In Debate PA, for instance, 89.5% of the respondents are in favor of large number of livestock. A considerable number of respondents in Yebabat PA (56.8%) are also glad to possess large number of animals irrespective of shortage of land. They did not feel that reducing the size of their herds would help overcome the shortage of grazing. Almost all of the respondents in all sampled PAs are not interested to reduce the number of their stock.

When asked about the ownership of grazing land, it was found that almost all of the respondents are dependent upon communally owned grazing areas. Although farmers are dependent upon communal grazing areas, there are considerable numbers of respondents (about 70%) who shift part of their farmland to grazing land during the rainy season. This kind of grazing land is exclusively reserved for oxen. Other animals are not allowed to graze on such reserved areas.

Farmers were also asked to indicate if they have received extension service on pasture management. The result have shown that about 61% of the respondents have received advises on pasture management. Ironically, however, about 93.5% of the respondents confirmed that the advice they get from DAs is not helpful in minimizing shortage of pasture (refer Table 25). The solutions suggested by DAs are either to apply controlled grazing or some other modern systems, which are usually beyond the capacity of the farmers (see part VI for further discussion).

Moreover, it is often argued that peasants in the highlands including the study area are mainly interested in maintaining large herds for traction power (MOA, 1985 :8-9). However, the statistical correlation between human and livestock population is higher (R=+0.5) than the correlation between the intensity of cultivated land (proportion of the land under cultivation to the total land) and livestock population (r=+0.3). These statistical results indicate that the livestock are not only source of draft power but also significant assets that the peasants in the study area would like to accumulate.

The other common view to be challenged by this study is the view that crop production and livestock rearing are complementary. Clearly, livestock provide crucial support to cropping in terms of traction, manure and transportation. However, it is a common observation in the study area that cultivation and grazing are in fierce competition. As revealed in Table 26, no land is available for grazing except in those areas that are not suitable for cultivation either because of the slope problem or exhaustion of farmlands due to continuous cultivation for long period of time. Thus, as the aforementioned statistics indicate, as population increases, so does livestock density resulting in an intense demand for grazing land. This situation, therefore, appears to be the major cause of land degradation in the study area through its effect on vegetation cover.

Table 25 Summery of the view of the peasantry about pasture and pasture management.

Sample PAs	Is there shortage Of Grazing land in Your locality		Do you Consider Large livestock Size as a problem		Have you ever Received advice on Pasture management		Was the advice useful to minimize shortage of pasture	
	Yes	No	Yes	No	Yes	No	Yes	No
Debate	36	2	34	4	27	11	1	37
Asendabo	38	1	17	22	38	1	1	38
Yebabat	35	9	25	19	41	3	-	44
D/Iyesus	61	8	40	29	26	43	6	63
Nabra	10	10	18	2	20	-	2	18
Inekoy	25	15	31	9	1	39	-	40
Total	205 (82)	45 (18)	165 (66)	85 (34)	153 (61)	97 (39)	10 (4)	240 (96)

Source: Computed by the author based on the household survey data, 1998
Figures in parenthesis indicate percentages

In order to see the effects of livestock population on the land cover in the study area, examination of grazing patterns seem relevant at this point. To uncover the effects of livestock on land cover, attempts have been made to find a pattern in the location of the major cropping plots and the grazing areas in the sampled PAs. In the relatively plain lower Dega areas, settlement is in most cases located in flat areas surrounded by farmlands. In middle and upper Dega, the original location of settlements is on the top of a hill or at the slope of a higher ground.

Here, valleys and relatively plain areas are reserved for farmland and no settlement is made on these areas except for villages formed during the former government villagization program. Thus hills, valleys and mountain ridges are the major and notable sites of grazing in the study area.

When asked to tell whether their livestock are grazing in different areas during the rainy and dry seasons, an overwhelming number of respondents indicated that grazing occurs on the same land in both the rainy and dry seasons. This question was designed to examine whether there is a strictly followed pattern or not. Only 27% of the respondents answered that their livestock are grazed in different areas at different seasons (see table26)

In the middle and lower Dega zones, where human and livestock population are higher, shortage of grazing land becomes acute during the rainy season when all lands are covered by crops, though the problem is reported to exist in both seasons. Therefore, the communally owned grazing lands are barley enough to feed the existing stock and this situation is compelling farmers to leave some parts of their farmland uncultivated so as to feed their oxen. Therefore, the land will be continuously grazed until a point of removal of the land cover exposing the soil to torrential rainstorm, which is common in the study area, during the rainy season. Thus, it is conceivable that grazing is in direct competition with cropping even at a time when land is urgently sought for cultivation.

Therefore, there are two conditions that directly contribute to soil erosion under this situation. First, most of the livestock graze on slopes during the rainy seasons, a period when most erosion occurs, the slope gradient greatly increases the velocity and the volume of runoff. Thus, livestock grazing has a great impact on the loss of vegetative cover and degradation of the soil at a time when the worst form of erosion is taking place. Secondly, a large number of livestock are grazing in a very small area that are communally owned in times of wetness leading to the destruction of soil structure and the damage of organic matter.

Table 26 Summary of Grazing Patterns in the Study Area

Indicators / Asmple PAs	Do you graze in different areas in diff. Seasons		Shortage of graing is accute during --- season			Where is your grazing area during the dry season			Where do you graze your stock during the rainy season			
	Yes	No	Rainy	Dry	Both	farmlands after harvest	uncultiv able areas	communally owned grazing areas	Communlly owned grazing land	uncultiva ble hilly areas	part of the farmland is left uncultiv	others
Debet	5	33	2	9	27	23	-	15	-	2	36	-
Wodeb Iyesus	17	27	8	10	26	22	5	17	3	4	37	-
Asendabo	16	23	10	1	28	16	7	16	-	9	30	-
Debre Iyesus	21	48	32	3	34	51	16	2	2	20	42	5
Nabra	1	19	9	1	10	11	5	4	3	17	-	-
Inekoy	4	36	3	-	37	-	34	6	15	25	-	-
Total	64	186	64	24	162	123	67	60.	23	77	145	5

Source: Computd by the author based on household survey, 1998

Livestock also equally affect croplands. In the study area, almost all of the households graze their livestock on cropland during the long dry season, which lasts for about 6-7 months. Immediately after harvest, no matter where the area is located, croplands are left for uncontrolled grazing. Livestock roam every where feeding on crop residue and create enormous stress on the agricultural lands. This form of grazing results in soil crusting which reduces infiltration and the ability of the soil to absorb moisture. Consequently, the soil on the farmland becomes vulnerable to different forms of erosion. Thus, the effects of grazing pattern on the land are not only problems in a time when there is shortage of grazing land (rainy season) but also at the end of harvest time where the farmland is left for uncontrolled grazing.

In the study area, ownership of both farm and grazing land is transient and the management of the land varies with season. Private plots that are used for cropping during the rainy season are thrown open for public grazing after harvest. Each member of a PA would have unrestricted access to other members' plots during the dry season. With regard to communally owned grazing lands, no body is responsible for the management of the land with indiscriminate grazing taking a common place. This condition reminds us of the scholarly work of Garret Hardin's 'The Tragedy of Commons.' The real situation in the study area is, nonetheless, tempting to argue for and against the notion of the 'Tragedy of Commons'.

In a straight foreword observation, the problem appears to be related not so much to ' the tragedy of commons' mainly because neither communal nor private holdings in the study area are properly managed. The so-called 'private holding' attracts the attention of the holder so long as it is under crop. After harvest, the owner seldom bothers about his/her holding. In this perspective, therefore, improper resource management appears to be the problem. Closer examination of the situation is, however, tempting to strongly support Hardine's thesis. Farmers were asked in the household survey and in the group discussion as to why they are reluctant to conserve and wisely utilize their holdings. The absence of wise utilization and conservation of holdings in the study area, as reported by the household heads, is invariably related to the issue of ownership insecurity.

No body in the sampled households feels that his/her holding will remain with him for long. They do not believe that they are the owners of the holdings. Thus, the existence of private holdings in the study area is apparent and implied, as communal lands owned by a PA for these holdings are transient. In a situation where there is temporary ownership, the owner will simply maximize the immediate benefit without applying appropriate management practices leading in to the future. There is no reason for the owner to invest in the holding so long as he/she is sure that his/her holding will be taken partly or fully. In this perspective,

VI. Perceptions of the Peasantry to Resource Degradation and The Role of DAs in Resource Conservation

6.1 Perceptions of the Peasantry to Resource Degradation

The threats exerted by ever worsening resource degradation in Ethiopian environment are extensively debated issues. Numerous reports have been written and policy recommendations made on the subject. The Ethiopian government and donor agencies have formulated a series of policies to combat ecological degradation. However, little attention has been given on household level studies to identify the socioeconomic forces that accentuate the process of resource degradation. Environmental degradation is ultimately local, places specific process and must be understood as such. Given this, going down at local level, generating data and observing realities are of great importance to understand the problems of environmental degradation and forward possible solutions.

The aim of the foregoing discussion is to investigate the perception of the peasantry to resource degradation and the causes to the problem. Resource degradation in this study refers to land degradation. The problem of pollution due to industrialization and difficulties associated with excess utilization of chemical inputs can not be expected in the study area. For the sake of convenience, farmers' awareness about land degradation is analyzed into two categories, i.e. farmland degradation and deforestation. To identify the process of land degradation, some of the widely used indicators such as soil erosion, soil fertility, and soil depth, level of farmland stoniness, forest and fuel wood availability are selectively used. It has been attempted to forward these indicators to sampled household heads and gather information on the perception of the local people about resource degradation. Moreover, the information gathered through household survey has been enriched by group discussion with elderly farmers in the sampled PAs.

6.1.1. Farmers Perception towards Farmland Degradation

The responses of sampled household heads and the outcome of the group discussion are analyzed here descriptively. It must be acknowledged, however, that the indicators applied to assess resource degradation have been interpreted according to the responses of household heads and observations undertaken through Rapid Rural Appraisal that was undertaken at the time of the field survey. Thus, the findings should be understood in relative terms. Indicators such as soil erosion and soil fertility are difficult to measure let alone in studies of this kind with acute resource constraint and limited expertise even when the means and the resources are available. The level of soil erosion whether it is 'severe' 'moderate' or 'low' is determined by peasant experience and perceptions and is therefore based on subjective judgment. The underlying issue in posing these questions was to ascertain the farmer's awareness about land degradation.

During the household survey and group discussion, the peasants' views on the level of erosion were elicited and subsequently strengthened by on-the-spot observation of farming plots in some of the PAs. Farmers were generally reluctant in expressing their views about land degradation. This was because of the fear that DAs in their localities will interfere in their activities and the farmer will be 'ordered' to practice conservation activities that he/she may not consider useful (See 6.2 about peasant and DA relations). Even though farmers are fully aware of the importance of some of the conservation strategies suggested by DAs, they are not willing to devote their time and resource on a land that could be taken in some unforeseeable future. It, therefore, appears to be logical for farmers to refrain from expressing their views that might expose them for actions, which they do not like to perform.

Acknowledging this limitation, farmers were asked to express their views about the level of erosion on their cropland. The focus was on assessing the level of erosion on cropland mainly because, as indicated by different researchers, the loss of soil in Ethiopia is highest on cropland (see part 2.3). Moreover, it is easier for farmers to remember the condition of their farmland. The results along this line have indicated that about 77% of the respondents are facing the problem of soil erosion and about 19% of them have reported no problem of erosion in their farmland. Only a negligible proportion of the respondents (4%) were indifferent to the issue and failed to tell whether their farmland suffers from soil erosion or not (refer Table 28). In spite of the fear that farmers might conceal information, majority of the respondents seemed to be frank in expressing the incidences of land degradation due to soil erosion. The finding indicates the seriousness of the level of erosion in the study area.

Moreover, the response of the farmers has revealed that those who considered a serious problem of erosion are dominantly found in upper Dega and Wurch zones. Conversely, those peasants that have reported soil erosion as a minor problem or no problem at all are found in the lower Dega area. Field observation of some selected farmland in the sampled PAs supports the farmers. There are, however, some discrepancies: Firstly, farmers that are found in the same peasant association and are equally affected by land degradation gave responses that are not complementary. This is probably caused by the intra PA variation of surface configurations and secondly, though this study cannot give quantitative evidence, most respondents in sample PAs uniformly underrated the seriousness of the problem.

The group discussion was rather much more revealing than the household survey to uncover the farmers' view of the problem. The household head interview might have been influenced by different factors pertaining either to the respondent's own experience or the way the interview had been administered. The group discussion was free from any kind of abstraction and farmers were open in expressing their views. On the whole, the result of the discussion with those elderly farmers has revealed that erosion is much more severe in upper Dega and Wurch zones and farmers in those localities are fully aware of the incidence.

The other indicator applied as a measure of land degradation was the level of farmland stoniness. Just like soil erosion, farmers were asked to rate the level of stoniness of their farmlands. This can, some how, indicate the condition of soil depth. It was revealed in the field survey that levels of stoniness is severe in steep slope areas such as in Inekoy, Nabra and some parts of Debre

Iyesus PAs than in relatively plain areas of Asendabo and Debate PAs. The result of the household survey was almost complementary to what has been actually observed in the field survey. In spite of some variations in their topographies, all the sampled PAs, had numerous gullies. With the exception of one PA viz. Debate, all the others are affected by gullies.

Put numerically, about 34% of the respondents reported that they are suffering from severe farmland stoniness. Of the 72 respondents facing severe farmland stoniness, 43 were from two PAs (Inekoy and Nabra). About 36% of the respondents indicated that the level of farmland stoniness is moderate. Here also the majority of the respondents (52 out of the total 75) are from two PAs in the middle Dega (Debre Iyesus and Yebabat). On the other extreme, farmers with minor farmland stoniness constitute about 24% of the total respondents. These respondents are dominantly from lower and some parts of middle Dega (for details refer to Table 27).

Farmers were also asked if they had experienced a decline in soil depth and soil fertility. These indicators augment and validate the farmers' previous responses to the issue of erosion as it indicates soil loss. Although abut 66% of the respondents in the survey indicate that they had observed a decline in soil depth, a considerable proportion (about 26%) found it difficult to respond whether or not there had been a decline in soil depth. This was because of the fact that a change in soil depth is not as easily observable as farmland stoniness. In the group discussion, however, the author elaborated the question and farmers were allowed to combine their ideas in answering the question. Thus it was revealed from the experience of farmers that soil depth, especially in steep slope areas, is decreasing from time to time (see Table 28).

Table-27 Summary of Farmers Perception abut Farmland Degradation

Indicators / Sample PAs	Do you face problems of Erosion on your farmland?			Have you observed stonniness in your farmland?			Have you observed a decline in soil depth?		
	Yes	no	can't tell	Yes	no	can't tell	Yes	no	can't tell
Debet	12	26	-	30	8	-	18	8	12
Asendabo	20	10	9	32	7	-	25	5	9
Yebabat	37	7	-	36	8	-	29	2	13
Debre Iyesus	65	4	-	62	7	-	39	4	26
Nabra	20	-	-	17	3	-	17	1	2
Inekoy	40	-	-	34	6	-	36	-	4
Total	194	47	9	211	39	-	164	20	66

Source: Household Survey by the author, 1998

Table-28 Summary of Farmers View of level of erosion, farmland stoniness and decline of farmland productivity (1998)

Indicators / Sample Pas	How do you view the level of erosion ?				How do you view the level of farm land stoniness?				How do you view the decline in farm land productivity?			
	severe	moderate	minor	can't tell	severe	moderate	minor	can't tell	severe	moderate	minor	can't tell
Debet	-	-	12	-	2	6	21	1	-	8	27	3
Asendabo	-	4	16	-	4	10	15	3	8	6	25	-
Yebabat	5	16	15	1	7	18	8	3	-	16	26	2
Debre Iyesus	22	26	12	5	6	34	7	5	9	25	32	3
Nabra	10	7	-	3	13	3	1	-	12	6	2	-
Inekoy	25	10	5	-	30	4	-	-	20	18	2	-
Total	59	65	60	9	72	75	52	12	49	79	114	8

Source : Household Survey in the study area , 1998

Questions designed to summarize the effects of erosion, farmland stoniness and soil depth on farmland productivity have also been forwarded to the peasants both in the survey and group discussion. About 20% of the respondents reported that they had observed a severe decline in farmland productivity. The proportion of the respondents who cited a moderate decline is about 32%. On the other hand, For the majority of the respondents (46%), the decline of farmland productivity is minor. The results of the group discussion with some selected farmers complemented the outcome of the household survey.

The other question forwarded to the farmers was to state the major causes/factors responsible for land degradation. The major reason given by almost all of them was population growth. Nearly all farmers, both in the household survey and group discussions have confessed that they are cultivating the land more than they used to. The peasants' response sound mainly because the impact of burgeoning population on farm size particularly, when there is limited potential to expand land is a serious problem affecting farmlands. The size of individually owned plots is shrinking from time to time leading to intensive cultivation. In the absence of modern techniques that can enrich the soil and the conversion of dung as a source of fuel will inevitably result in farmland degradation. The other factor that has been mentioned by the peasants, especially in the group discussion, was lack of individual initiatives to conserve holdings due to socioeconomic constraints.

After assessing the view of the peasantry toward land degradation, farmers were asked to indicate the copping strategies that they use to alleviate land degradation. Many of them have reiterated the usage of traditional methods of maintaining soil fertility such as crop rotation, multiple and inter cropping (see part 4.3.3). Methods that are employed to protect the physical loss of the soil from farmlands, such as terracing, are rarely applied. This does not mean that peasants are ignorant about terracing and agro-forestry in protecting land degradation. It is the cost barrier that made it inapplicable in the study area. According to the elderly farmers, the greatest constraint that has impeded farmland management and related conservation activities is absence of ownership security.

6.1.2 Deforestation and Farmers' Perception

Even in the eye of the casual observer, the bare mountains and hills testify the extent to which deforestation in the study area has been intensified. Gullies swarming the hills of the study area are testimonies to this effect. With massive deforestation, it was known long before that the amount of moisture recycled into the atmosphere after rainfall diminishes while runoff increases. Hence, the disappearance of forest contributes to the disruption of the equilibrium, which ultimately affects the carrying capacity of the land. Thus, questions regarding the importance of forests in preventing land degradation were used as indices (indicator) to know farmers' perception to the problem.

Farmers do recognize the crucial role that trees and forests play in their livelihood. The most frequently cited use of trees has so far been for construction (45%) and fuel (43%). Besides The about 12% of the respondents indicated as trees are important sources of cash (refer to Table 29). The single most important tree species that is used both for fuel and construction in most of the sampled PAs is eucalyptus. There is altitudinal difference in the use of this tree. In the upper and some parts of middle Dega zones eucalyptus trees are mainly used for fuel and construction respectively. In the lower Dega, where the tree can grow with minimum limits exerted by temperature, the eucalyptus is basically used for construction. Utilization of this tree as a source of fuel in the lower Dega zone is often considered as a luxury and the major source of fuel is cow dung.

Table 29 Major Use of trees in the Sample PAs

PA	Fuel wood	Construction	Sale	Total
Debate	8	30	-	38
Asendabo	12	24	3	39
Yebabat	20	19	5	44
Debre Iyesus	35	21	13	69
Nabra	12	8	-	20
Inekoy	21	10	9	40
Total	108	112	30	250

Source: Household Survey

Despite the favorable physical condition for the growth of eucalyptus tree in the lower Dega zone, it is much more abundant in the middle and some areas of the upper Dega zones. Farmers were asked in the group discussion to state reason(s) for this state of affaire. Farmers in the lower Dega responded by saying that they often prefer to grow annual crops with a relatively higher diversity than devoting their land for perennial trees. The response of the peasants in the upper Dega is almost opposite to their counterparts in the lower Dega. Here crop diversity is limited as compared to the lower Dega and, more important, the relief is rugged embracing spectacular features of steep slopes and escarpments. Thus, these and other factors have led them to grow eucalyptus tree particularly in areas where cultivation is difficult.

The most important observation with regard to trees in the study area is that most of the planted areas are not recent ones. In the entire sample PAs, recently planted areas are very few and are totally under the command and supervision of the community forestry programs. The observed plant species in the community forestry program such as in 'Kuy Terara' and ' Doboza Terara' located in the lower Dega, are overwhelmingly dominated by a single type of plant known as Juniperous procera (Yeabesha Tid).

Natural forests are none existent in the study area. There are, however, some remnants in such areas as Konch Mariam, Debre Iyesus and Nazareth Medhanialem. These areas are located on high altitudes that are elevated above 3500 meters. Owing to the ecological limits, Erica arborea (Asta in Amharic) is the dominant plant species in these areas. The other features, which attract the sight of any by–passers, are churchyards. Here, the natural forests are well preserved. There are also some forested areas outside the church compounds composed of mainly old giant plants, mainly Tid, under the ownership of churches. Indeed, these areas are basically secured for religious purposes and access is only possible for churches. Though the security of these forests is not directly meant for ecological stability, it is an important reminder of the role of social institutions in the conservation of nature. Thus, it may be appropriate to suggest 'ecological theology' as a strategy to alleviate the problem deforestation and its ultimate effects on resource degradation.

Generally, the responses of farmers regarding natural forest had been consistent with what was actually observed in the field survey. Interviewers were thoroughly introduced as to what a natural forest constitutes and this was done in an attempt to avoid definition problems. The greater proportion of the respondents (87%) indicated that there are no natural forests in their locality. About 13% of the respondents reported that there are natural forests in their localities. Of the total number of respondents, 33 of them (13.2%) indicated the presence of natural forests (refer to table 30). The reason for the variation of respondents from the same PA reporting differently is directly related to the classification of a PA into small villages, locally known as 'Gote'. Therefore, if there is no forest in his/her 'Gote' a respondent may report as if there is no forest in the PA.

Table 30 The view of the Peasantry about trees and forests in the Sample PAs

Indicators	is there a natural forest		is there shortage of fuel wood		do you plant trees		do you support a tree planting program	
PAs	Yes	No	Yes	No	Yes	No	Yes	No
Debet	-	38	33	5	6	32	32	6
Asendabo	-	39	39	-	5	34	28	11
Yebabat	3	41	43	1	7	37	38	6
Debre Iyesus	18	51	56	13	13	56	48	21
Nabra	4	16	19	1	-	20	19	1
Inekoy	8	32	32	8	1	39	29	11
Total	33	217	222	28	32	218	194	56

Source: Household Survey

They were also asked to state reasons for the disappearance of natural forests. (refer to Table 31). The rapid loss of forests, according to the household survey and group discussion, is the direct consequence of the substantial increase in both human and livestock population. This, according to the peasants, has put more demand on forestland for cultivation and fuel wood consumption. Therefore, the major causes of the disappearance of forests include the increases in land cultivation, human consumption for fuel, housing and other necessities, livestock grazing and settlements. At the same time most of the interviewed farmers (54%) considered the need to expand cultivable and grazing lands as the primary cause. Clearly, the clearing of forests for annual crops and livestock rearing should take a common place so as keep up with the dramatic surge in population. As a prolonged fallow could no longer be sustained and forest and woody vegetation could no longer be regenerated.

Dwindling forest resources brought a serious shortage of fuel wood, in turn, escalating the corresponding reduction in the application of dung to enrich the soil's organic content. In the study area, particularly in PAs with scant forest resources, dung is increasingly used as a primary source of fuel. Hence, increasing the wood supply is an important means by which land degradation and soil erosion could be minimized. Though difficult to put it in numerical terms, it does not require advanced expertise to notice the bald reality that the demand for wood to meet basic needs is much higher than the supply in the study area. The most important factor in influencing the demand for wood is population size. Given the present trend of population growth, the possibility for adjusting this imbalance is dismal. The question then becomes whether this imbalance can be adjusted by increasing the wood supply.

Table 31 Causes of deforestation

Causes	Frequency	Percent	cumm. percent
The need for farm and grazing land	136	54.4	54.4
The need for fuel wood and construction	114	45.6	100
Others	-	-	-
Total	250	100	

Source: Household Survey

The fuel wood supply in the study area comes from trees around the homestead and farmlands; natural and man made woodland (refer to Table 32). Peasant households, in principle, have access to all of the above sources of fuel wood. Natural woodland is nearly exhausted and is not a reliable source. No matter how and who should utilize it, the contribution of community forest to peasant wood supply is insignificant. Such a scenario left the trees around the homestead as the single most important sources of wood supply. It has also been observed that individual interest in planting trees is dying out in the study area with only 13% of them showing some sign of interest.

Table 32 Principal Source of fuel wood of households in sample PAs

PAs	Wood	Dung	Crop residue	Total
Debate	8	25	5	38
Asendabo	12	23	4	39
Yebabat	21	18	5	44
Debre Iyesus	47	19	3	69
Nabra	17	3	-	20
Inekoy	33	6	1	40
Total	138	94	18	250

Source: Household Survey

The question that should be posed at this point is why are individual initiatives dying out. Here, a number of factors pertinent to social, economic and political problems could be cited. For the majority of the respondents,' to fear of confiscation, and shortage of land around the homestead and other areas stands out as the most important factors. Of the respondents who gave socioeconomic reasons for not planting trees, the largest proportion fall within the group that felt land insecurity (59%) (refer to Table 33). The problem of insecurity should have most probably if not wholly, been intensified due to the lack of clear laws governing the ownership and utilization of land. For instance, there were some cases where farmers, following the recent land redistribution, were prohibited to use their own tree within their former plots that were recently give to others.

Table 33 Major problems to plant trees

Problems	Frequency	Percent	Cumulative percent
Luck of Seedlings	16	6	6
Shortage of land	87	35	41
Security Problems	147	59	100
Total	250	100	

Source: Household Survey, 1998

Such a measure, according to official sources of the PA administrations, was designed in an attempt to avoid indiscriminate cutting of trees. This kind of measure would, however, have a detrimental effect on farmers' sense of agroforestry and its ultimate ownership. It seems as if the tragic consequences of these actions have not yet been understood and the issue of ownership to the peasantry in the study area is not in any case at good condition. The role of individual initiatives in afforestation is still marginalized because of land security problems. Putting aside the interest of individuals, the information from the group discussion reveals that the PA administrations do not give permits to individuals to plant trees around unoccupied gullies and bare lands.

6.2 The Role of Extension Services in Resource Conservation and DA-Peasant Relationships

The need for preserving natural resources and alleviation of degradation problems are felt and considered by the Woreda Agriculture Office. To this effect, a variety of intervention mechanisms are being applied. The development efforts are carried out through local actors, i.e. peasants and Development Agents (DAs). The behavioral and professional relationship between farmers and DAs has, however, been rarely assessed and very little has so far been done. The attempt in this part of the paper is, therefore, to assess the prevailing state of mutual understanding between peasants the two and examine its impact on resources conservation.

6.2.1 The Role and Position of DAs in the Extension Service

A development agent is a representative of the government agricultural service who is assigned at the village level. The functioning of a government agency vis-a-vis the rural population is basically uni-directional. The information flow and transfer of incentives descends from the national level through several geographical administrative echelons to the villages. By implication, DAs occupy a strategic position. They are the representatives of the government agricultural service assigned to operate at village level.

Due to their strategic position, local DAs are perceived as the link par excellence between the service and the local population. It is, however, questionable whether this approach viz. one way communication in the extension service with respect to the management of natural resources is appropriate. There should be a kind of two-way communication in the service offered whereby DAs would also convey local information and the needs of the population upwards. The critic, here, is not so much on the linear relationship but on the discontinuities resulting from the interaction between the two parties involved in the development process.

The result of the discussion that the author had with the staff of the Woreda Agriculture Office about the ongoing extension service and the DA-Peasant relationship confirms the hitherto existing uni-directional approach. They are working with full effort to implement their plan and are eager to see the desired outcome. Unfortunately, knowledge about the problems of DAs and the view of the peasantry towards the services that they offer is awfully scant. No matter how problematic the working and life environment in rural area, DAs are expected to implement the policy of extension services.

The problematic aspect of the position of DAs, which is called 'the interface' in development sociology, is rarely known. The 'interface', according to Wiersum and Deprez (1995:232), is conceived as a critical point of intersection or linkage between different social systems, fields of social order where structural discontinuities, based upon differences of normative values and social interest, are most likely to be found.

According to the idea of the interface, the DA is seen as an arena where the interest of the government, his/her own lifestyle (i.e., the personal domain of the DA), and the realities of the local population confront one another. The arena of interaction is often of a conflictive nature. Development agents are a point of intersection for two conflicting pressures. The first one is the interest of the state institution (agricultural office) based on an enduring ideology of the state stewardship over natural resources and the second is the interest of the peasantry with an enduring demand for autonomy. For the state institution, the DA is primarily appointed to exercise supervision and loyal compliance to the rules and regulations that are promulgated by the government.

As a result of these conflicting interests, the peasantry views DAs as watchdogs placed by the government to hinder the local people access to resources to which they claim traditional rights. Even worst than this, some even perceive DAs as a mole operating under cover whose primary objective is to practice espionage over the peasantry. The informal discussion with the peasantry during the field survey was an important source of information as to how the peasants view development agents. They never believe that the existence of DAs in their locality is of help to them. Moreover, even leaving aside the idea of what DAs are after, the outlook of the peasantry is filled with contempt about their efficiency. The entire activity is viewed as a funny thing whereby an urban amateur is wasting time to teach a borne farmer that has a complete mastery of his/her environment. This problem is much more severe particularly with regards to female extension agents. Seen the other way, the feeling of DAs towards their job and the peasantry at large is not good. They feel that the peasantry is a 'bad doer' on whom they have the 'authority with the expertise' to correct their 'unwise acts'. With regards to their job, they feel disadvantaged to lead a peasant style of life despite being educated. Generally, the actual relationship between extension agents and the local population in the study area is characterized by hidden hostility and fraught with problems.

6.2.2 The Effort of DAs and the Response of the Peasantry

The cumulative effect of conflicting interests and absence of consensus between the two actor's viz. DAs and peasants is directly reflected in the outcome of the extension services. As summarized in Table 34, farmers acknowledged as they are visited by DAs. They are often instructed by the local DAs to undertake a variety of conservation activities. When asked to indicate the importance of conservation and farming methods suggested by DAs, their response was invariably negative (see Table 34). In fact, the peasants do accept the importance of some of the methods initiated by the extension agents, but the problem is that they are not confident to undertake those methods because of a variety of socioeconomic constraints.

Table-34.Summary of the responses of the sample household heads about the assistance they receive

Indicators	Have you received advice/order to prevent soil erosion?		*Was the advice /order useful to avoid soil erosion?		Have you ever been encouraged/ordered to plant trees?		**Was the encouragement use full to avoid wood shortage?	
	yes	no	Yes	no	yes	no	yes	no
Debate	33	5	3	30	28	10	7	21
Asendabo	34	5	2	32	32	7	4	28
Yebabat	36	8	3	33	42	2	8	34
D/Iyesus	52	17	8	44	55	14	14	41
Nabra	14	6	2	12	15	5	4	11
Inekoy	34	6	3	31	32	8	5	27
Total	203 (81.2)	47 (18.8)	21 (10.3)	182 (89.7)	204 (81.6)	46 (19.4)	42 (20.6)	162 (79.4)

Source: Household Survey, 1998

** For yes respondents only

Figures in parentheses indicate percentages

The case of area closure better illustrates the state of resource management suggested by DAs and the Peasants. Area closure is one of the most important mechanisms applied to deal with the problem of land degradation. It is a protection system to improve land with degraded vegetation and /or soil through regeneration. It precludes livestock and human interference until the area is believed to have fully recovered. The most common form of this kind of protection in the study area is hillside closure. Though the mechanism is important and has no direct cost, it is resented by the peasants. This has something to do with the exclusion of peasants in planning and implementation such programs. In principle area closure is to be established in close consultation with the peasantry. In reality, however, peasants are simply instructed by DAs that a certain area is designated for area closure and each must comply with the instruction. This provides direct evidence of lack of participation among the peasantry in such activities that so greatly influence their lives. As a result, the peasants perceive area closure as another top-down order that intrudes in their lives and show disinterest in the program (refer to Table 35).

Table-35 Summary of the view of the peasants on pasture management and area closure

Indicator PAs	Have you ever received advice on pasture management		Was the advice useful		Does area closure exist in your locality		Do you support the practice and importance of area closure	
	Yes	No	Yes	No	Yes	No	Yes	No
Debate	27	11	3	24	19	19	-	38
Asendabo	38	1	5	33	11	28	10	28
Yebabat	41	3	6	35	30	14	9	35
D/Iyesus	26	43	7	19	25	44	19	50
Nabra	20	-	2	18	17	3	1	19
Inekoy	1	39	-	1	40	-	10	30
Total	153 (61.2)	97 (38.8)	23 (15)	130 (85)	142 (56.8)	108 (53.2)	49 (19.6)	201 (80.4)

Source: Household Survey, 1998
Figures in parentheses indicate percentages

Peasants' opinions about hillside closure is negative as summarized in Table 35. Nearly all of the respondents have asserted that area closure would result in shortage of grazing land. Ironically, hillsides are being protected while the most productive cropland is being exposed to enormous livestock pressure. Unless some mechanisms are sought that would compensate closed area or gain peasants' cooperation to change grazing patterns this kind of action will have a damaging effect in the currently productive lands.

Local authorities and DAs are trying to protect the over- exploitation of resources and are eager to see the implementation of successful conservation practices and resource recovery. This attitude, however, has no effect on the local people. Individual initiatives, the most important factor in any kind of development activity, are stifled due to a variety of socioeconomic constraints. In principle the local people are encouraged to practice resource conservation. In actual fact, however, preconditions such as the recognition of property rights and of the right of individuals should be respected to make both ends meet.

Recognition of property rights and land security are the key to the protection and restoration of natural resources. In the absence of legally secured ownership, it may be futile to attempt to conserve nature. Nor is it surprising that people started, for instance, felling trees indiscriminately under the feeling that if they do not do this now for themselves, others will do it soon, leaving them with nothing. While doing this, they are aware of the harm that would be inflicted upon the community in the future but have no alternatives to compromise the present for future conditions.

In nearly all-agricultural systems land is the first and most important production factor. Its availability, distribution and quality determine the production process and its potential results in the form of agricultural products and useful residues. Soil degradation and loss of fertility, deforestation and loss of biodiversty are all determined, to a great extent, by the situation in which land is managed and owned. The policy, which sticks on mere state ownership (monopoly) of land with the absence of individual initiatives and yet expecting people to conserve nature, would yield nothing. Individual farmers who lack the real sense of land ownership, the basic production factor, and whose first objective is survival are not expected to practice resource management.

VII. CARRYING CAPACITY OF THE STUDY AREA

One of the objectives of this study is to assess agricultural potential of the study area. The attempt in this particular section is to indicate the current level of food production and food requirement of the population. To this effect, an assessment of population support capacity is carried out for the sampled PAs. Based on the information gathered by household and field surveys, the current carrying capacity of the sampled PAs is estimated. In essence, the study focuses on the estimation of the current subsistence requirement of food for both the human and livestock population. For the sake of comparison the gross calorie available per head per day is examined before the population support capacity of the study area based on net calorie intake is undertaken.

7.1. Consumption (level of gross calorie intake)

In an attempt to draw a general view about the level of calorie intake the gross calorie available per head per day is analyzed for all the sampled PAs. According to the Ethiopian Nutrition Institute (ENI, 1977), the average daily calorie requirement per person is 2000, whereas the United Nations estimates put it between 2300 and 2400. In view of per capita production in the country, it is evident that per capita consumption will be rather low.

If the average gross production of different crops produced by a household is converted to calories, it is equivalent to 1785 calories per day per person (89.5% of the requirement of Ethiopian standard set by the ENI). Gross calorie available obtained from food crops vary among the six PAs. It ranges from 1605 in D/Iyesus PA to 2068 in Asendabo PA. It should, however, be kept in mind that this value is for the gross. The estimation has not taken into account reductions for marketing, seed requirement, post harvest losses and raw product conversion etc in to consideration (Refer to Table-36).

Table-36 Gross calorie produced from food crops in sample PAs

PAs	Produce/ Kcal	Teff	Wheat	Barley	Maize	Bean	Field Pea	Chick Pea	Lentil	Vetch	Oil seeds	Total Cal. 10^3
Debet	Produc	230	90	-	32	28	-	-	-	79	15	
	KcalX10^3	340	335	330	360	345	365	365	360	340	460	
	Total	78200	30150	-	-	9660	-	-	-	26860	6900	163290
Asendabo	Pro/qt	212	117	-	-	35	-	60	3	79	1	
	Kcal	72080	39195	-	-	12075	-	21900	1080	26860	460	173650
Yebabat	pro/qt	74	124	69	3	75	21	81	23	55	29	
	Kcal	25160	41540	22770	1080	25875	7665	29565	8280	18700	13340	193975
Debre Iyesus	pro/qt	4	213	264	-	129	94	-	37	1	49	
	Kcal	1360	71355	87120	-	44505	34310	-	13320	340	22540	274850
Nabra	pro/qt	-	69	83	-	25	22	-	6	-	2	
	Kcal	-	23115	27390	-	8625	8030	-	2160	-	920	70240
Inekoy	pro/qt	-	114	224	-	64	36	-	22	-	25	
	Kcal	-	38190	73920	-	22080	13140	-	7920	-	11500	166750

Source: Household Survey

However, crops are not the sole source of food in the study area. Peasants also consume meat, milk and milk products. But meat is eaten only on very special holidays like New Year, the Founding of the True Cross, Christmases, Easter and on one or two other holidays. Besides, there are occasions on which meat is consumed e.g. when there accidents, which may cause the death of animals (cattle, sheep/goats). As could be seen in Table 37, sheep/goats are the dominant source of meat followed by cattle and Chickens. On the aggregate, the consumption of meat is very low, which is about 37 kg/HH/year or about 15 grams of meat per head per day on the average (obtained by dividing the amount of meat available by the number of day in a year and household size). Similarly, consumption of milk and milk products is also very low with average household consumption confining to 44 litters or about 19 grams per head per day. However, the variation in milk consumption between the sampled PAs is very high ranging between from 68 litters/HH/year in Debet to 15 litters /HH/year in Debre Iyesus. The average calorie obtained from meat and milk is about 36 calorie per head per day.

Table-37 Annual Consumption of Meat and Milk (milk products) in Sample PAs

PAs	Beef		mutton		Chicken		Milk/products		Total Calorie
	Kg	calorie	Kg	calorie	Kg	calorie	Kg	calorie	
Debet	330	617100	930	1739100	57	68400	2565	949050	3373650
Asendabo	320	598400	1120	2094400	68	81600	2025	749250	3523650
Yebabat	410	766700	1210	2262700	66	79200	2475	915750	4024350
D/Iyesus	510	953700	1870	3496900	103	123600	1035	382950	4957150
Nabra	190	355300	530	991100	30	36000	945	349650	1732050
Inekoy	340	635800	1040	1944800	66	79200	1935	715950	3375750
Total	2100	3927000	6700	12529000	390	468000	10980	4062600	20986600

Source: Computed by the author from the household survey data

Note: The calorie obtained from beef and mutton is 187 per 100 gram. In the case of milk and milk products the calorie obtained from one gram of buttermilk (37/100gm) is taken to calculate calorie yield. This is because of the fact that rural households seldom consume milk but its by-products

Table-38 Summary of Gross calorie yield from food crops, meat and milk (milk products)

PAs	Annual Gross Calorie yield from :			Total annual calorie	Gross Calorie available per head per day[2]
	Food crops	Meat	Milk/products[1]		
Debet	163290000	242600	949050	164481650	1824
Asendabo	173650000	2774400	749250	177173650	2109
Yebabat	193975000	3108600	915750	197999350	1868
D/Iyesus	274850000	4574200	382950	279807150	1634
Nabra	70240000	1382400	349650	71972050	1826
Inekoy	166750000	2659800	715950	170125750	1879
Total	1042755000	16924000	4062600	1061559600	1818

Source: household Survey Data, 1998

[1] the reported number of cows is about 244. The result of the survey about milk consumption is almost equivalent to the estimates of Jhenke (1984:20) where the annual yield of milk is about 45k/cow

[2] Gross calorie from different sources is obtained by dividing total calorie yield by average size of sample households and number of days in a year.

Generally, food crops are the major sources of energy accounting for about 98% and the contribution of meat and milk is negligible contributing only to 2% of the available calorie. As indicated in Table-38, the gross calorie available per head per day ranges from 2109 in

Asendabo PA to 1634 in Debre Iyesus. Hence, with the exception of one PA (Asendabo), the gross calorie available per head is lower than the requirement for productive life. This being the general description of the gross calorie available of the sample PAs, the forgoing discussion will employ Population Support Capacity (PSC) model to analyze the carrying capacity of the land for both human and livestock population.

7.2. THE POPULATION SUPPORT CAPACITY (PSC) MODEL

The determination of the Population Support Capacity on an area-specific basis is based on a matching of the land requirements of the population for cropping and livestock production with the availability of land suitable for these purposes. Hence, the determination of Population Support Capacity is carried out in two stages. Firstly, the population requirement for cropland is compared with the net arable land in the sampled PAs. The results are expressed in terms of the ability of the land stock to support its population in different time horizons. Secondly, assuming a preferential allocation of land is made to different crops, an assessment is carried out on the ability of the remaining land suitable for grazing and crop residue to support the present livestock population. Towards this end 'Cropland Sub-model' and 'Livestock Sub-model' are used to make the above-stated assessments

7.2.1. Cropland Sub-model

While applying the Cropland Sub-model attempts have been made to calculate the total cropland requirement of an average family for each of the sampled PAs. The potential population carrying capacity of each PA is determined by comparing the total net arable land with the total cropland required by the population in 1998.

Although the Cropland Sub model provides the tool to investigate land requirement of households for cash crops and fallow, these two components are not considered in this study because land is not as such allocated for such kinds of land use types and farming systems in the study area. This study, therefore, confines itself to only the subsistence components. The total crop land requirement of an average family is calculated by using two alternative options. The first option is land requirement at low level of input, which roughly corresponds to the present situation in the area. The second option is concerned with the assessment of the land requirement at an anticipated 50% increment in yield (50%IY) that comes through the use of some fertilizers, insecticides, herbicides and improved management of resources.

The results of the modeling exercise are expressed in terms of the ability of the PAs to meet the land requirement of the present and projected population. The first stage in cropland sub-model is the assessment of the total area and the determination of the net arable land in each PA by excluding areas that are located on steep slopes, water logged area, and built-up areas. The net arable land is obtained from the records of the Wereda Agriculture Office that have recently undertaken land redistribution and from respective DAs that have compiled relevant data from PAs (refer to Table 39).

Table-39 Size net arable land in Sample PAs

Sampled PAs	Total Area in ha*	Net arable Land in ha**
Debet	4075	2502
Asendabo	4100	2435
Yebabat	3525	2794
Debre Iyesus	4350	2703
Nabra	1675	888
Inekoy	5875	1903
Total	23600	13225

Source: * CSA Department of Cartography, 1992
** Field survey and Records of WAO and DAs in respective PAs

The assessment of cropland requirement of an average family at the existing low level of input and an anticipated 50% increase in yield is the next stage. This is obtained by dividing calorie requirement of an average household by net calorie yield from one hectare. The latter, in turn, is based on crop mix of the sampled PAs. The productivity of a crop mix in each PA is calculated from the net crop yields and the proportional area under each crop. Net yields, expressed in quintals per ha, are then converted in to calories for calculation of land requirement for subsistence. Thus, land requirement for subsistence is equal to calorie requirement of an average household divided by net calorie yield from one hectare (for details about the calculation of net calorie from one ha, see Annex II). The annual calorie and land requirements of an average family in the sampled PAs are summarized in Table 40 and Table 41 respectively.

Table-40 Annual calorie requirement of an average family in the sampled PAs

Sampled PAs	Household Size	Age structure of Sampled Households (in years)			Average annual calorie requirement of average samples households
		<10	11-14	>15	
Debate	6.5	1.3	2.5	2.7	3905500
Asendabo	5.9	1.3	1.9	2.7	3555100
Yebabat	6.6	1.3	2.4	2.9	3993100
Debre Iyesus	6.8	1.7	2.2	2.9	4022300
Nabra	5.4	1.5	1.8	2.1	3131700
Inekoy	6.2	1.4	2.2	2.6	3693800
Average	6.4	1.5	2.2	2.7	3803300

Source: Household Survey Data

Note: Daily calorie requirement per adult = 2000

-Annual requirement of an adult = 2000X1X365=730,000) (INI, 1977)

-Average requirement of the age group 11-15 years is 80% of an adult (80%X730000) = 584000

-Average requirement of the age group 0-10 years is 50% of an adult (50%X730000) = 365000 (LUPRD/UNDP/FAO: 1989:147).

Table- 41 Land requirement of households for subsistence life

Sampled PAs	Average Household Size	Net Calories produced per hectare (10^6)		Calorie requirement /HH (10^6)	Land required for food(hectares)	
		Low	50% IY*		Low	50% IY*
Debate	6.5	1.911	2.947	3.905	2.044	1.325
Asendabo	5.9	1.916	2.955	3.555	1.855	1.203
Yebabat	6.6	1.786	2.757	3.993	2.236	1.448
Debre Iyesus	6.8	1.662	2.611	4.022	2.419	1.540
Nabra	5.4	1.453	2.297	3.132	2.155	1.363
Inekoy	6.2	1.663	2.546	3.694	2.221	1.451
Average	6.4	1.732	2.685	3.803	2.196	1.416

Source: Computed by the author

* IY denotes Increment in Yield

Human carrying capacity is obtained by dividing the net arable land by the land requirement of an average family. The result is compared with the 1998 population size of the sampled PAs (refer to Table 42). A comparison of the balance of cropland availability by PAs is given in Table-43 at the low level of input and with an anticipated 50% increase in yield. The study PAs show an overall current deficit of cropland of about 22% under the requirement of the population at the current state of farming system. With an anticipated 50% increase in yield, the cropland requirement will be fulfilled and generates a surplus of 20%.

Table 42___ Population Support Capacity (PSC) of Sample PAs

PAs	Net arable land (hectares)	Required Cropland for average HH (hectares)		Estimated size of households in1998	Population Support Capacity	
		Low	50%IY		Low	50% IY
Debet	2620	2.044	1.325	1226	1282	1977
Asendabo	2435	1.855	1.203	1263	1313	2024
Yebabat	2794	2.236	1.448	1407	1249	1929
D/Iyesus	2703	2.419	1.540	2184	1117	1755
Nabra	888	2.155	1.363	640	412	651
Inekoy	1903	2.221	1.451	1301	857	1311
Total/ave.	13343			8021	6230	9647

Source: Computed by the author from Table 41

Considerable variation is observed in cropland capacity of PAs at current level of technology to support the present population. Owing to the nature of surface configuration and fierce topography, PAs with the exception of Asendabo and Debet suffer from a considerable deficit of cropland at the current level of farming technology (refer to Table 43). The location of PAs is the major factor to determine the availability of cropland. In the plain lower Dega a surplus is observed while in steep sloped areas of middle, upper Dega and Wurch zones a deficit is observed.

Of the sampled PAs showing a deficit of cropland, Debre Iyesus is at a critical stage showing deficits of 48.9% and 19.7% of cropland both at low level of input and at an anticipated 50% increase in output per unit area respectively. Despite the deficit of cropland that is presently seen, the remaining PAs (Yebabat, Nabra, and Inekoy) could be self sufficient if the anticipated 50% increment in yield is achieved. In other words, Yebabat, Nabra and Inekoy PAs can support only 88.8%, 64% and 65% of the present population at low level of input but could bring a surplus of 36.7%, 1.7% and 0.8% of cropland required by the population at 50% increment in yield respectively. The two PAs in the lower Dega are indeed at good condition even at low level of input. The available farmland in Debet PA shows a surplus of 4.6% at low level of input but could rise to 61.3% at the anticipated 50% increment in Yield. Similarly a surplus of 3.9% in cropland requirement at low level of input is observed for Asendabo PA, which, however, could rise to 60.2% at 50% increment in yield (for details refer to Table 43).

Table-43 Balance of cropland and cropland requirement of households in the sampled PAs

PAs	Low level of input (hectares)		50% increase in yield (hectares)	
	Potential (%)	Surplus/deficit (%)	Potential (%)	Surplus/deficit (%)
Debet	104.6	4.6	161.3	61.3
Asendabo	103.9	3.9	160.2	60.2
Yebabat	88.8	-11.2	136.7	36.7
D/Iyesus	51.1	-48.9	80.3	-19.7
Nabra	64.4	-35.6	101.7	1.7
Inekoy	65.9	-34.1	100.8	0.8
average	78.0	-22.0	120.3	+ 20.3

Source: Computed by the author based on Table 42

7.2.2. Livestock Sub-model

In the study area livestock is an integral part of the farming system. The primary purpose of the cattle herd, which comprises the dominant livestock population in terms of Tropical Livestock Unit (TLU), is to provide traction for land preparation as draught animals. PAs can, therefore, be considered 'none critical' in terms of population support capacity if there is adequate land both for cropping and livestock.

In the model used in this study a preferential allocation of land to cropping is assumed. Data on livestock number that is obtained through the household survey is used to calculate the number of livestock in a PA. Taking the cropland required to support the present population as a base, the resources of each PA are further analyzed to determine livestock support capacity. The determination of the number of livestock in TLUs by PAs is obtained from the responses of the household heads via in the questionnaire and converted into TLU and multiplied by the reciprocal of sample size to obtain the total number of livestock population in a PA (see Table 44)

Table 44 Number of animals owned by sampled households and its TLU equivalent

PAs	Number of Livestock Owned by a Household and its TLU equivalent									
	Cattle	TLU	Sheep/ goat	TLU	Equine	TLU	Total	TLU	Average stock	TLU (average)
Debate	186	130.2	107	10.7	30	18.7	323	159.6	8.5	4.2
Asendabo	165	115.5	137	13.7	42	26.2	344	155.4	8.8	4.0
Yebabat	198	138.6	273	27.3	50	31.25	521	197.1	11.8	4.5
Debre Iyesus	157	109.9	268	26.8	56	35.	481	171.7	6.9	2.5
Nabra	81	56.7	138	13.8	15	9.4	234	79.9	11.7	4.0
Inekoy	162	113.4	236	23.6	43	26.9	441	163.9	11.0	4.1
Total	949	664.3	1159	115.9	236	147.5	2344	927.6	9.4	3.7

Source: Household survey by the author, 1998

Note: Conversion factors are 0.7, 0.1, 0.625 for cattle, sheep/goat, and equines respectively (FAO/UNDP, 1984)

Table-45 Livestock population in TLU in sample PAs (TLU Multiplied by reciprocal to sample size)

Pas	Cattle	Sheep/goat	Equine	Total
Debet	4200.25	345.18	603.26	5148.69
Asendabo	3739.89	443.61	848.36	5031.86
Yebabat	4432.43	873.05	999.37	6304.86
D/Iyesus	6092.62	848.22	1107.75	8048.59
Nabra	1814.40	441.60	300.80	2556.80
Inekoy	3687.77	767.47	874.79	5330.03
Total	23967.36	3719.13	4734.33	32420.82

Source: Computed by the author from Table 44 i.e., TLU multiplied by reciprocal to sample size.

In the study area, forage comes from crop residue, aftermath grazing and from grazing/browsing land (refer to Table 46). Forage from crop residue is obtained from yield data and conversion is made using residual/grain factor at low level of input and at an anticipated 50% increase in yield. Forage from aftermath (post harvest) grazing is obtained from the size of cropped area and yield data. Available grazing land is obtained by subtracting the total cropped area and the livestock exclusion area from the total area of the PA. Similarly, forage yield of natural grazing is calculated from the data obtained from the Wereda Agriculture Office (for details of calculation of see Annex III). The total forage supply is obtained by adding the forage supply from the three sources. Annual forage requirement in Kg of Dry Matter (DM) is estimated by using the formula forage requirement = TLU X 0.02X 250X365 (LUPRD/UNDP/FAO, 1986). Based on this formula, the annual forage requirement of the livestock population in each of the sampled PAs is presented in the Table 47

Table-46 Total Forage Supply by PAs (tons)

Pas	Forage Sources			Total
	Crop residue	Aftermath grazin	Grazing/browsing land	
Debet	2229.55 (3344.32)	1105.2	2618.6	5953.35 (7067.87)
Asendabo	2541.64 (3812.46)	1010.4	1964.7	5516.74 (6787.56)
Yebabat	2774.75 (4162.12)	1206.8	478.5	4460.05 (5847.42)
Debre Iyesus	3370.63 (5055.94)	1242.0	880.0	5492.63 (7177.94)
Nabra	852.53 (1278.79)	408.0	942.2	2202.73 (2628.99)
Inekoy	1976.55 (2964.82)	936.0	2678.8	5587.35 (6579.62)
Total	13745.65 (20618.45	5908.4	9562.8	29216.85 (36089.65)

Source: Computed by the author based on Annex III

* figure in parenthesis indicate 50% increases in yield

Tbale-47 annual Forage Requirement (in Kg of dry matter) by PAs

PAs	Total TLU	Forage Requirement in kg
Debet	5148.69	9396359.25 (9396.36)
Asendabo	5031.86	9183144.50 (9183.14)
Yebabat	6304.86	11506399.50 (11506.37)
Debre Iyesus	8048.59	14688676.75 (14688.68)
Nabra	2556.80	4666160.00 (4666.16)
Inekoy	5330.03	9727304.75 9727.30
Total	3242.82	59168014.75 (59168.01)

Source: Computed by the author

Figures in parenthesis indicate amount of forage in tones.

Examination of the availability of forage resources based on the current distribution of land use in the sampled PAs do indicate that the study area can currently support only 49% of the livestock population at the present low level of input. With increased input (50% IY) and improved practices in cropping, the livestock population support capacity of the study area can be raised to 61%. Put differently, the livestock supporting capacity of the study area is in critical stage both at low level of input and at an anticipated 50% increment in yield of forage. The balance between livestock forage requirement and the available forage resource is presented in percentage in Table 48

Table 48 The balance between Forage requirement and available resources in the sample PAs

Sample	Low level of Input		50% increment in Yield	
PAs	Potential (%)	Surplus/deficit (%)_	Potential (%)	Surplus/deficit (%)
Debet	63	-37	75	-25
Asendabo	60	-40	74	-26
Yebabat	39	-61	51	-49
D/Iyesus	23	-77	34	-66
Nabra	47	-53	56	-44
Inekoy	57	-43	68	-32
Total	49	-51	61	-39

Source: Computed the author based on Table 47

The situation is more precarious when we see it at PA level. Just like human carrying capacity, the livestock carrying capacity of Debre Iyesus PA is at critical stage supporting only 23% of the livestock population at low level of input and showing a minor improvement (34%) when allowing a 50% increment in forage yield. The next critical PA in livestock carrying capacity is Yebabat where the forage resource is only enough for 39% of the population at low level and 51% at fifty percent improved yield. In general, the livestock supporting capacity of all PAs is at critical stage.

VIII. SUMMARY OF FINDINGS, CONCLUSION AND POLICY IMPLICATION OF THE STUDY

This study has attempted to examine the currently burning issue of population and resources relationships by selecting Debay Tilatgin Wereda, which is located in East Gojjam-Amhara National Regional State. The study had been conducted by selecting six samples PAs covering 23600ha of area and 8021 households. Applying stratified sampling technique, 250 sample households were selected from six PAs to represent the target population. The summary of the findings made in this study would be highlighted hereunder

8.1. Summary findings

The study area is part of the north central massifs. The topography is rugged in the north and undulating in the south. The elevation of the area rages from 2400 to more than 3800 meters. In terms of agroecological distribution, 25% of the area is under Wurch and the remaining 75% under Dega ecological zones.

The study area is underlain by tertiary basaltic lava, which is covered by Quaternary deposits at higher altitudes. As to the type and distribution of soils, the higher slopes of Mount Choke are dominated by Andosols and Cambisols developed on pyroclastic parent materials. The plateau area is dominated by Vertisoles in the flatter and gently sloping areas with Cambisols, Luvisols and Nitosols on moderate slopes.

With the exception of few hillside closures, there is no observable forest in the study area. The lower and middle Dega areas are totally dominated by eucalyptus tree with occasional bushes. In the upper Dega and Wurch zones eucalyptus ceases its importance and gives way to some high altitude plants such as 'Tid' and 'Asta'.

Temperature is mild and pleasant in the lower Dega whereas it is harsh in the upper Dega and Wurch zones. Its influence is clearly observed in crop restriction and the stunted growth of plant observable in the zones. Most of the annual precipitation falls in the main rainy season ('Kremt') which normally spans June to September. Annual rainfall in the study area ranges between 1100-1250 mm for Wurch, 1150-1250 mm for upper Dega, 1050-1350 mm for middle Dega and 950-1300 mm for lower Dega.

The estimated population size of the Wereda in 1998 is 111310, of which 56207 are males and 55103 females. The current crude density of the study area is estimated at 1.6 Persons per hectare whereas the agricultural density at 3 persons per ha. The data generated based on the recently undertaken land distribution indicates that there were about 24,212 farm households in the Wereda having an average family size of 4.6 persons. Of the total population in the Wereda, urban population accounts for 4.8% (5326 in size) and rural population 95.2% (105,984).

The size of household members in each family varies from two in newly formed households to twelve in long established families. The sex ratio of the study area, according to the 1998 estimate, is almost one to one. Unlike sex ratio, there is a considerable variation in age structure resembling a pyramid that has a wide bottom and narrow apex. Taking the age group of 15-59 years as economically active and the population less than 15 and more than 59 years as economically dependent, the dependency ratio stands at 108.12%. This indicates that a single economically active person is expected to feed him/here self and more than one person.

The population is totally homogenous in ethnic and religious compositions with the entire population being Amharas and the followers of Orthodox Christianity. The survey result has also shown that the marital status in the area is of predominantly monogamous. The composition of families in the study area is almost the same and involves nuclear family members namely husband, wife and children.

The assessment of land tenure and administration, particularly the recent land redistribution, in the study area has shown that several factors were responsible to undertake the new land redistribution in the region. According to official sources at regional and Wereda level the major reason given was unjust land distribution, which benefited the former pro-government elements and the growing land demands that came as a result of growing demand by newly married couples. The authorities in the Region have strongly argued by saying that the marginalization of the bulk of the peasantry necessitated to undertaking the new land redistribution.

An attempt has been made to assess the attitude of the population towards the recently undertaken land redistribution. The majority of the population in the sampled PAs, including former PA leaders, was not against the distribution per se but were against the ways by which it has been effected. They showed reservations on its fairness. In principle, two major criteria have been followed for the allotment of land in the study area: family size and the quality of land. Meaning, farm size allotment has been assumed to consider the size of the family and the status of the land stock. The greatest discontent of the farmers in the study area lies on the subjectivity of the principles. Peasants were heard complaining that the fertile land is inaccessible to poor and marginalized peasants. According to the information gathered from the group discussion, most of the peasants in the study area felt disadvantaged in the face of the present PA leaders that are not different from the former ones. The study has also assessed the reaction of PA leaders about peasants complains. They seem to be over satisfied by the entire process and for them it was just and fair and, above all, it was taken as a great victory against 'bureaucrats' and 'feudal remnants'.

The study has also examined farm size and fragmentation. Currently, the maximum land size a household could possess is 3 hectares. Since there is no standard classification of land holding in Ethiopia, an attempt has been made to categorize land holdings of sampled PAs based on the upper limits (3 ha.) and lower limits (0.5 ha. for single): small holding (<1ha); medium holding (1-2ha) and large holding (>2ha). Based on this classification, the proportion of the small holders possessing about 6.9% of the total cultivated land is 5.2%. The medium farm size holders own 64.8% of the total farmland and support about 66% of the sample population. Similarly, large holders accounted for 28.3% of the total farmland and support about 28.8% of the population.

Simple correlation analysis has been run to see the relationship between farm size and family sizes. The overall result has indicated a direct but weak relation (0. 4). Looked at PA level, the relation is stronger in the case of Debre Iyesus PA indicating an r value of 0.7 and it is weaker in Debate and Asendabo PAs (r=+ 0.4). This implies that family size stands for far from being an explanatory factor in the variations of farm sizes (only16% is explained). There are many more factors that attribute to farm size variations such as nepotism, subjectivity etc.

Land fragmentation also stands as an important feature in the study area. The major cause for land fragmentation is the need to balance the distribution of poor and fertile land stocks amongst the population. The survey has indicated that the sampled households altogether cultivate 1081 plots with each household having an average of four plots. The level of fragmentation is higher in the lower Dega than in Wurch and Upper Dega zones.

This study has also tried to examine the condition of farming system and farm inputs in the study area. The results have indicated that like in many parts of rural Ethiopia, agricultural practices in the study area are also traditional. The commonly used farm implements in the study area include oxen, the plough, sickle, axe and other materials usually made by the farmer him self. Oxen are used as main traction powers and the utilization of other animals such as equines, as traction power to pull the traditional plough, is rarely practiced. Digging tools are used to prepare a farmland in areas that are too steep to use oxen power and, obviously, by oxen-less farmers.

Family labor and oxen are the most important input in the study area. All family members, including children aged above 6 years, are active participants in one way or another. The major farming activity, namely tilling the land, is exclusively the duty of males. Children are usually assigned in household activities. This does not, however, mean that children are free from agricultural activities. Food preparation, fetching water, firewood and dung collection, on the other hand, are the duties of women.

The number of oxen per household is related to the size of land holding. Households with a relatively larger land holding are the owners of more than two oxen. Simple correlation analysis has also been made to see whether there are relationships between family size and oxen, farm size and number of oxen. The findings have revealed that the correlation between family size and oxen is moderately positive ($r=+0.5$) whereas the association between farm size and oxen is strong ($r=+0.8$).

The application of modern inputs is not common in the study area and is limited to the areas where teff is growing. Chemical fertilizers are not used in upper Dega and Wurch zones. It is only in the lower Dega and some parts of the middle Dega zones that fertilizers are applied to a limited extent and on limited types of crops. Farmers that are found in the lower Dega zone are well aware of the importance of fertilizers but their weak purchasing capacity prohibited them to became users. None of the sampled respondents reported to have used improved seeds, pesticides or weed killers.

With regard to areal coverage and yield of crops, the average cultivated land per household in the study area is about 1.49 ha. The average cultivated area per household for the sampled PAs (1.55ha) and sampled households' (1.53) had not been that different from the Wereda average. The total cultivated area of the sampled PAs was about 12,461.4 ha, of which 382.125 ha (3%) was cultivated by the sample households. The total crop production in all sampled households was about 3,018 quintals. This output indicates that the average annual production was about 12.07 quintals per household. Cereals are the predominant crops both in terms of areal coverage and production. Of the total area under major crops, about 65% (250 ha) was occupied by cereals. The letter claim for about 64% (1922 quintals) of the annual production.

The second important groups of crops grown in the study area are pulses. They account for about 31% of the total area under crops and 32% of the total crop production. Though pulses are secondary in terms of importance in all of the investigated PAs, similar to cereals, one finds inter-PA variations in the relative importance of different types of pulses. For instance, lentil is commonly grown in the upper Dega zone where as vetch and chickpea in the lower and middle Dega. Oilseeds are the third group of crops that are grown in the study area. There are two types of oilseeds commonly cultivated in the study area with niger seed being cultivated in lower and parts of middle Dega zones and linseed in middle and upper Dega zones.

One of the working assumptions of this study was to prove whether there is a variation in the productivity of agricultural lands. The variation of yield of crops for all the sampled PAs has been analyzed through the calculation of standard deviation (SD) and coefficient of variation (C.V.). The aggregate variation of the yield of crops per unit area is generally low with the highest variation recorded for barley (3.0 S.D. and 36.6 C.V.) and the lowest for field peas (1.5 S.D. and 21.1 C.V.). With the exception of field peas the variation of yield for pulses is more or less identical. Similarly oilseeds have shown lower variations on the aggregate level (2.5 S.D. and 30.1 C.V.). Generally, the variation is greater between agroecological zones than at an aggregate level.

Despite the fact that the variation of yields on the aggregate is very low, disparities in the yield of crops per unit area are relatively higher between PAs of the same agroecological zone. The highest yield per unit area is observed for horse bean and maize in the lower Dega zone. Maize, however, is not a major crop both in size of production and areal coverage. It is mostly grown on homesteads and the relatively good yield should be accounted for this reason. The other important figure that came into sight is the production of barley in the middle Dega zone. Yield of barley in Yebabat PA is very low being only 5.9 qt/ha, while the mean yield of barley in the middle Dega zone is 7.5 qt/ha. The area devoted for this crop in this PA was about 44% of the farmlands under cereals. Thus, it appears irrational to grow this crop while the yield of other crops is much better off.

In order to prove one of the working assumption of this study, the efficiency of farmers in land use decisions has been analyzed using two indices viz. Crop Concentration Index (CCI) and Relative average Yield Index (RAYI). The results of both indices have revealed that some peasants are making rational land use decisions while others not. Farmers in Debate PA (lower Dega) are typical examples of those that make unwise land use decisions. The CCI here is higher for teff (3.4) while the RAYI value of 91 indicates that it is the lowest of all crops. Just like those farmers in the lower Dega, farmers in Yebabat PA (middle Dega) can also be labeled as inefficient in their land use decisions. Although a CCI value of below 1 is considered as no concentration, barley (0.8) is the second most concentrated crop in Yebabat PA. The RAYI for this crop (75.6, which is much lower than the indicated level of efficiency,) is, however, the lowest of all crops. The crop with the highest RAYI in Yebabat PA is teff (108.1) the CCI (0.7) is even lower than the crop with the lowest RAYI.

The other surprising observation that has been seen in almost in all of the PAs is the case of oil seeds. All of the PAs are efficient in the production of oilseeds but show no concentration of the crops. Farmers in Inekoy PA (Wurch/upper Dega) are more efficient in their land use decisions. Barley and wheat are not only concentrated but are also crops with high RAYI. The other observation seen in the upper Dega indicates that the peasants are highly concentrating wheat and barley while the relative average yield for these crops compared to other crops such as field peas and linseed is very low. Thus, farmers in Nabra PA could have substituted barley and wheat for linseed and field peas. Barley however is the staple food of the people in the upper Dega and Wurch zones.

On the bases of the findings pertinent to variation of yield and as per the objective of the study, attempt has been made to identify factors affecting yield of crops. Linear regression model has been applied to see the degree of association between sets of paired variables. Two separate regressions were run to identify the major variables affecting yield i.e. for all PAs on the aggregate and for individual PAs.

On the aggregate, the regression results have indicated that there is a strong positive relationship between yield and four independent variables, i.e. oxen supply, fertilizer input, labor supply and, to some extent, size of cultivated land. Conversely, two variables, viz. risk of erosion and stock density are negatively associated with yield (for selection and justification of variables see part 5.3.1.). The adjusted R^2 (i.e., 0.79) indicates that the above stated variables do explain about 79% of the variation of yields in the study area. The result is significant at 0.01 level.

With regards to the result of the regression analysis run at PA level, four independent variables namely, cultivated land, labor input oxen supply and modern input, are found to be relatively stronger predictors of yield in Debet and Asendabo PAs explaining for about 78% and 82% of the variations respectively. In Yebabat and Debre Iyesus PAs, four variables, viz. cultivated land, labor input, oxen supply and risk of erosion in both PAs and; additionally modern input in Yebabat and stock density in Debre Iyesus PAs are retained in the regression and explained the variation by 82% and 64% in the two respective PAs. In Nabra PA, on the other hand three variables, namely, cultivated land, labor input and risk of erosion explained about 73% of the variation in yield. The analysis in Inekoy PA retained one more variable (oxen density) in addition to those in Nabra PA to explain the variation in yield by about 75%.

The other concern of this study was the assessment of livestock production. The livestock population of the sampled households for the year 1998 consisted of 949 cattle (including oxen); 1159 sheep and goats and 236 equines. With regards to their distribution, there is a moderate variation between PAs in the average number of animals per households. More often, livestock rearing is generally regarded as a major activity of lowlanders and is commonly viewed to have secondary importance. In the study area, however, the role of livestock production is equally treated with cultivation. The other common view that is hardly supported by the findings of this study is the view that crop production and livestock rearing are complementary. Clearly, livestock provide a crucial support to cropping in terms of traction, manure and transportation. However, as commonly seen in the study area both of them are competitive instead of being complementary.

One of the major reasons given by the respondents about the problems attached to livestock raising was shortage of pastureland. Of the sampled household heads in this study, 205 (82%) of them indicated that they are facing a serious shortage of grazing land. In spite of such a bottleneck, nearly 75% of the respondents indicated a desire to increase their stock size.

The other attempt in this study was the assessment of peasants' perception towards resource degradation in their locality and to prove the working assumption formulated about the response of the peasantry to resource degradation. To identify the process of land degradation, some of the widely used indicators such as soil erosion, soil fertility, and soil depth, level of farmland stoniness, forest and fuel wood availability are utilized in this study. Attempts has been made to forward these indicators to sampled household heads and gather information on the perception of the local people about resource degradation. Moreover, the information gathered through household survey has been enriched by group discussion with elderly farmers in the sampled PAs. The results along this line have indicated that about 77% of the respondents are facing the problem of soil erosion and about 19% have reported no problem of erosion in their farmland. Only a negligible proportion of the respondents (4%) were indifferent to the issue and failed to tell whether their farmland suffers from soil erosion or not.

The other question forwarded to the farmers was to identify the major causes/factors responsible for land degradation. The major reason given by almost all of them was population growth. Nearly all farmers, both in the household survey and group discussions, have confessed that they are cultivating the land more than they used to do in the past. The peasants' responses seem sound mainly because the impact of burgeoning population on farm size, particularly, when there is limited potential to expand land, is a serious problem affecting farmlands. Lack of individual initiatives to conserve basic resources was also reported in the group discussion as one of the major factors worsening resource degradation.

With regards to forest resources, the rapid loss of forests, according to the household survey and group discussion, is the direct consequence of the substantial increase in both human and livestock population. This, according to the peasants, has put more pressure on forestland both for cultivation and fuel wood consumption purposes. Therefore, the major causes of the disappearance of forests include the increase in cultivation, human consumption for fuel, housing and other necessities, livestock grazing and settlements. It has also been observed that individual interest in planting trees is dying out. This is related to a number of factors pertinent to socioeconomic problems. For the majority of the respondent fear of confiscation of trees (ownership insecurity) and shortage of land stands out as the most important factors.

This study has also attempted to assess the role of extension services in resource conservation and DA-peasant relationships. The information flow and transfer of incentives in the extension service is basically unidirectional in which a certain package flows from government agency (agriculture office) to the local level without any attempt to consult the peasantry. Owing to the national policy, the government agency follows an enduring ideology of state stewardship over natural resources whereas the peasantry wishes to have autonomy. As a result of these conflicting interests and top-down nature of the extension service, the peasants view DAs as watchdogs placed by the government to hinder local people access to resources to which they claim traditional rights. The survey data and group discussions have also revealed that the actual relationship between extension agents and the local population in the study area is clouded with a state of hidden hostility and fraught with problems.

The assessment of population supporting capacity has also been carried out to examine the balance between the current supply of suitable land for cropping and forage production at two input levels and requirements of the present human and livestock population. The results have revealed that given the current low level of crop and livestock productivity and competition for land between cropping and grazing, there is an overall deficit of 22% and 49% for the requirement of cropland and forage production at the present level farm input. On the other hand, with a possibility of 50% increment in yield the available cropland shows a surplus of 20% at the current requirement. The situation in forage production, however, is different and the deficit is still prominent (39%) at an anticipated increment in yield.

8.2. Conclusion

Generally, the findings of this study confirm the fact that the current human and livestock population is outweighing the carrying capacity of the area. The problem is escalated by the ever-worsening resource degradation in the study area. Government agencies, such as the Wereda Agriculture Office, are striving to reverse the situation and the peasantry is encouraged to practice conservation activities prescribed by the government experts who hardly know the peasantry and his locality. Conservation mechanisms such as area closure are usually designed and implemented with out any attempt to consult the local people. In this perspective, though it might be too early to comment on, it is tempting to draw a conclusion that the current decentralization process has failed to invite the involvement of local people in the formulation of policies/strategies to be practiced in their localities.

The result of the household survey and group discussion has revealed that the involvement of the peasantry in conservation activities is not based on consensus but rather force. The major problem that precludes personal initiative among the peasantry to practice resource conservation is lack of ownership security and absence of clear guidelines in resource utilization.

Problems associated with land tenure are controversial in the sense that many scholars argue for and against state ownership of land. The major rationale given by those scholars in favor of sate monopoly of land is the fear that landlessness would escalate within rural population if the peasantry is granted absolute autonomy. The bold reality, however, is that such a policy that is designed to protect the peasantry is acting against the objective thought to address. The findings of this study have also clearly indicated that the current land policy, inter alia, is actively contributing to resource degradation, malnutrition and phenomenal growth of rural poverty. Central to the problem of land issue is the administration at PA level, which is run by pro government forces.

The policy that is promoting state monopoly of the basic production factor is exacerbating the misery of poor. The ever-worsening resource degradation and the steadily shrinking carrying capacity of land resources in the study area seem to be the result of policy induced problems. Peasants in the study area are suffering from the cause of declining soil fertility-not so much because they are greedily exploiting the land but because they simply do not have the autonomy over their land and the resources to make the simple investments to protect and replenish soils. If poor farmers are given tenure security rather than keeping it as state owned or open access, they would be able and willing to invest in protecting the soil.

Empowering the poor through granting private ownership of land is a means to restore the utterly crippled situation of individual initiative to conserve nature and a way out of the soul-destroying impacts of poverty. The advantages of private ownership of land seem much higher than the would-be side effects. Thus, policy makers at national level should reconsider the prejudice against private ownership of land. Security to ownership of land, the basic production factor, is the base for food security for the present population and could also act as means of transferring resources for the generation to come.

8.3. Policy implications of the Study

Based on the findings of this study, a set of policy measures are suggested here under:

1. Protection of natural resources from irreversible depletion is a central point. However, for areas with high fertility- like the study area, a mere attempt to protect the environment alone is not possible. The need to improve productivity is fundamental. To produce more from a given unit of land one needs modern inputs. Hence, the provision of fertilizers, improved seeds and improved farm implements etc, should be made accessible through purposely-organized agencies on credit basis.
2. Changing the present farming system requires better control over water, which can be accomplished by flood control and irrigation schemes. The expansion of irrigation

facilities will definitely increase productivity. In this regard the potential of rivers, particularly in lower Dega, is enormous. Moreover, the development of small ponds in the field and unused barren land to hold water could be accomplished by the peasantry with little investment. This would help peasants to enjoy more than one cropping season

3. To improve the poor calorie intake in the study area, total dependency on grains should curbed by introducing changes in dietary habits and supplementing the usual and mono-type food by vegetables, which would be available for every household without high cost and a large farmland.

4. In order to alleviate the fierce competition between cropping and grazing and minimize its ultimate impact on land degradation, the number of livestock swarming in the study area should be minimized. Introducing a limited number of animal breeds, which could compensate the existing large, albeit but low-product, stock could be taken as a panacea to this problem.

5. The relationship between DAs and the peasantry is the most important factor for the success of the extension service. To achieve this, the peasantry should reap concrete benefits from the services rendered by DAs. The professional efficiency of DAs must be improved through in-service training and capacity building. Moreover, the top-down nature of the existing service provision must be reversed so as to allow local people identify their own problems and provide the service in line with their desires.

6. Absence of clear laws towards land use and ownership is a basic problem escalating ownership insecurity. If the government is to stick to the present policy, a solid ground must be laid towards this end. The peasantry should be convinced about the regulations governing the administration of basic resources. There must also be prudence not only in selecting PA leaders but also equipping them with the rules and regulations pertinent to land administration.

7. Finally, the findings of this study and the prevailing economic system are hard incentives to recommend private ownership of land whereby the autonomy of the peasantry will be respected and a more reliable resource management and utilization would be achieved.

REFERENCE

Assefa Hailemariam, 1992, An overview of the Determinants of High Fertility in Ethiopia. Ethiopian Journal of Development Research V.14 No.2 PP1-30

Abbi Mamo, 1995 "Environment, population and agricultural development in Ethiopia", in Dejene Aredo and Mulat Demeke (ed), 1995, Ethiopian Agriculture: Problems of Transformation, Addis Ababa.

Abebe Zegeye, 1994 " Environmental degradation, Population movement and war". In Ababe Zegeye and S. Pusewang (ed), 1994, Ethiopia in change. British Academic Press, London.

ADB/ECA (African Development Bank/ Economic Commission for Africa) 1989 Economic Report on Africa, Abidjan and Addis Ababa. Afshar Hareh (ed) 1987 Women, State and Ideology studies from Africa and Asia, London: Macmillan.

Behnke, R.H and Scoones, I 1993. *Rethinking range ecology*. Implications for rangelands management in Africa. London: International Institute for Environment and Development.

Behinke R.H., Scoones, I and Kerven, C. 1993. *Range Ecology at Disequilibrium*. Overseas Development London: Overseas Development Institute.

Bell, R.H.V 1985. *Carrying capacity and offtake quota*. In Bell, R.H.V and McSane Caluzi, E (eds.) Conservation and Wildlife Management in Africa. Washington: US Peace Corps.

Bille, Jc and Assefa Eshete 1983. *Rangelands management and range condition:* A Study in the Medecho and Dir Hara areas of the effects of rangeland utilization. Addis Ababa: ILCA (International Livestock center for Africa).

Boserup, Ester 1965. The conditions of agricultural growth: The economics of agrarian change under population pressure. London: Allen and Unwon. (Republished, London: Earth's can, 1993)

Bounder, B., 1987 Environmental problems in developing Countries, Progress in Physical Geography, vol. 11, No. 2.

Campbell, J., 1991 "Land or Peasants? The dilemma confronting Ethiopian resource conservation", African affairs, 5-21, 90.

Caughley, G 1979. " *What is this thing called carrying Capacity?"* In Boyce MS and Hayden-wing L.D (eds.) North American Elk: Ecology, behavior and management, Laramie Wyoming University Press

CSO/CSA, 1987 Agricultural Sample Survey, Results of Area and Production by Sector. Addis Ababa.

CSA 1996, Statistical Abstract. Addis Ababa

CSA (Department of Cartography) 1992, Area of Peasant Associations in Debay Tilatgin Wereda, Addis Ababa

Daniel Gemechu, 1990 "Environment and Mass Poverty" in Pauswang, et al (ed.) Ethiopia Development Options. London: Zed Books Store, Ltd.

Dejene Aredo, 1996, Population density, cultivation systems and intensification in pre industrial agriculture: Review of the literature and illustrations from Ethiopia. In Mulat Demeke and et al (ed), 1996 sustainable intensification of Agriculture in Ethiopia: Proceedings of the Second conference of the Agricultural Economists Society of Ethiopia, 3-4, October 1996, Addis Ababa, Ethiopia.

Dejene Aredo and Teferri Regassa, 1995, "Land Tenure and Policy issues in Ethiopia" in Dejene Aredo and Mulat Demeke (ed), 1995, Ethiopian Agriculture: Problems of Transformation, Addis Ababa.

Dejene Aredo and Mulat Demeke (ed) 1995, Ethiopian Agriculture: Problems Of Transformation. Proceeding of the fourth annual Conference on the Ethiopian economy, Addis Ababa.

Dennis J. Mahar (ed) Rapid Population Growth and Human Carrying Capacity. Two Perspectives, World Bank Staff Working Papers No. 690, Population and Development Series No.15.Dessalegn Rahimatto, 1986 " The crisis of livelihood in Ethiopia", Paper presented at the Peace and Development, University of Sussex, England, April 13-18.

Dessalegn Rahimatto, 1987 Famine and Survival Strategies, A case study from Northeast Ethiopia, Food and Famine Monograph series No. 1. Addis Ababa, Institute of Development Research (IDR).

Ehrlich, P.R, Ehrlich, A.H, E, Holder, 1977 ECOSCIENCE: Population, Resources, Environment. San Francisco: W.H Freeman and Company:

Ellis J.E and Swift, D.M 1988 *Stability of African Postural ecosystem:* Alternate paradigms and implications for development. Journal of Range Management 41: 450-459.

EMA (Ethiopian Mapping Agency) 1981, Atlas of Ethiopia, Addis Ababa

Estephanos Oqubasellassie, 1995 Agricultural Sector development policies and strategies in Ethiopia, FAO, Addis Ababa.

FAO, 1986, Ethiopian Highlands Reclamation Study (EHRS) Final Report, Rome, 2 volumes.

FAO/ UNDP/MOA, 1987 Assistance to Land Use Planning Ethiopia: Land Evaluation Of Bichena Awraja. Field document 19 Addis Ababa.

__________________ 1989 Assistance Land Use Planning Ethiopia: Land Evaluation of Hykoch and Butajira Aweraja. Field document 40 Addis Ababa

Fassil Gebrekiros, 1990 An Assessment of The Economic Consequence of Drought, Crop failure and Famine in Ethiopia, 1973/74-1985/876. Ethiopian Journal of Development Research Monograph Series No.1

FDRE, (Federal Democratic Republic Of Ethiopia.) 1997, Environmental Policy. Environmental Protection Authority and Ministry of Economic Development and Cooperation. Addis Ababa

Harrison, p. 1983 Land and People: The growing Pressure. Earth watch, 13.

Hutchinson, E. P. 1969 The Population Debate; The development of Conflicting theories up to 1900. Boston: Houghton Miffin.

Hurni, Hance 1988, "Ecological Issues in the Creation of Famines in Ethiopia." Paper Presented at National Conference On a Disaster Prevention and preparedness Strategy For Ethiopia. Addis Ababa.

ENI (Ethiopian Nutrition Institute), 1968 Food Consumption Table for Use in Ethiopia. The Food Analytical Department. Addis Ababa.

Ibrahim Abdulahiziz, 1995 "The impact of macro economic policy reform on agriculture" in Dejene Aredo and Mulat Demeke (ed), 1995, Ethiopian Agriculture: Problems of Transformation, Addis Ababa.

ICUN, 1990. Ethiopian Natural Resources Conservation Strategy, Geneva.

Janake, H.E, 1984, An assessment of the Recent Pas and Present Livestock Situation in Ethiopian Highlands. EHRS Working Paper 7. (Draft) Addis Ababa, Johan, E and Turkington R. 1995 Herbaceous *vegetation in the understory of the Boreal forest.* Journal of Ecology Vol. 83 No. 3 581-590.

Kahn, H. 1982 The Coming Boom. New York: Simon And Schuster.

Kebede Tato 1989 " The Ethiopian Soil Conservation Program and Its future trends" Proceedings of the Conference on National Conservation Strategy in Ethiopia. Vol. 2. May 22-25, Addis Ababa.

Kessler, J.J and Laban, P. 1994 " Planning Strategies and Funding Modalities for Land Rehabilitation" Land Degradation and Rehabilitation. Vol.5, 25-32

Kirchner W.J, et al 1985 " Carrying Capacity, Population Growth and Sustainable Development" in Dennis J. Mahar (ed) Rapid Population Growth and Human Carrying Capacity. Two Perspectives. World Bank Staff Working Papers No. 690, Population and Development Series No. 15.

Laban, Hoben 1995 "Paradigms and Policies: The Cultural Construction of Environmental Policy in Ethiopia" World Development Vol. 23 No. PP. 1007-1021

Lester R. Brown and Edward C. Wolf, 1985. Reversing Africa's Decline, World watch Paper (Washington D.C. World watch Institute,)

Mahar, Dennis J, 1985 (ed) Rapid Population Growth and Human Carrying Capacity. Two Perspectives. World Bank Staff Working Papers No. 690, Population and Development Series No. 15.

Mesfin Wolde Mariam, 1991, Suffering Under Gods Environment: a vertical study of the Predicaments of peasants in North-Central Ethiopia: Missouri Walsworth Pub. Co.

Mesfin Wolde Mariam, 1984. Rural Vulnerability to Famine in Ethiopia, 1958-1977. New Delhi, Vikas Pub.

Muluneh Woldesadik 1994, Population Pressure, Land use Change and Patters of Agricultural Productivity in Ezana Wollene and Cheha 'Weredas' Sebatbet Gurageland. MA Thesis (Unpub.) A.A.U.: Addis Ababa.

Muscat, R 1985 " Carrying Capacity and Rapid Population Growth: Definition, Cases and Consequences" in Dennis J. Mahar (ed) Rapid Population Growth and Human Carrying Capacity. Two Perspectives. Population and Development Series No. 15, World Bank Working Papers No. 690.

Nair, S. 1983 Economic Analysis of Land Use in Ethiopia. LUPRD Technical Report Vol. 1A No. 8

ONCCP, 1984 (Office Of the National Commission for Central Planning), Ten Years Perspective Development Plan. Addis Ababa.

Payne,W.J.A 1990. *Rangeland Management*: the Significance of the concept of carrying capacity, Woburn: UK.

Repetto, R. 1989 " Renewable Resources and Population Growth: Post Experience and future Prospects" population and environment, Journal of Interdisciplinary Studies Vol.10 No.4 PP.221-236.

Repetto. R and Holmes, T 1983 " The Role of Population in Resource Depletion in Developing Countries", Population and Development Review 9, 4 (1983), 609.

RRC (Relief and Rehabilitation Commission) 1985 Combating the effects of Cyclical Drought in Ethiopia. Addis Ababa.

Seyoum Geberesellasie, 1991, Labor Market Requirements and The Socioeconomic Cahracteristics of Job seekers in modern sector in Ethiopia. Ethiopian Journal of Development Research. Vol. 13 No. 2

Simon, J, l. 1987, Theory of Population and Economic Growth. Oxford: Basil Blackwell

Sirvastava, P. Jitendra and Harold Aderman (ed), 1993, Agriculture and Environmental Challenges: Proceedings of the thirteenth agricultural sector symposium, the World Bank, Washington D.C.

Tadesse Gebre Giorgies 1989 Population Density and Peasant Agriculture in Dejen Woreda. MA Thesis (Unpub.) A.A.U.: Addis Ababa.

Tadesse Kidane Mariam 1989" Ethiopia's Population Distribution in relation to Resources and the Environment", Paper Presented for the National Conference on ' Population Issues in Ethiopia's National Development." Addis Ababa, ONCCP.

Tegegne Gebre Igziabher , 1995 " Assessment of Ethiopia's Agricultural land Resources" in Dejene Aredo and Mulat Demeke (eds) 1995, Ethiopian Agriculture: Problems of Transformation. Addis Ababa.

Tesfaye Tafesse, 1994, The agricultural, environmental and Social Impacts of the villagization Program in Northern Shewa, Ethiopia, IDR research report no 44, Addis Ababa University.

Teshome Tafa 1994 Impacts of Population Pressure on Land, Land Cover and Land Use Patterns in Robi Catchment, North Shewa. MA Thesis (Unpub.), A.A.U. : Addis Ababa.

Yibeltal Gebeyehu, 1992, The Problems of Population Pressure and Land Fragmentation. Unpublished MA Thesis Addis Ababa University.

Watts, M. 1989 " Social theory and Environmental Degradation" in Yuhuda Gradus (ed), Desert Development: Man and Technology in Sparse lands. Boston: D. Reidel Pub. Company.

Wiersum, K. Freerk and Deprez Berry E.J.C. Lekanne Dit, 1995 " the Forestry Agent at the Interface between Local –Level Environmental Management and External Polices: Reflections on Forestry Interventions in the Sahel." In J.P.M van der Bereemer, C.A. Drijver and L.B Venema (Eds.) Local Resource Management in Africa. Baffins West Sussex: John Wiley and Sons Ltd. PP 229-242.

Wood, Adrian 1990. " Natural Resources Management and Rural Development " Ethiopia Rural Development Options in Pauswang, Et al (ed.). Zed Books Store, Ltd. : London.

World Bank, 1986. Ethiopia: Forestry Project (Washington D.C.: World Bank.

ANNEX I
I. QUESTIONNAIRE USED FOR THE STUDY

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
REGIONAL AND LOCAL DEVELOPMENT STUDIES
QUESTIONNAIRE NO.

Objective:-

This survey is designed for the purpose of gathering information regarding agricultural production, environmental degradation and carrying capacity in Debay Tilatigin Woreda, East Gojjam. The result of this survey will be used to make inferences about agricultural practices and resource base of the Woreda. You are, therefore, kindly requested to cooperate in providing accurate and reliable information as much as you can. The paper that will be written based on this survey is intended to serve an academic purpose and as partial fulfillment of the requirement for a Masters degree in regional and Local Development Studies.

I. Household Location

1. PA's Name___________
2. Type of AEZ
   1. Wurich 2.Upper Dega 3. Lower Dega 4. Dega 5. Woina Dega
3. Distance from all weather road ----------------km
4. Distance from the nearest market -------------Km

II Background of the Household

5. Sex of the respondent: 1. Male 2. Female
6. Age of the Respondent_______
7. Marital status : 1. Single 2. Married 3. Separated 4. Widowed
8. Religious affiliation of the household
   1. Christian 2. Muslim 3. Others
9. Ethnic origin of the house hold
   1. Amhara 2. Tigraway 3. Oromo 4. Others.
10. How many children (both dead and alive) do you have so far ?
11. How many persons live in your house including your children
12. Age of members of the Household

Age	No. Of members of the household
0-5	------
6-17	------
18-60	------
60+	------

13. Can you and your spouse read and write ?
    Household head 1. Yes 2. No
    Spouse 1. Yes 2. No
14. Do you send your children to school?
    1. Yes 2. No

III. Land Use and Farming system.

15. What is the major occupation of the household ?
    1. Crop farming 2. Livestock 3. Mixed farming. 4. Others
16. What is the total size of your land holding ?____ha.
17. What is the total size of your cultivated land ?____ha.
18. Where is your main plot located ?

1. Top hill and upper slope 2. Middle slope 3. Lower slope
4. Valley 5. Plateau 6. Escarpment 7. Plain

19. Indicate the major crops you grow and average year yields and their primary use inthe following table:

Type of produce	area/plots	normal year yield (in quintals)	Primary Use		
			consumption	cash	
Cereals					
Teff					
Barley					
Wheat					
Maize					
sub total					
Pulses					
Horse bean					
Field peas					
Chick peas					
Vetch					
Guaya					
Lentils					
Sub total					
Oil seeds					
Niger seed					
Linseed					
Sub total					
Others					
Potatoes					
Honey					
Sub total					
Grand total					

IV. Resource Degradation and Peasants' Perceptions.

A. Soil and Water availability

20. Do your plots of land have problem of erosion ? 1. Yes 2. No.
21. If yes, how do you view the level of erosion on your Plot since you started farming ?
    1. Very Severe 2. Severe 3. Minor 4. No problem 5. Can't tell
22. If Yes, (for question No. 23) when did it start?
    1. Prior to birth (heard it from parents) 2. Since childhood 3. Since Marriage
    4. In recent years
23. Have you observed a decrease in soil depth ? 1. Yes 2. No 3. Can't tell`ll
24. If Yes, what is the extent of stoniness on your main plot?
    1. A great deal 2. Considerable 3. Negligible 4. None 4. Not certain
25. How serious is the decline in soil fertility on you main plot, since you started farming with reference to normal year (adequate rainfall)?
    1. Very severe 2. Severe 3. Minor 4. No problem 5. Can't tell
26. Have you received advice/ assistance on how to prevent soil erosion ?
    1. Yes 2. No
27. If yes, was it useful in preventing erosion? 1. Yes 2. No.
28. Do you use any irrigation Scheme ? 1. Yes 2. No
29. Do you Experience water logging on your land ? 1. Yes 2. No
30. If yes, on What plot ? _________

B Pasture

31. Do you graze in different areas during the rainy and dry season ? 1. Yes 2. No
32. If no, where is your main grazing area in both seasons ?
1. Slope (top, middle, and lower) 2. Valley 3, Plateau 4. Cropland 5. Other
33. Is this grazing area: 1. Your own plot 2. Owned by PA 3. Other
34. If you graze in different areas, where is your main grazing area during the rainy season ?
1. Slope (top, middle , and lower) 2. Valley 3. Plateau 4. Cropland 5.Others
35. Is this grazing area 1. Your own 2. Owned by PA 3. Other
36. Which one is your main grazing area during the dry season ? 1. Slope (top, middle and Lower Valley) 3. Plateau 4. Cropland 5. Other
37. Is this grazing area 1. Your own 2. Owned by the PA 3.Other
38. Do you face shortage of grazing land ? 1. Yes 2. No
39. If yes, during which season ? 1. Rainy season 2. Dry season 3. Both seasons
40. Would you still face the same problem if your stock is reduced by:
1. 3/4 2. ½ 3. 1/4 4. Would not like it to be reduced
41. Does area closure exist in your PA ? 1. Yes 2. No
42. What is your opinion about area closure ?
1. Positive, because ___________________
2. Negative, because ___________________
3. Indifferent
43. Do you consider a large livestock size:
1. Advantage ___________________
2. Disadvantage ___________________
3. Both advantage and disadvantage ___________________
44. Have you received advice/assistance on pasture management ? 1. Yes 2. No
45. Was the advice useful 1. Yes 2. No
46. Indicate the number of cattle and other animals you own in the following table:

Live stock	Number
Cattle Oxen	
Cows	
Heifers	
Bulls	
Calves	
sub total	
Sheep and goat Sheep	
Goats	
Subtotal	
Equines Horses	
Mules	
Donkeys	
Subtotal	
Grand Total	

C. Vegetation

47. Do you plant trees ? 1. Yes 2. No
48. If no, why ? ____________________
49. If yes, is this 1. A private initiative 2. Communal one
50. What do you use trees for, in order of importance
    1__________2__________3__________4__________
51. Is there a natural forest in your PA ? 1. Yes 2. No

52. If there are none, have you heard or remember when there was one ?
    1. Heard from parents that there was natural forest
    2. Have seen it during childhood
    4. Have seen it in recent years
    5. Others
53. What are the major causes for the disappearance of forests in you locality?
    1. Bringing forest land into agriculture (cultivation)
    2. Human consumption for fuel and other necessities
    3. Livestock grazing and fodder
    4. Settlements
    5. Others
54. What are your sources of fuel wood and in what proportion ?
    1 fuel wood _____ 2. Dung ____ 3. Crop residue ____ 4. Others _____
55. Is there a shortage of fuel wood in your PA? 1. Yes 2. No
56. If yes, how serious is this shortage ?
    1. Extremely serious shortage (no fuel wood)
    2. Considerable shortage (3/4 shortage)
    3. Minimal shortage (½ shortage)
    4. No shortage (always available)
57. The average time you spend in collecting your major fuel is ? ________
58. Do you buy fuel ? 1. Yes 2. No
59. In general, how do you view trees ?
    1. Trees have advantages
    2. Trees have disadvantages
    3. Trees have advantages and dis advantages
    4. Have no opinion
60. Is there a tree planting program in your PA ? 1. Yes 2. No
61. Of the available tree species, which do you prefer for fuel ? ____________
62. Of the available plants, which do you prefer for forage? ______________
63. Of the available plants, which do you prefer for construction ___________

V. Socioeconomic Issues

64. Did you inherit your holding ? 1. Yes 2. No
65. If no, when did you Possess the land ? 1. During the Derg 2. During EPRDF
66. When did you start faring the land ? ___________
67. How do you view the quality of your land
    1. Fertile 2. Adequate 3. Poor 4. Very poor
68. Do you grow enough for family consumption on your farm during normal years ?
    1. Yes 2. No
69. Do you feel secure that the land belongs to you ?
    1. Yes 2. No
70. How do you view the recent land redistribution in your locality?
    Positively, because____________________________
    Negatively, because ____________________________

71. Would you prefer to change your holding ? 1. Yes 2. No

72. If yes give reasons____

____

73. What input do you use to maintain soil fertility ?
1. Chemical fertilizers 2. Manure 3. Plant residue 4. Others

74. If you use modern fertilizers, how much do you apply in a year? 1. DAAP ___qt.
2. Uria______qt. 3 Others _________

75. Do you have the potential to purchase enough amount of fetilizer for your farm?
1. Yes 2. No

76. Do you have oxen to plough all your land 1. Yes 2. No

77. If no, how do you get access to oxen ? 1. Hire 2. Oxen for labor exchange
3. Oxen sharing 4. Others

78. How much can you plough with your own stock ?
1. All 2. 3/4 3. ½ 4. Less than ½ 5. Others

79. Do you have a labor shortage in operating your farm ? 1. Yes 2. No

80. Do you have some reserve food at present ? 1. Yes 2. No

81. If yes can it last until the coming harvest ? 1. Yes 2. No

82. If no, do you have some cash which can be used to by food ? 1. Yes 2. No

83. If yes for the above question, what is the source of the cash ?
1. Livestock sell 2. Aid 3. Fuel wood 4. Others

84. What are the major crops you sell (in order of importance)?
1. _____________2. __________ 3. ____________ 4.______________

85. What are the major crops you buy? 1.________2.________3.__________4. ______

86. Indicate the type of tax, levies and contributions you pay and the amount

Type of tax/ contributions	Amount
1____________	_________ birr.
2.____________	_________ birr.
3.____________	_________ birr.
4.____________	_________ birr.

87. Are you able to pay these taxes / contributions
1. Yes 2. No

VI. Food Intake of the Household

88. How much food is adequate to all members of your household per annum ?
Cereals _____quental Pulses_________ Oilseeds_________

89. Indicate the quantity/ amount and frequency of consumption of meat, vegetables, animal products and oil in the following table:

Type	Quantity per consumption	Frequency of consumption per month.
Meat	sheep	
	goat	
	beef	
animal products	milk	
	butter	
	chicken	
Vegtables		

ANNEX II. PROCEDURES USED FOR CALCULATING PSC

(i) The cropland sub model analysis is carried out at PA level, at current level of production and food requirements of the population. Assessment of the requirement of the population for cropland is carried out using the following steps.

(a) Assess the total area (in ha) of each PA in the study area.

(b) Identify the net arable area in each PA by deducting areas vulnerable to erosion and water logging, crop exclusion zones, settlements etc.

(c) Determine cropland requirements of an average family. This is obtained by dividing the calorie requirement of an average household by net calorie yield obtained from one hectare. The latter data is obtained from the household questionnaire.

(d). Determination of total land requirements by addition of areas required to produce a surplus and requirements for fallow land based on the current land use. This gives the surplus or shortfall in available cropland relative to the needs of the population.

(ii) The livestock grazing sub-model is based on the assumption that livestock forage comes from both the cropland as crop residues and aftermath grazing and land allocated to grazing. The assumptions used in the sub-models and the methods of calculation are outlined as follows: -

(a) The livestock number is based on data collected by the household survey.

(b) The livestock size is converted into Tropical Livestock Units (TLU).

(c) Forage production (supply) is obtained from cropped area i.e. aftermath grazing and from available grazing land.

(d) The annual forage requirement in kilograms dry matter is equivalent to TLUs X 0.02 X250 X 365.

Procedures for calculating Net Calorie Yield from one hectare:

a. Determination of the productivity of each crop mix is carried out in the following steps.

b. Obtain crop yield from household survey data at its actual form and a 50% increase in yield.

c. Deduct seed requirement

d. Adjusting yields according to the proportionate area under each crop.

e. Correcting for post harvest losses and raw product conversion factor and,

f. Calculate net calorie yields.

Net calorie from One Hectare in Debet.

Main Crops	Yield qt/ha[1]		Seed Reqirmen	Share /crop are	Post Harvest loss[2]	Row product conversion[3] factor	Calorie in 100g[3]	Net cal yield (10^6)	
	low	50%						Low	50%
Teff	7.6	11.4	0.4	0.553	20	90	340	0.975	1.489
Wheat	8.3	12.5	1.2	0.177	15	75	335	0.268	0.427
Maize	9.8	14.7	0.6	0.053	10	85	360	0.134	0.206
Bean	10.1	15.2	0.9	0.045	15	100	345	0.121	0.189
Vetch	8.9	13.4	o.7	0.144	15	100	340	0.341	0.528
Oilseed	8.6	12.9	0.3	0.028	15	70	460	0.071	0.108
Total				1				1.910	2.947

Source: [1] Household survey and group discussion,
[2] Tehome, 1994: 158, [3]LUPRP/UNDP/FAO, 1986

Table Asendabo Procedure of Calculating Net calorie from One Hectare.

Main Crop	Yield qt/ha		Seed Reqir	Share /cr	Post Har loss	Row produ conversion	Calorie in	Net cal. yield (10^6)	
	low	50%						Low	50%
Teff	7.8	11.7	0.4	0.434	20	90	340	0.786	1.200
Wheat	7.9	11.9	1.0	0.236	15	75	335	0.348	0.549
Bean	8.5	12.8	0.8	0.066	15	100	345	0.149	0.232
Cheapea	8.6	12.9	0.6	0.112	15	100	365	0.278	0.427
Lentil	8.0	12.0	0.4	0.006	20	100	360	0.131	0.020
Vetch	8.8	13.2	0.7	0.144	15	100	340	0.337	0.520
Oilseeds	8.0	12.0	0.4	0.002	5	70	460	0.005	0.007
Total				1				1.916	2.955

Source: Household Survey undertaken by the author in 1998

Net calorie yield from one hectare in Yebabat

Main Crops	Yield qt/ha		Seed Reqirment In kg	Share /crop	Post harvest loss (%)	Row product Conversion factor	Calorie in 100g	Net cal. yield (10^6)	
	low	50%						low	50%
Teff	8.0	12.0	0.45	0.125	20	90	340	0.231	0.353
Wheat	7.3	10.9	1.00	0.234	15	75	335	0.315	0.495
Barley	5.9	8.9	1.00	0.161	15	65	330	0.144	0.232
Maize	8.0	12.0	0.50	0.005	10	85	360	0.010	0.016
Bean	7.9	11.9	0.90	0.132	15	100	345	0.271	0.426
Pea	7.0	10.5	0.60	0.042	15	365	100	0.083	0.129
Chickpea	9.0	13.5	0.70	0.125	15	100	365	0.322	0.496
Lentil	8.0	12.0	0.40	0.039	20	100	360	0.091	0.138
Vetch	8.6	12.3	0.70	0.088	15	100	340	0.201	0.295
Oilseeds	8.2	12.1	0.30	0.049	5	70	460	0.118	0.177
Total				1				1.786	2.757

Source: Household Survey By the Author, 1998

Debre Iyesus Procedure of Calculating Net calorie from One Hectare.

Main Crops	Yield qt/ha		Seed Reqir	Share /crop	Post harvest l	Row product	Calorie in 100g	Net calorie yield (10^6)	
	low	50%						Low	50%
Teff	8.0	12.0	0.5	0.005	20	90	340	0.009	0.014
Wheat	7.3	11.4	1.2	0.282	15	75	335	0.385	0.614
Barley	7.9	11.9	1.1	0.333	15	65	330	0.413	0.656
Bean	9.1	13.7	1.0	0.143	15	100	345	0.339	0.532
Pea	7.2	10.8	0.7	0.130	15	100	365	0.262	0.407
Lentil	8.7	13.1	0.4	0.043	20	100	360	0.109	0.167
Vetch	8.0	12.0	0.8	0.001	15	100	340	0.002	0.003
Oilseeds	7.8	11.7	0.4	0.063	5	70	460	0.143	0.218
Total				1.000				1.662	2.611

Source: Household Survey by the Author, 1998

Nabra Procedure of Calculating Net calorie from One Hectare.

Main Crops	Yield qt/ha		Seed Reqirm	Share /cro	Post harvest	Row product	Calorie in 100g	Net calorie yield (10^6)	
	low	50%						Low	50%
Wheat	7.1	10.7	1.1	0.351	15	75	335	0.449	0.719
Barley	7.5	11.3	1.0	0.396	15	65	330	0.469	0.744
Bean	7.7	11.6	0.95	0.117	15	100	345	0.231	0.365
Pea	8	12.0	0.70	0.099	15	100	365	0.224	0.347
Lentil	8	12.0	0.40	0.027	20	100	360	0.059	0.090
Oilseeds	8	12.0	0.35	0.009	5	70	460	0.021	0.032
Total				1.000				1.453	2.297

Source: Household Survey by the Author

Inekoy

Main Crops	Yield qt/ha		Seed Reqirm	Share /cro	Post harvest	Row product	Calorie in 100g	Net calorie yield (10^6)	
	Low	50%						Low	50%
Wheat	8.4	12.6	1.1	0.231	15	75	335	0.360	0.567
Barley	8.6	12.9	1.1	0.444	15	65	330	0.607	0.955
Bean	8.1	12.2	0.90	0.135	15	100	345	0.285	0.447
Pea	7.4	11.1	0.65	0.083	15	100	365	0.174	0.269
Lentil	7.6	11.4	0.40	0.049	20	100	360	0.102	0.102
Oilseeds	8.0	12.0	0.40	0.058	5	70	460	0.135	0.206
Total				1.000				1.663	2.546

Source: Household Survey by the Author, 1998

ANNEX III. FORAGE PRODUCTION

Forage supply from Grazing Area by PAs.

PAs	Sources of Natural grazing	Area (ha.)	Yield of DM (tons/ha.)	Total
Debet	Bush land/or shrub land	62	0.3	18.6
	Grass land/ with scattered trees	640	3.5	2240
	Seasonal wet lands	80	4.5	360
Asendabo	Bush land/or shrub land	49	0.3	14.7
	Grass land/ with scattered trees	453	3.5	1585.5
	Seasonal wet lands	81	4.5	364.5
Yebabat	Bush land/or shrub land	45	0.3	13.5
	Grass land/ with scattered trees	93	3.5	325.5
	Seasonal wet lands	31	4.5	139.5
Debre Iyesus	ush land/or shrub land	99	0.3	29.5
	Grass land/ with scattered trees	243	3.5	850.5
	Seasonal wet lands	-	4.5	-
Nabra	Bush land/or shrub land	59	0.3	17.7
	Grass land/ with scattered trees	241	3.5	843.5
	Seasonal wet lands	18	4.5	81
Inekoy	Bush land/or shrub land	906	0.3	271.8
	Grass land/ with scattered trees	608	3.5	2128
	Seasonal wet lands	62	4.5	279
Total				8960

Source: Computed by the author based on the date from Wereda Agriculture Office

Forage from Cropland

PAs	Cropped land /ha.	Yield of DM(tons/ha)*	Total yields (in tons)
Debet	2763	0.4	1105.2
Asendabo	2526	0.4	1010.4
Yebabat	3017	0.4	1206.8
Debre Iyesus	3105	0.4	1242.0
Nabra	1020	0.4	408.0
Inekoy	2340	0.4	936.0
	14771	0.4	5908.4

Source:- Household survey

* Jahanke, H.E (1984: 6-7)

Yield of forage from crop residuals

Type of Crops	Total crop production in tonnes						Residual Grain Factor[1]	Residual Production in toones						Total
	Debet	Asendabo	Yebabat	D/Iyesus	Nabra	Inekoy		Debet	Asendabo	Yebabat	D/Iyesus	Nabra	Inekoy	
Teff	741.98	679.98	236.65	12.66	-	-	1.29	957.15	877.17	305.28	16.33	-	-	2155.93
Wheat	290.34	378.85	396.55	674.14	220.80	370.73	1.17	339.69	443.25	463.96	788.74	258.34	433.75	2727.73
Barley	-	-	220.66	835.56	265.60	728.45	0.93	-	-	205.21	770.07	247.01	677.46	1899.75
Maize	103.23	-	25.58	-	-	-	1.96	202.51	-	50.14	-	-	-	252.65
Bean	90.33	113.33	239.85	408.29	80.00	208.13	2.30	207.76	260.66	551.65	939.07	184.00	478.69	2621.83
Pea	-	-	76.16	297.51	70.40	117.07	2.05	-	-	156.13	609.89	144.32	239.99	1150.33
Check pea	-	194.28	259.04	-	-	-	2.05	-	398.27	531.03	-	-	-	929.30
Lentil	-	9.71	73.55	117.10	19.20	71.54	2.05	-	19.90	150.78	240.05	18.86	146.66	576.25
Vetch	254.85	255.80	175.89	3.16	-	-	2.05	522.44	542.39	360.57	6.48	-	-	1431.88
Oil Seeds	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	1398.73	1631.95	1703.93	2348.42	656	1495.92	-	2229.55 (3344.32)	2523.64 (3812.46)	2774.75 (4162.12)	3370.63 (5055.94)	852.53(1278.79)	1976.55 (2964.82)	13745.65 (20618.45)

Source: Computed from Table 13, i.e, crop production in tonnes multiplied by reciprocal to sample size.

[1] Teshome, 1994:159

APPENDIX IV. Population of Debay Tilat Gin Woreda

Population size of Debay Tilatigin Woreda , 1990

N0	PA	Male	Female	total	Household s.
1	Kuy urban	2455	2871	5326	
2	Kuy rural	2746	2586	5322	1216
3	Asendabo	2942	2744	5686	1263
4	Debet	2219	3301	5520	1226
5	Mengisto	3666	3541	7207	1650
6	Yekebabat	3052	2901	5953	1360
7	Yebabat	2779	2577	5356	1407
8	Jerems	2298	2121	4419	1010
9	Nabra Yebalat	1441	1438	2879	640
10	Nabra Michael	3118	3019	6137	1402
11	Nabra Gewecha	4294	2075	6369	1455
12	Wodeb Euesus	3254	3079	6333	1447
13	Angech	2536	2448	4984	1139
14	Arajo	1976	1878	3854	880
15	Kidstei	2326	2267	4593	1049
16	Debra Eyesus	4839	4490	9829	2184
17	Nabra M/Alem	1217	1171	2388	564
18	Enkoy	3018	2838	5856	1301
19	Shemei	2356	2409	4765	1089
20	Yedeama	2110	2019	4129	943
21	Emewulad	1575	2830	4405	1006
	Total	56207	55103	111310	24212

Source: Woreda Agricultural Office, 1990

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sources of materials used for the Thesis have been dully acknowledged.

Name	Zewdie Shitie
Signature	
Place	Addis Ababa University
Date	January 1999

The Thesis has been submitted for examination with my approval as a university advisor

Tesfaye Tafesse (Ph.D.)

January 1999