Ethiopian Agricultural Research Organization
(EARO)

International Centre for development-oriented Research in Agriculture
(ICRA)

# IMPROVING SOIL PRODUCTIVITY FOR INCREASED AND SUSTAINABLE CROP PRODUCTION IN THE MID-ALTITUDE AREAS OF YILMANA-DENSA WOREDA, WEST GOJAM, ETHIOPIA


| | | |
|---|---|---|
| **Birhane Assayehegne** | **Entomology** | **Adet Research Center** |
| **Getaw Tadesse** | **Agricultural Economics** | **Sirinka Research Center** |
| **Halima Hassen** | **Animal science** | **Adet Research Center** |
| **Minale Liben** | **Agronomy** | **Adet Research Center** |
| **Selcshi Gesese** | **Forest Management** | **Ministry of Agriculture** |
| **Yeshanew Ashagrie** | **Soil Managment/Agroforestry** | **Adet Research Center** |

This report is the product of teamwork with equal contribution from the authors whose names are listed in alphabetical order.


Working Document Series No.4

**International Center for Development Oriented Research in Agriculture (ICRA)**

**Ethiopian Agricultural Research Organization (EARO)**

**Adet Agricultural Research Center (AARC), Amhara National Regional State (ANRS)**

# IMPROVING THE DECLINING SOIL PRODUCTIVITY FOR INCREASED AND SUSTAINABLE CROP PRODUCTION IN THE MID-ALTITUDE AREAS OF YILMANA-DENSA WOREDA, WEST GOJAM, ETHIOPIA

**Working Document Series**
**Ethiopia – 1999**

# Table of contents

# Foreword

The course program aims at consolidating the participants' ability to engage in collaborative work with other institutions and disciplines and in more client-oriented, participatory research and development activities.

The 7 week classroom-based preparation phase in Nazret was divided into 6 topics. The first is an introduction to the principles of interdisciplinary teamwork, which focused on team processes, facilitation and negotiation, work organization and team contract to be able the field teams to rapidly develop a common work procedure and agree on rules of behavior and decision making. This was followed by a short module on the basic of objectives and clarifying the terms of reference of their field study. The second topic includes an introduction to system thinking; agricultural and knowledge systems. The focus was on tools to analyze these systems: modeling, typologies, identification of actors, etc. At each of these two stages (systems and teamwork planning), the practice was based on the participants' own experience. Participants were asked to work on their terms of reference to define their objectives, draw models of the relevant knowledge and agricultural systems, and identify the missing information, as the basis of their research plan. The third topic is on the principles of client-oriented research. The fourth topic focused on evaluating impacts and setting of priorities. The fifth topic provides participants with the survey tools needed to carry out their field study. Finally, the 6th topic is a period of active field study preparation by the 4 teams joined by their tutors. The preparation will enable each team to recapitulate all the information generated during the 6 preceding weeks, decide on what further information is needed, what tools they expect to use, to collect it and plan accordingly.

The 10-week field studies were conducted in Adet, Ambo, Areka and Holetta. The teams were part time tutored by researchers with experience of such field studies, specially hired for that purpose. They were jointed by NGO resource persons for a number of days. Each field study has specific terms of reference, worked out by task force members of the above centers, some of whom are course participants.

The ICRA-EARO in country training course has benefited from the support of several institutions. Funding was contributed by:

- The International center for development oriented Research in Agriculture (ICRA). Through special funding from the Swiss Development Cooperation (SDC)
- The Ethiopian agricultural Research Organization (EARO) through the Melkassa Research Center
- The Royal Netherlands Embassy in Addis Ababa through its project "Strengthening Client-Oriented Research in Ethiopia:
- The department for International Development (DFID) through its Africa, Greater Horn and Co-ordination department (London) and the British Embassy (Addis Ababa)
- The Netherlands Development Organization (SNV) in Addis Ababa
- FARM Africa, through its Farmers' Research Projects (FRP) in Awassa, Ethiopia.

Other institutions helped with the preparation of the course in various ways were Alemaya University of Agriculture, Dire Dawa, Ethiopia, the Bureaus of Agriculture of Amhara, Southern and Oromiya National Regional States, and the Royal Tropical Institute (KIT), Amsterdam, The Netherlands. The course coordinators were Dr. Nour-Eddine Sellamna (ICRA), Dr. Aberra Deressa (Melkassa Research Center), and Yali Edessa (Alemaya University, Assistant coordinator). I thank them all for their indulgence

*Abera Deressa, PhD*
*1999, Malkassa*

## List of Maps



## List of Tables

## List of Figures



## List of appendices

## Abbreviations

| | |
|---|---|
| **AARC** | Adet Agricultural Research Center |
| **ABW** | African Boll Worm |
| **ACSI** | Amhara Credit and Saving Institute |
| **ADLI** | Agricultural Development Led Industrialization |
| **AI** | Artificial Insemination |
| **AISE** | Agricultural Inputs Supply Enterprise |
| **AKIS** | Agricultural Knowledge Information Systems |
| **ANRS** | Amahara National Regional State |
| **ARTP** | Agricultural Research and Training Project |
| **BoA** | Bureau of Agriculture |
| **CDO** | Cooperatives Development Office |
| **CSA** | Central Statistics Authority |
| **DA** | Development Agent |
| **EARO** | Ethiopian Agricultural Research Organization |
| **ESE** | Ethiopian Seed Enterprise |
| **EGME** | Ethiopian Grain Marketing Enterprise |
| **FAO** | Food and Agricultural Organization |
| **FS** | Farming System |
| **FSR** | Farming System Research |
| **GDP** | Gross Domestic Product |
| **ICRA** | International Center for development oriented Research in Agriculture |
| **ICRAF** | International Center for Research in Agroforestry |
| **MoA** | Ministry of Agriculture |
| **NRM** | Natural resource management |
| **PA** | Peasant Association |
| **PADETS** | Participatory Agricultural Demonstration & Extension Training System |
| **PRA** | Participatory Research Appraisal |
| **R & D** | Research and Development |
| **SIDA** | Swedish International Development Agency |
| **SG 200** | Sassacoa Global 2000 |
| **T&V** | Training and Visit |
| **WAC** | Woreda Administrative Council |
| **WADO** | Woreda Agricultural Development Office |
| **ZDOA** | Zonal Department of Agriculture |

## Acknowedgements

An interdisciplinary team of researchers from EARO and an expert from MoA conducted this study, in close collaboration with ICRA. First and foremost we would like to thank ICRA and EARO for designing and sponsoring the study program. We are extremely grateful to Dr. Nour Salamna, the program coordinator and instructor, who shared with us his reach experience during the whole study period. We would like also to thank Dr. Aberra Deressa, Center Manager, Melkasa Research Center and the National Coordinator of the program who has greatly contributed for the success of the program by providing all the necessary facilities. Furthermore, we would like to thank Ato Wolugan Negeri, Tutor of the Team, who assisted us in reviewing and improving the study document.

Thanks are also due for the management and support group of Adet Research Center for providing us valuable information, comments, accommodations and vehicles. The team also would like to acknowledge peasant association leaders, key informants and farmers who provided basic information, identified priority problems and expressed their personal views during interviews and Workshops. The study team is grateful of the WADO agricultural experts who were highly cooperative in providing secondary data and sharing their experiences.

In addition, the group also would like to thank WAO, WADO, Regional bureau of Agriculture, Zonal Agricultural Office of West Gojam, ACSI, Ambasel Trading Company, Amalgamated Pvt. limited company and EGME who have contributed for the enrichment of this document.

Last but not least, we would like to thank all assistant data collectors, drivers, cookers and cleaners who provided us their support and services during the whole study period.

Finally, we thank all who have contributed to the study in one way or another but their names could not be mentioned here.

ADET STUDY TEAM

## Executive Summary

The objectives of the study were to describe and understand the prevailing farming system, identify major soil degradation constraints and opportunities for conservation, investigate major causes for soil productivity decline, study the relationships between the stakeholders and suggest means of strengthening the relations, look into policy related issues, and develop participatory R and D proposals that would help bring solutions for the study area.
The work was organized around four problem areas that covers economic factors, agronomic practices, livestock management and natural resources conservation and management practices.

During the informal and formal (focused questionnaire) field survey the study team used participatory approach to investigate the problems and interests of various stakeholders involved in the study area. The initial field survey plan and findings of both field surveys were presented in three consecutive workshops attended by representatives of all stakeholders. As far as possible, the comments and interests of these clients were incorporated in the final report. The role of women in the farming system was investigated to identify their problems and interests in the development of future research programs.

Currently, farmers could not harvest sufficient amount of crop yield without the application of chemical fertilizers. But, most poor farmers could not afford to buy adequate amount of agricultural inputs. They do not have the courage to take required amount of credit, fearing risk of natural calamity like failure of crops, pest damage and other factors that frequently appear in the area. The fragmented small sized grazing lands were already highly deteriorated and over grazed. To date, no attempt was made to improve the grave situation facing the animals regarding feed shortage.

Deforestation had reached its climax long ago. Natural forests do not exist in the study area today, except some small patches that surround churches. Thus, the bare topsoil is under severe soil erosion. Sheet and gully erosion types are the main factors worsening the decline of soil productivity. Aware of these problems, the regional government and farmers launched different interventions through extension programs. Unfortunately, some of the efforts did not bring the anticipated impacts for the farming community due to ill- designs and inappropriate technologies and applications.

After making problem analysis and identifying opportunities related to each of the above-mentioned subjects, comprehensive analysis was also made to integrate them into the on going broad specific conditions of the area. On the basis of this comprehensive problem and opportunity analysis, R and D recommendations for the enhancement of sustainable agriculture were suggested, and research proposals were also developed. The recommended R and D interventions, in addition to policy issues and stakeholders linkage, cover three major problem areas that would need collaborative efforts of all stakeholders towards their implementations. AARC, WADO, and farmers are expected to be the leading actors in the implementation of these proposals.

# PART I

# 1. INTRODUCTION

## 1.1 Institutional Framework

The study was conducted as a joint activity of the Adet Agricultural Research Center (AARC) of the Amhara National Regional State (ANRS), the Ethiopian Agricultural Research Organization (EARO) and the International Center for development oriented Research in Agriculture (ICRA). ICRA and The Netherlands Government have a special interest to further strengthen client-oriented research efforts. Adet Agricultural Research Center has a regional mandate to address agricultural production constraints in all the agro-ecological zones of Gondar and Gojam; it is also cooperating with the grain and forage legume and barley improvement projects supported by the Netherlands government. Thus, the study was undertaken within the framework of a broader collaborative program involving EARO, ICRA, AARC and the Netherlands Embassy through the vertisol management and, cool season forage and grain legume and barley improvement projects. The study team was composed of Ethiopian researchers of different major disciplines: an entomologist, agronomist, livestock specialist and soil and water conservation specialist (agroforester) from Adet Research Center, a socio-economist from Sirinka Research Center and a forester from MoA.

## 1.2 Significance of the Study

Agriculture has been significantly altered over the past few decades by the introduction of new crops and varieties, and new animal breeds and crosses. However, the pace of change has slowed in recent years and the products of plant and animal breeding have proved less useful to farmers on poorer land and smaller holdings where soil degradation is the most acute. The problem of soil degradation has not been given prominent focus in overcoming crop production problems. Research has not pinpointed the actual causes or perhaps the public is naive about the soil constraints. So far, we can not refer to solid information on how serious or imminent the decline in the productivity of the soil is. Neither can we say the potential danger that each forms of soil degradation have on the sustainability of the soil productivity. The outputs of research in the areas of soil, water and tree management have made even less headway in these environments. Of particular note has been the failure of research to appreciably influence the conduct or content of soil and water conservation programs. The reasons for this limited effectiveness are lack of diversity in the technical options proposed, the orientation of research to favourable environments and its failure to involve farmers early on the identification of problems and their possible solutions. Impact oriented research with a broad, interdisciplinary perspective has been hindered by several institutional and intellectual factors. Farmer participation in research must be more through involvement of the resource managers' in the development of technology and to be able to generate and test several options.

## 1.3 Objectives

*General*

The main aim of the studies is to analyze soil productivity constraints of the farming systems from a dynamic perspective, to better understand cause-effect relationships and to identify opportunities for research and development (R&D) efforts using a system oriented, integrated participatory approach.

*Specific*

- describe and understand the system and its major soil types and "toposequences" /catenas
- identify both the problems the system presents and the opportunities it offers
- identify the major soil related production constraints
- identify the major causes of declining soil productivity
- define research priorities by involving all actors and beneficiaries
- formulate participatory R&D programs that are targeted on finding solutions which are suited to the environment, compatible with the existing system and geared to farmers' concerns
- suggest policy recommendations

## 1.4 Outputs

- planing workshop
- mid term workshop
- final workshop
- final report containing R&D recommendations

The out put of the study apart from the participants enhanced knowledge and skills is the development of client oriented research proposal that will be executed by Adet research Center and other concerned stakeholders.

## 1.5 Organization of the Report

This document contains the result of field study by ICRA-EARO in-country training participants. The study deals with participatory analysis of declining soil productivity in Yilmana Densa woreda with the aim of developing participatory research and development options that mitigate the problem of low soil productivity.

The report consists of three major parts. The first chapter deals with introduction of the study, background information at national and regional level, preliminary description of the study area and methodologies used for the study. The second part explains detail description

of the prevailing farming systems components. These components include household characteristics and resources, crop production management, livestock production management, forest, rural energy source, communal resource, and stakeholder analysis. The major aim of this part is to clearly describe the existing systems and practices so that the strengths and weaknesses of the systems for soil productivity are identified subsequently. The third part deals with the analysis of soil degradation, problems and research and development options including recommendations. This part answers the central questions of the study by analyzing findings from the previous sections in relation to soil productivity.

In general the result provides farmers' experiences, attitudes and arguments and possible interventions in the future. It also gives relevant information in order to solve the problem of soil degradation in a holistic and participatory approach.

# 2. BACKGROUND INFORMATION

## 2.1. Background on Ethiopia

Ethiopia is a country with an area of about 1,112,000 $km^2$ located in the horn of Africa, lying roughly from 3° - 18° N latitude and 33° - 48° E longitude. About 65 percent of the land is arable, of which 15 percent is under actual cultivation. Relief is complex and is characterized by an elevated central plateau with flat-topped hills varying in height between 2000 and 3000 meters. In the north and central parts of the country there are some 25 mountains whose peaks rise over 4000 meters. Approximately 60,000 $km^2$ of the land is estimated to be above 3500 m.a.s.l. More than one-third of the country lies above 1800 m.a.s.l, about half of the country lies above 1500 m and the rest is below 1200 m.a.s.l (Sutuma, 1993). The country has a population of more than 58 million people growing at the rate of 3.2 percent a year and ranks third in Africa and 22nd in the world (Berhane, 1996; Central Statistical Authority, 1990).

About 90 percent of the population live in rural areas and depends on agriculture for its livelihood. Agriculture is the mainstay of the economy and the principal exports from this sector are coffee, oil seeds, pulses, flowers, vegetables, sugar, and foodstuffs from animals. There is also a thriving livestock sub-sector, exporting cattle, hides and skins. The sector contributes about 90 percent of the foreign exchange earnings and accounts for about half of the GDP. It is almost entirely dominated by small-scale resource poor farmers who are mainly concentrated in mid and high altitudes and produce 90 to 95 percent of all agricultural produces. Cereal production accounts for nearly 85 percent of the total cultivated land and nearly 70 percent of the calorie intake of the Ethiopian population. Livestock farms are part of the mixed farming system where crop production is the main economic activity of small holding subsistence farmers. It is also the main resource base of subsistence pastoralists in the arid and semi-arid areas (Belay, 1996). The overall growth rate of agriculture and GDP is far below that of population growth widening the gap

between food production and demand. These emanate from a number of factors among which are the predominance subsistence small scale and fragmented holdings, degradation of natural resources and poor research-extension-farmer linkages. The average land holding of Ethiopian farmers is very small, though it varies greatly with agro-ecology and the farming systems. Excluding Somali and other nomadic areas, the average land holding of small farmers is only 1.1 hectares ranging from 0.4 to 1.36 (ARTP, 1998).

The pattern of land use in Ethiopia varies. The highland areas, which account for 44 percent of the territory and with annual rainfall ranging from 800-2200 mm are usually good for agriculture (ICRAF, 1993). It contains 90 percent of the human population, over 95 percent of the regularly cropped area, about two thirds of the livestock herd and over 90 percent of the country's economic activity. The lowlands are generally drier with lower annual rainfall (< 800 mm) and higher temperatures. Traditionally, lowlands have been marginal areas supporting pastoralists and wild life. The major soil types are vertisols and nitosols. The highland vertisols are underutilized due to their poor internal drainage. The depth of soils has been reduced in many parts of the country because poor farming practices induce soil erosion. High forests that once covered a considerable proportion of the country are already cleared. Savannah grassland and desert steppe woodlands cover few areas in the lowlands.

## 2.2 National and Regional Economic Development Policy

The economic policy of the federal government of Ethiopia is based on agricultural-development-led industrialization (ADLI) with a 20 years perspective. The basic elements of ADLI include:

(1) replacement of the command economy by market forces
(2) enhancement of regional autonomy and promotion of popular participation in the mobilization and utilization of local resources
(3) introduction of structural changes in the economy to create an enabling environment for self-reliance, use of appropriate technology and domestic raw materials, and greater interdependence between the various sectors of the economy.

Elements of the agricultural policy include improvements in small holder agricultural productivity, expansion of large scale privately owned farms and industrialization based on domestic raw materials and labor-intensive technology. The policy recognizes that the first item on the development agenda is to improve traditional agricultural practices through the provision of credit and agricultural inputs. From the regional development perspective, the most important economic policy principles are enhancement of regional autonomy and the promotion of popular participation in the mobilization and utilization of local resources (EFAP, 1994). ANRS is heavily dependent on subsistence smallholder agriculture and is

generally food insecure, especially the western half of the region and the areas linking the highlands and the lowlands. The regional policy and its twin objectives are (i) increased food production on sustainable basis and (ii) natural resource and environment rehabilitation that will enable the region reach the two essential goals of sustainable agricultural development, namely: (a) food security/sufficiency and (b) enhanced natural resources conservation and development (ANRS agricultural research master plan, 1999 un pub.; Bitew Meles and Minale Kasie, ANRS-BoA, 1999 un pub.)

### 2.3. Background on Amhara Region

Amhara National Regional State, one of the federal states of Ethiopia, covers an area of 170,752 $km^2$. ANRS borders include, Tigray in the north, Oromia in the south, Afar in the east and Benshangul-Gumuz and Sudan in the west. For administration and planning reasons the region is grouped in to 11 administrative zones and 105 woredas. The region has approximately 4.6 million hectares of arable land, of which 93 percent is under actual cultivation. The topography varies from lowland plains to undulating hills with flat-topped plateau and mountain areas. The highlands (about 65percent) lies at an altitude of above 1500 m, have mild temperature and high rainfall. The lowlands (about 35 percent) of the region, on the other hand, are characterized by high temperature and low rainfall. The population is about 14.7 million. The highland zone accounts for a larger part of the population and the remaining few live scattered over the lowlands. Average land holding in the region is 1.70 hectares (Ayele Gebre-Amlak, ANRS-Investment Office, 1999 unpublished). The small holder peasants living in the rural areas make up the majority of the population in the region. The region is entirely dominated by subsistence agriculture, with crop and livestock farming's being the principal practices. Cereals account for almost approximately 95 percent of the agricultural produce. Depending on the prevailing climatic conditions the type of agriculture varies in the different agro-ecological zones (Bitew Meles and Minale Kasie, ANRS-BoA, 1999 unpublished)

### 2. 4. The Problem of Soil Degradation

Due to the favorable climatic conditions and fertile soils settled agriculture in the highland areas of Ethiopia has been in existence for over 2000 years. Ethiopia is basically an agricultural country and the socio-economic advancement relates directly to the efficient use and management of the natural resources. Over the past few decades the country experienced a rapid decline of the natural resource bases through degradation. Land degradation is a major issue. It is estimated that as much as half of the highland area is degraded. Annual losses are estimated at 1.5 billion Birr, and about 60,000 hectares of agricultural lands are lost each year (ICRAF, 1993). This has been greatly influenced by lack of proper planning, high population pressure, poverty and lack of understanding. The increasing population and land scarcity have put greater demands on the resources, provoking people to cultivate areas of marginal productivity such as steep slopes, natural water ways and other types of marginal areas. Reduced yields and often-degraded soils are

usually the consequences. This situation shows that crop production in Ethiopia is not sustainable, neither human needs are satisfied, especially food demands, nor are the natural resources protected.

In ANRS massive deforestation and overgrazing have resulted in loss of vegetation cover. As a result, the entire region is currently suffering from environmental degradation. A recognizable syndrome of land degradation and deforestation across the region accompanied by an ever increasing population. Agriculture has intensified on land already cultivated and has expanded to valleys and steeper slopes. Thus, the land availability to the farming families has progressively declined. Most of the soils of the region are highly weathered, have low levels of nutrients and low organic matter content.

The ecological crisis and land degradation both in the highland and lowland areas of western Gojam are indeed immense. The process of land degradation can be regarded as both the cause and result of under development. The socio-economic situation in rural areas often forces people to use their environment inappropriately and thus induces land degradation which in turn reduces the productive potential of the land. This leads to crop failure, decreased yield and consequently to poverty and under development. It is a fact that soil degradation is among the pressing development issues in the study area and is likely to remain for a considerable time. Despite the economic and ecological importance of the problem, there has not been effective land use policy. Land use pressure resulting from population increase has led to the cultivation of steep slopes and shallow soils inspite of the incapability of these lands to sustain agriculture. The farming system has also remained largely unchanged, particularly the cereal-based farming systems that are now unable to sustain the ever-increasing population with increasing food and energy demands. Indeed these cereal-based farming system remains extensive compared to the more intensive horticultural-based farming systems of southern and southwestern Ethiopia. In general, agricultural productivity has not shown any improvement over the years. Much of the increase in food production is attributed to area expansion, particularly to marginal lands or lands previously under forests and grasslands (West Gojam Planing and Economic Development Department, 1993).

## 2.5. Agricultural Research and Extension Systems in Ethiopia

Agricultural research in Ethiopia started in higher learning institutions. Before it was reorganized as an independent institution in 1966 it has gone through different approaches. As a result, problem identification and priority setting methodology varied through time. The research approach at the beginning did not give much attention to the problem of the end users. With the initiation of Farming System Research (FSR) in late 1970s and its institutionalization in mid 1980s, there was a growing interest to base the research agenda on the users' problem through problem identification and validation of the research results. However, the principle of FSR has been followed marginally; as a result the level of farmers' participation in identification and validation of the research results was minimal. The composition of on-farm research teams was rarely followed as proposed. Moreover, the

commodity research that has been introduced in to the research system, having the tendency of the traditional top-down research approach, has further minimized the participation of end users. In spite of some of these drawbacks, however, commendable achievements were made.

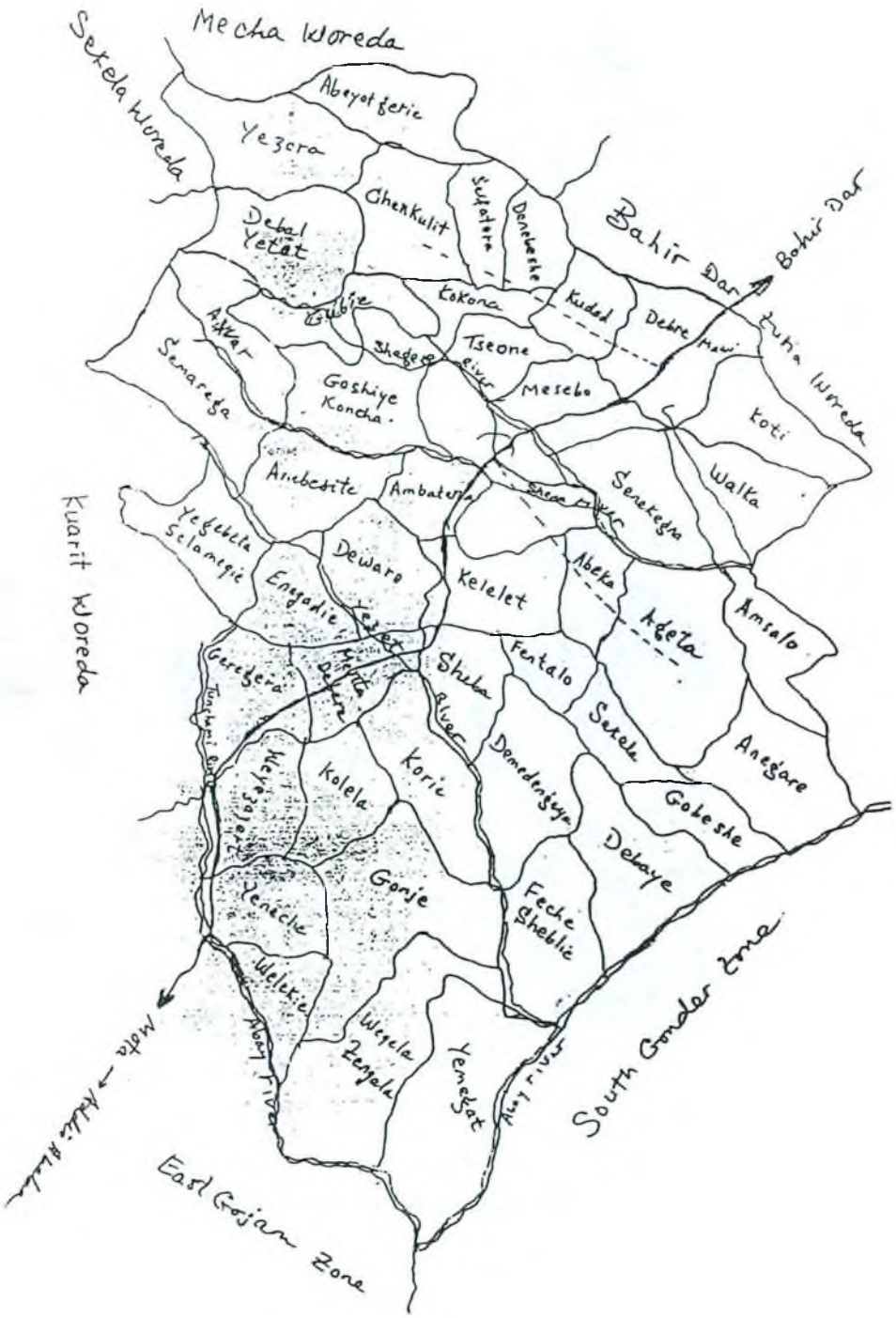
The formal extension service was started with the establishment of agricultural higher learning institutions in the 1950s. The service has been transferred to MoA and worked under different extension approaches. The current extension system, PADETS, adopted the merits of past extension approaches particularly that of T&V and the SG2000 experience. Although PADETS has to some extent improved the research-extension linkage, the linkage was rather informal, lacks budget and non-participatory approach for technology development.

# 3. THE STUDY AREA

## 3.1 Geographical Location

Yilmana-Densa is one of the woredas in Western Gojam zone. The altitude of the woreda varies from 1500 to 3200 m.a.s.l. Adet is the administrative town of the woreda, and is situated at $11^{0}17$`N latitude and $37^{0}43$`E longitude with an altitude of 2240 m.a.s.l. It is located some 45 km southeast of Bahir Dar on the road to Addis via Mota and Bichena towns. The woreda is bordered by Bahir Dar in the north, east Gojam in the southeast, South Gondar in the east and west Mecha in the west (Map1).

Map 1. Yilmana-Densa woreda Administrative map



## 3.2 Natural Environments

### *Climate*

Out of the total load area (144,707ha) of the woreda 24 percent is classified as *"dega"* (highlands), 57 percent as *"woyna dega"* (mid altitudes) and 19 percent as *"kolla"* (lowlands). The annual rainfall (1986-1998) ranged from 860 mm in 1986 to 1771 mm in 1996 (Fig. 3. 1) with significant variation from year to year. The average annual rainfall is about 1291 mm. The pattern of rainfall in the area is unimodal. Rainfall usually starts in March but the effective rainy period is from May to October with a peak in July, averaging of 331 mm. The overall monthly mean rainfall for the growing period May to October, is 1193 mm (Fig. 3. 2) The mean monthly maximum and minimum temperature for the Adet area is 25.5$^0$C and 8.4$^0$C, respectively. The mean maximum temperature ranges from 28.8$^0$C in April to 22.1$^0$C in August, while the mean minimum temperature ranges from 5.2$^0$C in January to 11.6$^0$C in September (Fig. 3. 3).

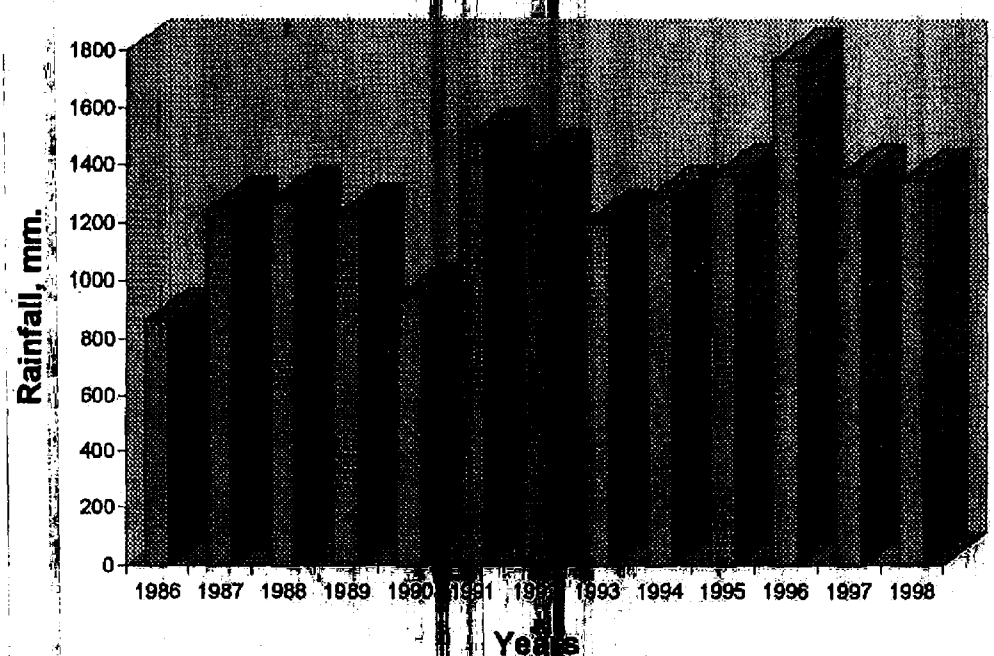



**Figure 3.1 Annual rainfall of Adet (1986-1998)**

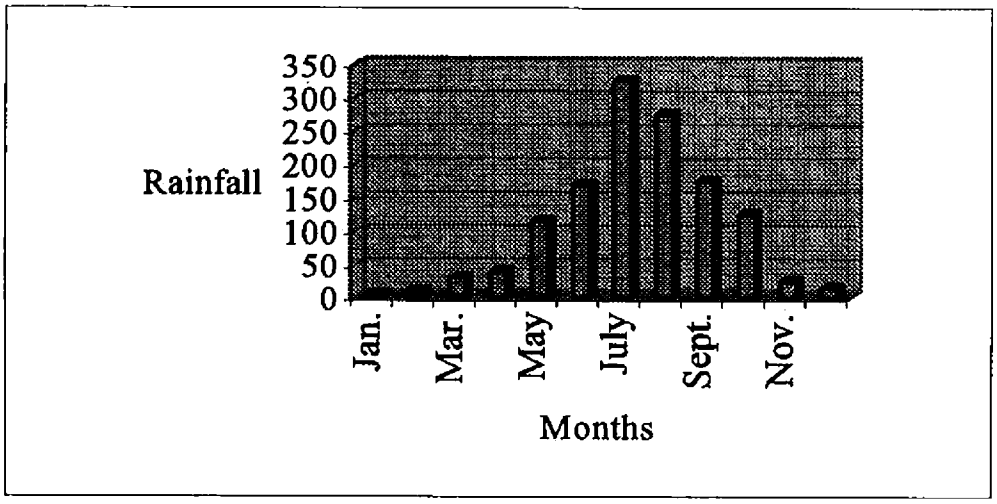



**Figure 3. 2. Average monthly rainfall of Adet (1986-1998)**

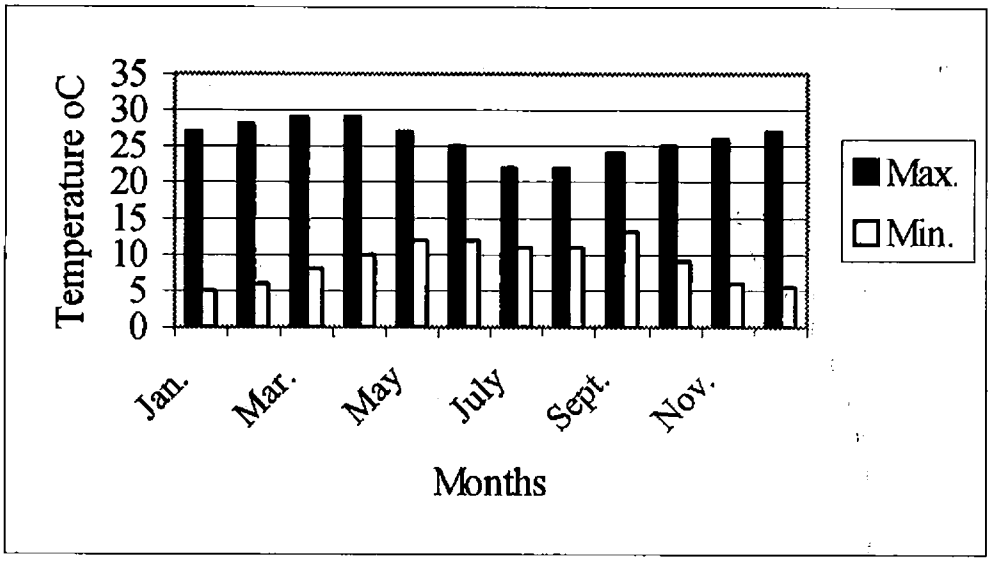



**Figure 3. 3 Mean monthly max. and min. temperature of Adet (1986-1998)**

## *Soil types and their characteristics*

About 80 percent of the area is covered by red or reddish brown soils while the remaining 20 percent is covered by black soils (WADO, 1999). Farmers have classified the soils of the locality into two: black and red or reddish brown soils. They consider the color of the soil as basic criteria for classifying the soil type as soil color helps them to decide on the choice of their crop and the frequency of ploughing.

### *Red soils*

These soils are red or reddish brown in color. Locally, farmers call it *Sheda* or *Borebore*. In most cases the red and reddish brown soils are found on the uplands and on higher slopes in the humid and sub-humid zones. In some places the red and black soil types can be found adjacent to one another even in a very short distances. Some times they can be found on the same farm. These soils usually contain more sand than the black soils. They are well drained and have good water infiltration capacity. They are highly affected by water erosion. But, they do not demand as much labour as the black soils at the time of land preparation. According to FAO-UNSESCO (1987) soil maps, these soils are classified as Nitosols. They are red in color, freely drained and friable. Clay skins are visible in the profile. Proper soil analysis has not been done for Yilmana-Densa woreda. The major crops grown on these red soils are wheat, faba bean, field pea, barely, finger millet, maize, potato and teff.

### *Black soils*

Locally the black soils are called *Walka*. In most cases, these soils are found in the valley bottoms. In some flat valley areas, the black and red soils lies adjacent to one another. Some time they can be found even on the same plot of land. Black soils have clay texture that makes them very sticky and slippery when they get wet. Due to their high clay content, these soils become hard when they are under dry conditions and also develop big cracks. Under excessive rainfall conditions waterlogging becomes a serious problem. Farmers believe that in the past black soils were more fertile than red soils. Nowadays, both type of soils need equal amount and type of inorganic fertilizer.

Black soils are the most preferred types of soil in the study area as they give higher crop yield than the red soils. Farmers having black soil field can produce second crop after barely. Black soils are also susceptible for water erosion as observed in highly eroded and gullied areas the depth of which reached up to 2 - 3 m. In addition to this, black soils need more labour and time at the time of land preparation. These soils are identified as Vertisols (FAO-UNSESCO soil map, 1987). Currently, there is no detail information regarding the characteristics of these Vertisols at woreda level. According to Brehanu Debele and Asnakew Weldeab (1987), the Ethiopian Vertisols share the following characteristics. They generally contain more than 40 percent clay in the surface horizon and close to 70 percent in the middle profiles. The sand fraction is low, often less than 20 percent, and is found in the bottom surface (plough layer)

horizons. The dominant clay minerals belong to the smectite group. The free and total iron contents are high, it is believed that Nontnite is the most prevalent smectite. Berhanu Debele (1995) further indicated that illitic minerals also constitute a significant proportion.

When dry, Vertisols are hard and impossible to plough with oxen drawn implements and may even be difficult to cultivate with heavy machinery. Therefore seedbed preparation is very difficult. When wet it become plastic and sticky, tillage and seedbed preparations are only possible within a narrow moisture range. In dry season surface horizons are characterized by huge, strongly developed prismatic primary structures separated from each other by deep vertical cracks of various sizes at intervals of 15-30 cm. In wet seasons all the cracks are almost completely destroyed and reduce the surface horizon to a massive block. During the dry season pores and root channels are limited. Plants usually confined to cracks and slickenside faces.

Vertisols have relatively high water storage capacity in its upper layer (2 to 3 m) because of high clay content and sufficient soil depth. The available water range has been reported to be 110 to 250 cm in the topsoil profile (Veronic et al., 1982). Due to compression effects the moisture content at deeper layers is much lower than the higher layers. The crop growing season on black soils are much longer than the red soils because of its higher water storage capacity. Farmers in Yilmana-Densa werda grow rough pea, check pea, and *"mesno"* barley only using the residual moisture. Farmers practice late planting to overcome poor drainage on Vertisols.

Due to shallow cultivation depth and their high clay content, Vertisols have some water logging problems. The effect of waterlogging on early sown crops could be stunted growth and low yield. During the field study the team observed that, most of the Vertisols are found on flatter or gentle slope areas although soil erosion was a serious problem that highly decreased the fertility and productivity of the soils. In most area gullies having 2 to 5 on width and 2 to 3 m depth have already developed. Severe sheet erosion is also going on all over the study area.

Percentage of farmers preferring soil types for different crops is indicted in Table 3. 1. According to farmers barley, maize, wheat, teff, finger millet, field pea, faba bean and potato grow better on red (light brown) soils than on black soils. On the other hand black soil is suitable for rough pea, chickpea, teff and wheat. Also, minor spice crops prefer well-drained black soils. Homestead area is used for potato and maize-rapeseed intercropping.

**Table 3.1 Farmers' preference of soil types for growing different types crops**

| Crops | % of farmers preferring light brown (red) soil | % of farmers preferring black soil |
|---|---|---|
| Teff | 33 | 67 |
| Barley | 90 | 10 |
| Maize | 85 | 15 |
| Wheat | 55 | 45 |
| Rough pea | 5 | 95 |
| Chick pea | 3 | 97 |
| Field pea | 93 | 7 |
| Faba bean | 90 | 10 |
| Finger millet | 100 | - |

Source: WADO

### *Land use*

Land use in the woreda is divided in to cultivated (43.7 percent); flooded and swampy areas (45.3 percent); grazing lands (5.9 percent); forest (4 percent); built up areas (1.1 percent) (WADO, 1999). There are no natural forests left in the area except around churches. But, there are some tree species scattered on farm lands, around homesteads, farm boundaries and along rivers. There are also small plantation forests on hilly and degraded lands planted mainly for rehabilitation purposes.

### *Relief features/topography*

The relief features are categorized as flat, mountainous, valley and undulating; each covering 16, 20 and 60 percent, respectively of the total area. About 54 percent of the land area constitute slopes greater than 15 percent.

## 3.3 Socioeconomic Environment

### *Population and its characteristics*

An overview of the age and sex structure of the population is shown in Table 3.2. In 1994 Yilmana-Densa woreda had a total population of 245133. In 1999 it was projected to reach 275004. The number of male and female is almost equal. As elsewhere in Ethiopia, the majority of the population lives in rural areas. In 1994 the proportion of working population to non-working population was closely equal. The projected population density of the area in 1999 is 190 persons per $km^2$, which is 11 percent higher than the population density in 1994.
About 99 percent of the people are Amhara who are predominantly Orthodox Christians. There are also other ethnic groups, mainly in urban areas. These include Kembata, Tigray,

Agew, and Oromo. In addition to Orthodox, some few people follow Protestant, Catholic and Muslim religions. Religion has an impact on farming activities. For instance, Orthodox Christians, who are about 98 percent of the total population, have fewer working days because of religious and cultural holidays.

**Table 3.2 Population by age and sex of Yilmana-Densa woreda in 1994.**

| Age group | Urban | | Rural | | Total | % |
|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | | |
| 0-14 | 2504 | 2569 | 56126 | 54988 | 116187 | 47.4 |
| 15-29 | 1571 | 2395 | 29827 | 31765 | 65558 | 26.8 |
| 30-44 | 892 | 1069 | 15783 | 16757 | 34501 | 14.1 |
| 45-64 | 446 | 489 | 11125 | 9847 | 21907 | 8.9 |
| 65+ | 116 | 127 | 4075 | 2662 | 6980 | 2.8 |
| Total 1994 | 5529 | 6649 | 116936 | 116019 | **245133** | 100 |
| Total 1999* | 6760 | 8131 | 130568 | 129545 | 275004 | |

* projected using growth rate of 2.23 for rural and 4.11 for urban

Source: CSA (1994)

## *Settlement and village setting*

Human settlement to the area dates back to many many years. As mentioned by elders, there were only few villages some 30-70 years ago. At that time villages were found scattered within large distances. Nowadays, farmers settled close to each other following chains of small hills to avoid floods and waterlogging in the valley bottoms. The lower lands are allocated to farming, while the uplands are allocated for villages and homestead farm. Even if they follow some sort of village chains in uplands, it is unlikely to find very dense villages in a given location, even toady. Villages are seen unevenly scattered with small clustered houses across farmlands. Each farmer has settled along his/her field. Following the villagization program of the ex-government, farmers of at least 5-6 villages, were forced to come together in one village. But, as soon as the new government came to power in 1991 they all returned back to their original sites.

## *Input and credit environment*

### *Input*

Though the agricultural system is subsistence with fragmented small-scale farms, farmers use external inputs, mainly for crop production. The major external inputs are chemical fertilizers, seeds of improved varieties and pesticides. Earlier these agricultural inputs were directly supplied by the agricultural development agencies in collaboration with other institutions. At present, however, private input suppliers such as Ambasel Trading Company, AISE, and Amalgamated trading company are involved in the provision of agricultural inputs mainly chemical fertilizers. Currently, farmers receive fertilizers at nearby accessible places or service cooperatives. Usually these companies supply inputs in cooperation with credit institutions. To get inputs farmers are expected to bring credit coupons in a group from credit institutions. Except improved seeds, other inputs can be purchased from small retailers at Adet. So far only BOA provides improved seeds obtained from ESE through PADETS program. But, farmer to farmer exchange of seeds also serve as important improved seed source.

There are no input supply problems. But some farmers complain that pesticides particularly herbicides and rodenticides supplied by traders are not effective. This might be because of using expired once or mis-handling of pesticides by the traders. Farmers also need pesticides packed in small quantities as the existing packs are too big for a single farmer.

### *Credit*

Most farmers use credits to pay for external inputs as only few afford to pay cash directly. Earlier, credit demand was higher than what credit institutions could provide. The regional government was the only major actor for credit supply to the rural poor. Today, however, profit oriented rural micro-finance institutions such as ACSI and Service Cooperative Development offices are widely involved in credit supply and hence credit demand for fertilizers are now satisfied. There is still unsatisfied demand for other small investments like small construction, purchase of oxen and fattening programs.

ACSI and Service co-operatives development office provide credit either through cooperatives or farmers' groups. At present there are about 26 rural service cooperatives that facilitate credit and input supplies. Where cooperatives are not existing farmers take credit by organizing themselves as credit groups. To be eligible for credit, they are required to pay down payments. Local administrative bodies including village leaders are involved in the collection of debts facilitating other formalities. Generally, farmers reported the following credit problems:

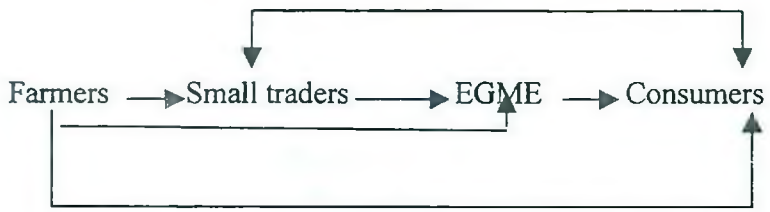
- To much bureaucratic formalities with credit institutions
- Delays in getting credit in relation to planting time of crops, particularly for potato and barley. Potato yields better when it is planted in March but due to lack of credit for fertilizer, planting is delayed up to May or June as a result yields are reduced.

to lack of credit for fertilizer, planting is delayed up to May or June as a result yields are reduced.
- Lack of credit for small investments.

### *Market and infrastructure*

There are several rural market outlets within the woreda. Adet is the largest market place where the entire population of the worda and traders from Bahir Dar exchange their goods and services. It is here where farmers sale grains, live animals and animal products, and purchase farm tools, inputs, construction materials and clothes. Other small market places are also available in each PAs where marketing is taking place on other days. These markets serve as primary outlets for grains in small quantities and animal products (egg, honey, butter and small ruminants). Farmers use only donkeys for transportation of goods to and from markets.

Private traders and EGME are the major buyers of farm outputs either directly from farmers or through rural assemblers. Well-established market channels exist for all outputs. Village assemblers and wholesalers collect from farmers and transport to Bahir Dar or Addis Ababa for retail. The major final destination is Addis Ababa, mainly for teff. For all farm outputs the market channel is simple. The common optional channels are:




Over a six year period (1985/86 to 1990/91 E.C) teff was the major output supplied to the market followed by maize and wheat (Fig. 3.4). Other crops including pulses and oil crops are supplied in small quantities when farmers are urged to pay cash expenses. Supply of all grains has increased over the years. An overview of market prices of major crops shows that oil crops fetch higher prices than pulses and cereals. The general price trend for each crops, however, is increasing through time.

The study area has poorly developed road infrastructure. There is only one all weather road that goes from Bahir Dar to Addis passing through the woreda. Only 21 percent of the PAs are found along this road. The rest are far from this road and are inaccessible. Other institutional infrastructures such as health centers and schools show signs of improvement. Most PAs do have at least one primary school. There are also rural clinics in some PAs. But health problem remains serious in most areas. Farmers are now extremely affected by diseases. According to the local farmers in one of our study village almost half of the household heads died of Malaria.

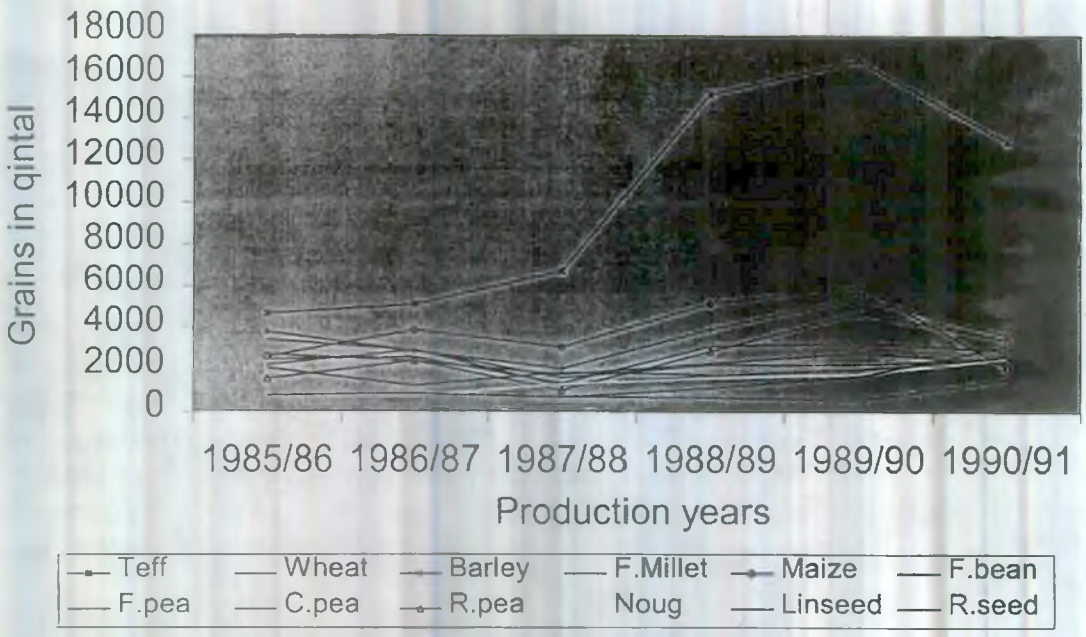



Figure 3. 4. Market supply of different grains at Adet market
Source: WADO (1999)

## 3. 4 Farming Systems

*Farming system components and interactions*

The farming system in Yilemana-Densa woreda is characterized by a crop/livestock mixed system. Off-farm activities and trees/agro-forestry production also play important roles in the system. These sub-systems and associated components (crop and livestock production, off-farm activities, trees) are usually managed by a household unit. External actors like extension, research organizations, support services and region/local administrations play important roles by providing services for the development and management of household activities thereby influencing decision making of a household.

All these components of the farming system interact (Fig. 3.5). Farm households depend on cereal crops, as a major sources of both cash and food. They also depend on milk, butter and meat from livestock for home consumption. In addition, Eucalyptus from wood lots and boundaries, and other trees serve as a major sources of fuel and construction material for the household. Cow dung is also an important source of fuel in the area during dry season.

Animals feed on crop residues particularly during the dry seasons. In return, livestock provides draft power and manure to crops. Manure is used for homestead fields to maintain soil fertility particularly on maize and potato fields. On-farm trees contribute much to the enhancement of soil fertility as well. Grains, butter, live animals and Eucalyptus trees are supplied to the market for cash. Moreover, off-farm activities like daily laborers, black smith and trade serve as a source of cash particularly to the poor households.

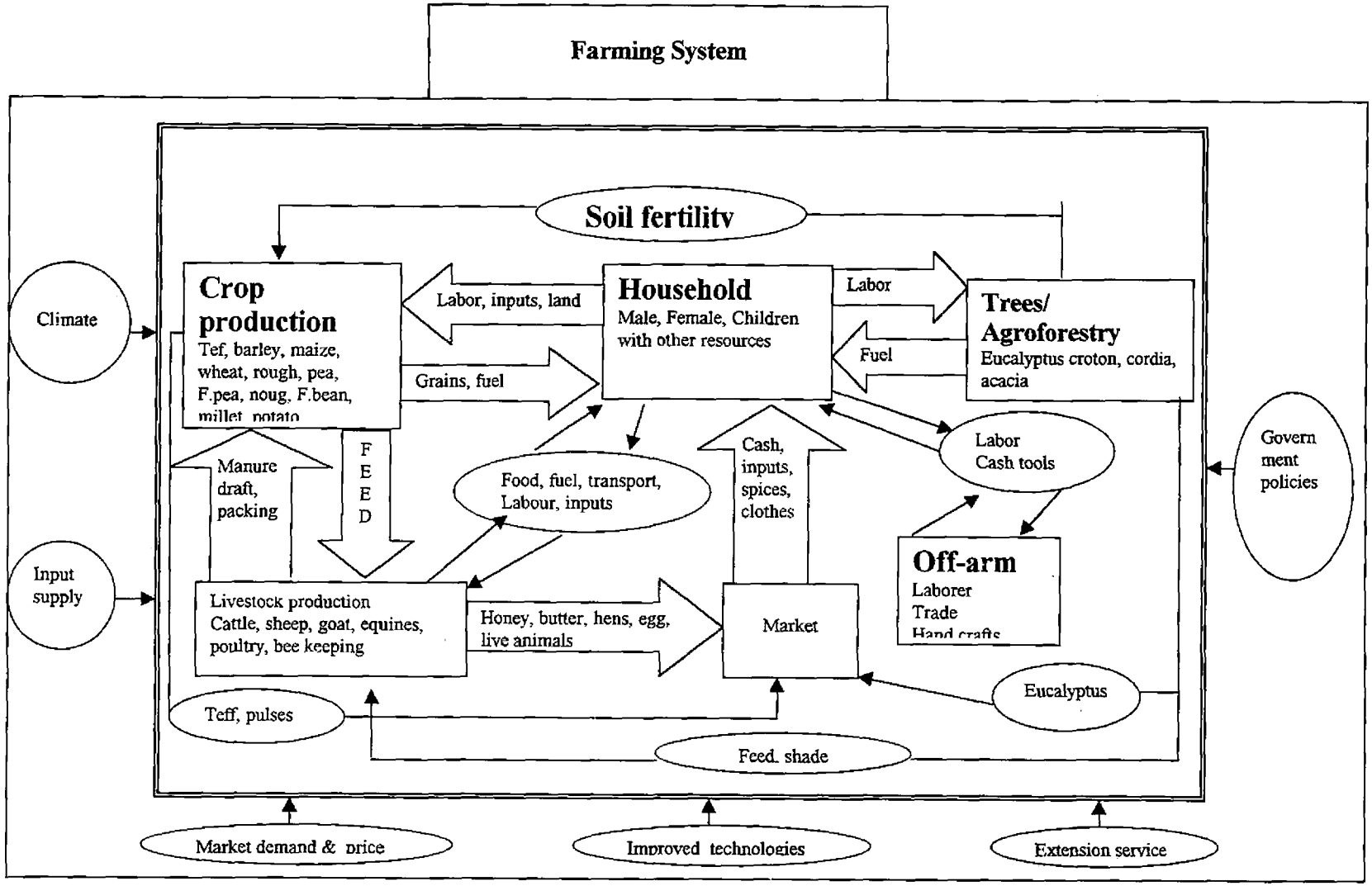





Figure 3.5. Farming system of Yilmana-Densa Woreda

*Farming system zones*

Small-scale agriculture is basically characterized by diversity of socioeconomic and biophysical settings. This variation exists both across geographical areas and across farming systems. Within an agroecology it is possible to find different farming systems as a result of interaction between several socioeconomic and biophysical factors. Consequently, different farming systems face different problems. As a result, general or broad agroecological based recommendations may not be appropriate for all farming systems.

The mid-altitude agro-ecological zone of Yilmana-Densa woreda seems fairly homogeneous. However, reconnaissance surveys and secondary data analysis revealed that there are variations in cropping pattern and farmers soil management practices. These variations are basically due to soil types that vary across villages. Taking this into account and based on the dominant soil color of the area two farming systems are identified (Table 3. 3), namely,

1. Black soil dominated farming system (FS-1): where farmers' priority crops are rough pea, chick pea and teff
2. Red soil dominated farming systems (FS-2): which covers majority of the mid-agro-ecological zone. Here, farmers priority crops are barley, teff, maize and faba bean.

**Table 3.3. Farming systems and their features**

| *Features* | *FS-1* | *FS-2* |
|---|---|---|
| Dominant soil type | Black | Red & Reddish brown |
| Topography | Undulated to gentle | Undulated |
| Crops | Rough pea, chick pea, tef | Barley, tef, maize, field pea, faba bean |
| Soil management | Use mainly DAP<br>Use drainage | Use both DAP & urea<br>Use cut-off drains/ ditches |
| Productivity | Better | Good |
| Level of soil degradation | Moderate | Severe |
| Typical soil problem | Water logging | Poor soil fertility |

# 4. METHODOLOGY

## 4.1. Pre- Field Study Preparation

During the eight weeks theoretical study and exercises period conducted in the class the team studied the agricultural system of Yilmana-Densa woreda based on the knowledge of researchers from AARC and available secondary data. A checklist that will help to gather necessary relevant data to the proposed research questions was prepared. An attempt was also made to formulate relevant research questions and develop seasonal calendar of the woreda agricultural production system. An anticipated output of the field study was outlined and appropriate methodology for carrying out the field study was selected. Apart from this general aspect, criteria for the selection of Peasant Associations (PAs) were also set. The team also drafted tentative schedule for ten weeks field study and prepared team contract that contains rules and procedures to be followed during the study period.

Before starting the informal field survey, the team prepared an introductory planning workshop at AARC and presented the objective, methodology and an anticipated outputs of the study as well as list of stakeholders. Relevant comments and issues that need due attention were incorporated in the study proposal.

## 4. 2. Secondary Data Collection and Analysis

Secondary data review was carried out for a week by screening and reviewing literature at WADO, woreda Administrative Council (WAC); Regional Bureaus of Agriculture and Planning in Bahir Dar. The secondary data analysis focused on the following main problem areas:

- Environment and soil degradation
- Livestock management, feeding system and feed shortage
- vegetation, prevailing natural resource management and development constraints
- Socio-economic status of the study area and its relationship with decline of soil fertility
- Stakeholders and their relationship

After analyzing the secondary data, the team amended previously designed checklist by incorporating the new findings.

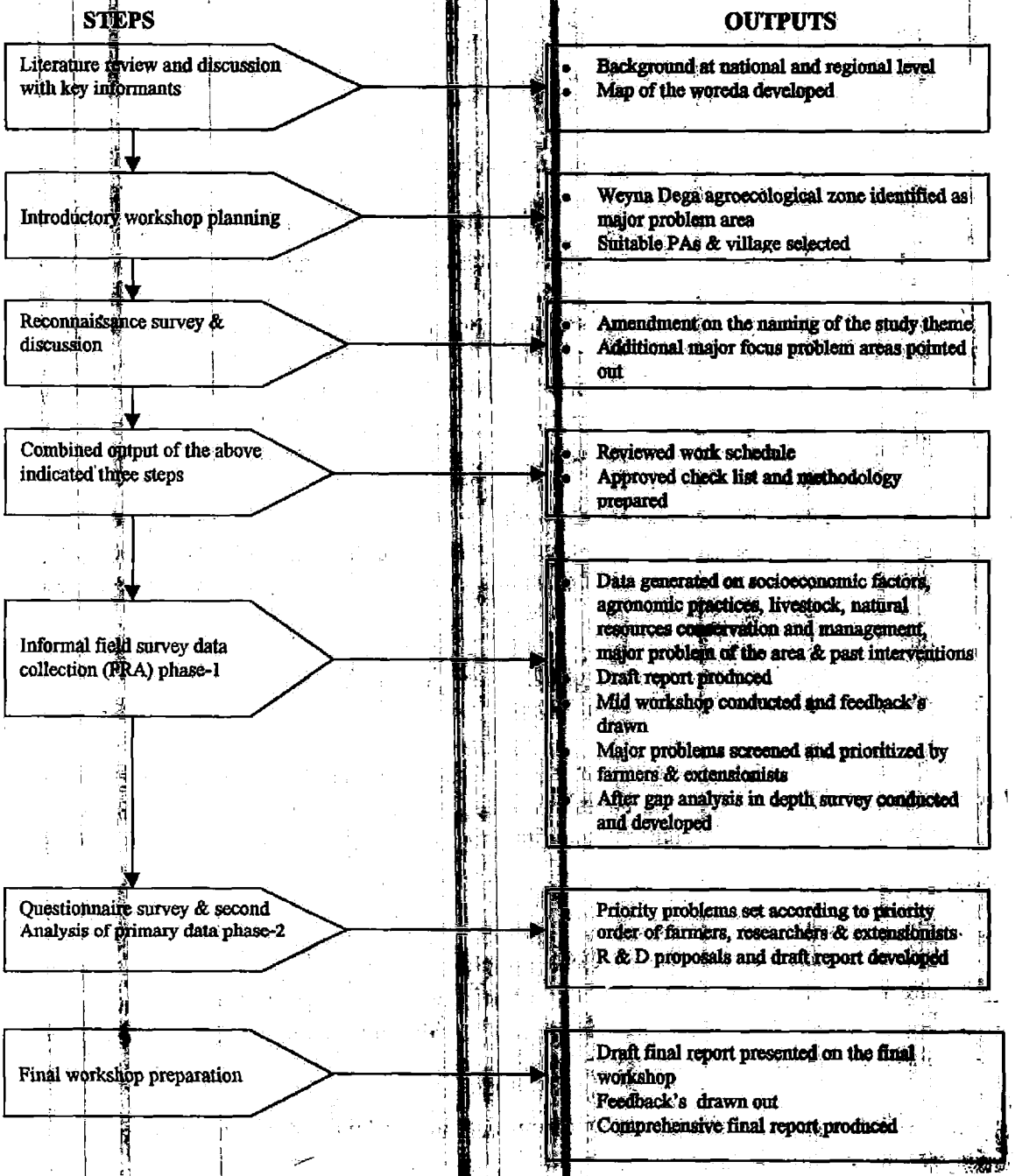



**Figure. 4.1. Summary of methodology applied at the study and main outputs**

### 4. 3. Site Selection

The team identified the *"Weyna-Dega"* agro-ecology zone as priority study area considering accessibility and soil type as the basic criteria. The level of degradation is more or less the same as that of the *"Dega"* agro-ecological zone. From this highly populated intermediate agro-ecological zone, only ten PAs were proposed for reconnaissance survey, taking the dominating soil type as determining criteria. Among these ten PAs, five of them were selected for reconnaissance survey using soil type, accessibility and taking in to account the time allocated for the field data collection, report writing and workshop preparation.

At the time of reconnaissance survey, keen observation was made by the team on all the five PAs in order to have common view about the existing natural features, settlement pattern, land use, vegetation cover and level of soil degradation. Depending on the knowledge gained at the time of field observation the team further developed appropriate criteria for selecting representative study areas (PAs & villages).

At the end of reconnaissance survey, on the basis observation and information gained from key informants, the team selected three PAs and four villages as core centers for primary data generation.

### 4.4. Primary Data Collection and Analysis

Primary data were generated using Participatory Rural Appraisal (PRA) techniques. This method allows active participation and involvement of the local community and other stakeholders in problem identification, screening and prioritization. Furthermore, PRA techniques are quick and efficient in generating the required data.

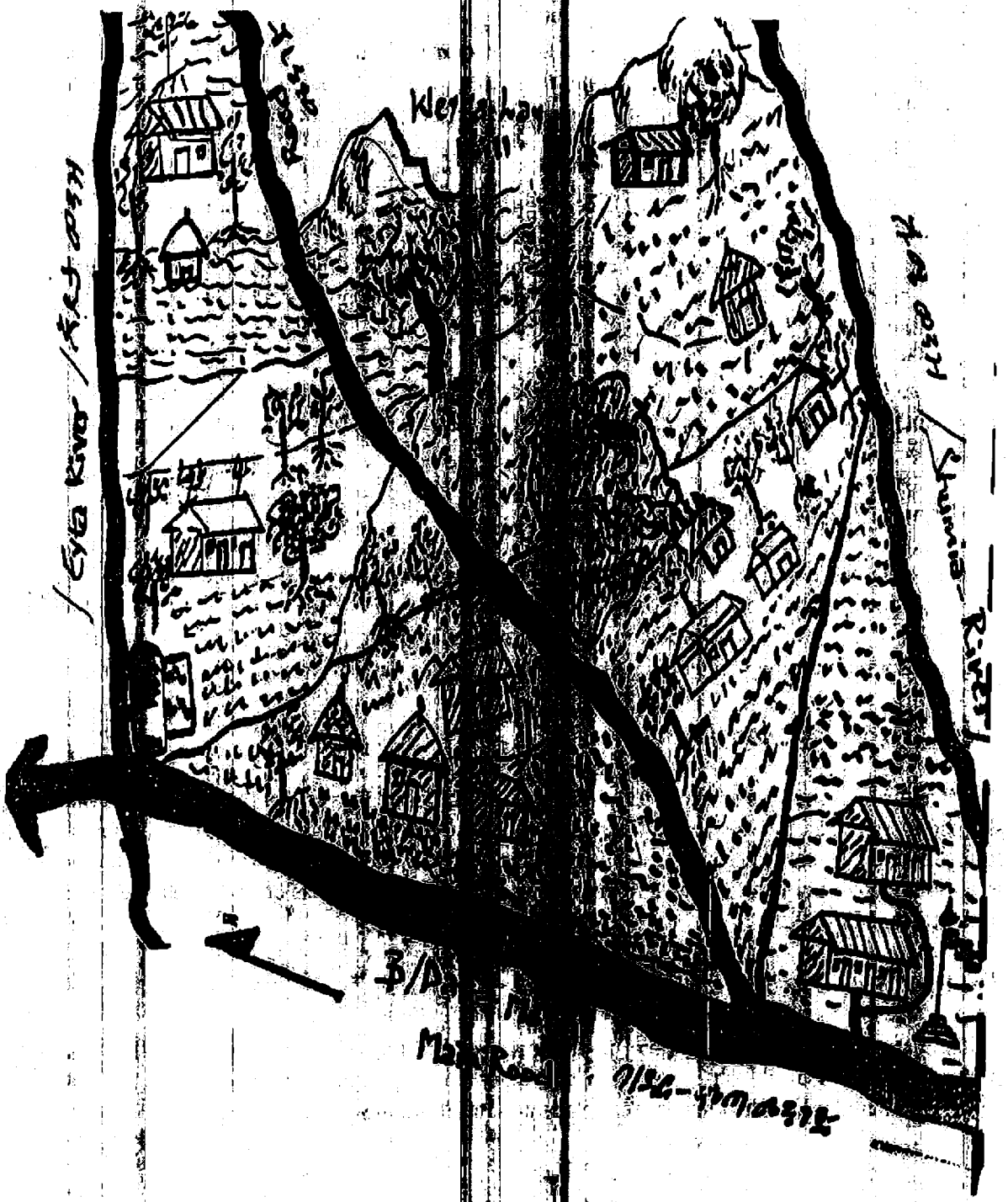
#### *Social and village mapping*

Social and resource maps of each study village were drawn by farmers on the ground and later sketched on paper by the team. The maps contain information about prominent natural features, land use, settlement pattern, different basic infrastructures, vegetation cover and other important factors in the area. The farmers' ability of drawing maps was beyond the expectation of the team (Map 2 &3).

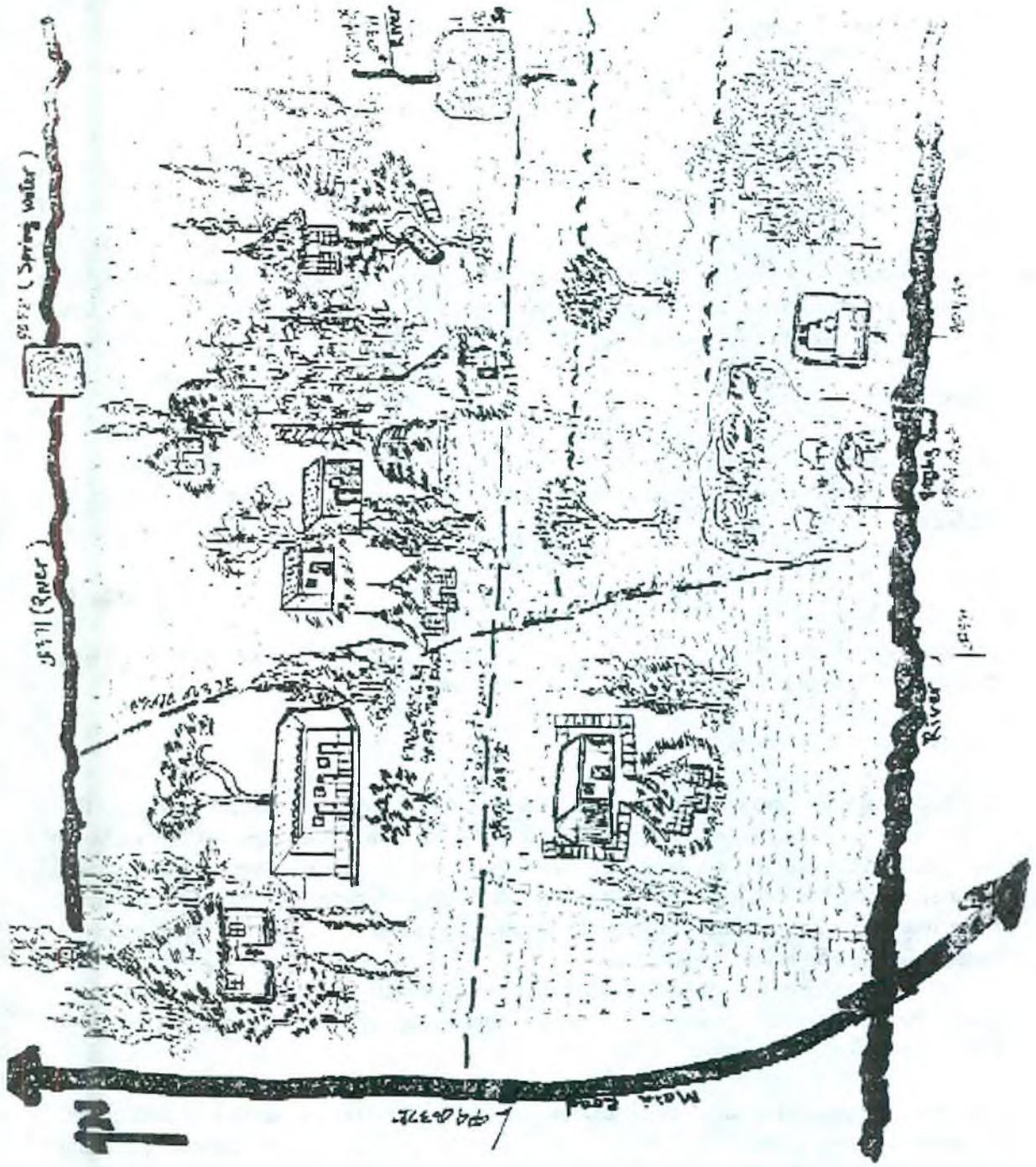
#### *Transect walk and observation*

Transect walk from the highest point to the lower end of the village was made by the team. Along the walking route observation on soil type, existing vegetation, land use, settlement, crops grown and other phenomena were made and information was gathered.

**Map 2. Resource map of village weyralye**



**Map. 3. Resource map of village Atmo**



*Semi structured interview*

In order to generate basic data, semi-structured interview was conducted with key informants, women group, farmers group representing different wealth groups and major stakeholders like experts in WADO, AARC and WAC. A prepared checklist was used as reference for open-ended interviews and follow-up discussions with all stakeholders. When conducting the interview care has been taken to avoid dominance of certain individuals or social group by providing equal opportunity when answering questions and expressing their opinion.

*Proportional piling*

On the basis of secondary and primary data gathered, the proportion of human and livestock population, composition, land use system, crop production, income and expenditure were determined by using proportional piling technique.

*Seasonality analysis*

Seasonal calendars containing information on agronomic practices, feed availability, tree planting, and soil conservation operations and other activities were developed using seasonality analysis.

*Ranking*

Farm/household differentiation, tree species preference, identification and prioritization of problems were done using pair-wise and direct matrix ranking.

**4.5. Mid-term Workshop**

The mid-term workshop was conducted on April 5, 1999 at AARC conference hall. Fifty four invitations were sent out of which 47 accepted the invitation and attended the mid-term workshop. The workshop was held after completion of informal field survey and after writing the draft report. The composition of the workshop participants include 17 farmers (of whom 2 were women), 10 agricultural experts, 14 researchers, 3 representatives of input supplying organization and 5 planners (policy makers).
The major objective of the workshop was to present preliminary findings of the informal field survey to all stakeholders, get their feedback and identify additional information needed to rectify the findings of the study.

The major topics and findings presented on the mid-term workshop were introduction and purpose of the study, the relationships between different stakeholders, prevailing socioeconomic conditions, status of natural resources, key factors causing low agricultural productivity and two sets of problems prioritized by the farmers and WADO experts. The presentation was followed by four hours discussion with the aim of providing feedback to help the team rectify the next focused informal survey.

The feedback from the workshop focused on the following major issues:-

- Why did farmers apply fertilizers below the recommended rates? Are they aware of the disadvantages of using fertilizers below the recommended rates?
- Farmers did not want to construct and maintain soil conservation structures by their own initiations. Why?
- Which factors should be considered to develop sustainable soil conservation strategy?
- Farmers put animal feed shortage as a top priority while the agricultural experts had ranked it as fifth priority problem. Explain?
- How can farmers increase their yield in order to overcome the steadily increasing fertilizer price?
- Explore further means of strengthening the relationship between different stakeholders
- To what extent did the absence of land tenure and land use policies aggravated soil erosion?

These and other issues were raised and discussed during the discussion session. After discussing on the issues raised the team agreed to conduct focused questionnaire survey.

### 4.6. Focused Questionnaire Field Survey and Workshop with Farmers

With the aim of generating quantitative data that can be used for rectifying the issues and problems pointed out at the mid-term workshop, the group prepared questionnaire and conducted interview with individual farmers. The questionnaire consisted of all sort of questions directly related to the above mentioned major problem areas. For conducting the field survey farmers were selected from previously identified farmers' group based on their wealth status. The data was collected using door to door and farm to farm walking and interviewing system. The quantitative data was analyzed using simple statistical description in order to test the difference between each farm types. Other out comes of the focused field survey data were incorporated into relevant section of this report.

In order to analyze the acceptability of the proposed recommendations, a workshop was held with participating farmers that came from different villages.

### 4.7. Final Workshop

Final workshop was conducted on May 6,1999 in the AARC conference hall. The participants were all relevant stakeholders comprising of researchers, extension and policy makers. In the morning session, the team members presented the methodology used, objectives of the study, major points of the study, prioritized problems, and participatory R and D recommendations. In the afternoon session, the participants were grouped into three discussion groups. Each group discussed on each of the presented papers and their comments were presented in a plenary. The main issues pointed out during their presentations include:

- Problems of land shortage and fragmentation
- The need of economic analysis on the use of chemical fertilizers
- Problems of population pressure and need of family planning
- Assessment on the need of small scale mechanization
- Bio- and chemical fertilizers application responses
- Encouraging small scale private improved seed producers
- Finding solutions on packaging size of inputs (seeds, pesticides)
- Encouraging integrated pest management
- Other important unlisted problems and recommendations

Thereafter, the team made exhaustive discussion and analysis on the issues and problems raised by the workshop participants and incorporated the comments into relevant chapters of the final reports.

# PART II

# 5. HOUSEHOLD CHARACTERISTICS AND RESOURCES

## 5.1 Farm/Household Typology

The rationale behind using farm typologies is that different groups of farmers have different needs, and hence require different solutions and/or interventions. Farmers living in the same area or agro-ecology face the same problem and their management practices used could vary depending on their socioeconomic conditions. Thus, general or broad recommendations for an average farmer may not be appropriate to the wide range of conditions experienced by farm families.

To identify farm types the team tried to group farmers using wealth ranking with the help of selected key informants. It was assumed that farmer's experiences and reactions to soil management problems depend on their wealth status. According to the key informants the wealth status of a farmer is based on his ability to produce more than his family food demands. This is the output of different factors such as oxen number, working habit - '*tatarinet*', level of cash income, etc. Thus based on wealth ranks farmers identified four farm/household types:-

1. Better-off farmers who produce more than their families' yearly consumption and lend the extra to others.
2. Medium farmers who produce just enough for a year consumption.
3. Poor-farmers who do not produce enough for yearly consumption but can feed themselves for at least nine months.
4. Very poor farmers who do not produce enough and are short of food for most of the year.

After this preliminary classification, focused questionnaire survey was conducted to test the variations among farm types and identify differentiating variables that have implication for soil management. This survey was conducted on selected farmers from each farm type. The survey indicates that there was no significant variation between farms with regard to some selected factors. The factors were farm size, soil type, fertility status of their farm, fertilizer use, soil erosion problem, frequency of plowing, credit access, tree planting and soil and water conservation practices, cash crop growing, sharecropping practice and oxen ownership. Some of these factors like traditional soil conservation practices, credit access, tree planting and cash crop growing do not vary at all. Others such as fertilizer use, manure, water-logging, soil type and frequency of plowing vary across field types rather than farms.

In-depth investigation of farmers' resources and practices, however, indicates that variation among farms do exist. These variations can be accommodated if the farm households are classified based on their oxen ownership. Oxen ownership affects the management practices like plowing frequency and time, planting date and access to farmlands through sharecropping. It is also possible to determine farmers' ability to purchase inputs because those farmers who have more oxen can have better income level. As a result and based on oxen ownership three farm types were identified. These three farm types are common for both black soil and red soil

dominated farming systems. Features of each farm types that differentiate them and have an impact on soil management is shown in Table 5.1

**Table 5.1. Soil management practices and resources of sample farmers in each farm type, Yilmana-Densa woreda, 1999**

| Variables | Farm-A | Farm-B | Farm-C | Mean |
|---|---|---|---|---|
| Oxen ownership | A pair of oxen | Single ox | Oxen-less | |
| Average family size (No.) | 6.00 | 5.00 | 4.6 | 5.3 |
| Average farm size (Ha) | 1.05 | 1.00 | 0.88 | 0.97 |
| Level of income | Better | Medium | Lower | - |
| Number of farmers who use sharecropping in (%) | 80 | 77 | 0 | 64 |
| Number of farmers who use sharecropping out (%) | 0 | 7 | 86 | 28 |
| Fertility status of farms (%) | | | | |
| Fertile | 10 | 23 | 16 | 19 |
| Medium | 38 | 34 | 53 | 40 |
| Poor | 52 | 43 | 31 | 41 |
| Number of farmers whose farm is affected by soil erosion (%) | 60 | 38 | 28 | 40 |
| Number of farmers whose farm is affected by water-logging (%) | 80 | 38 | 43 | 44 |
| Number of farmers who grow eucalyptus (%) | 80 | 61 | 57 | 64 |
| Number of farmers who use the recommended fertilizer rate (%) | 20 | 46 | 57 | 32 |
| Number of farmers who use traditional soil conservation measures (%) | 80 | 61 | 42 | 60 |
| Number of farmers who take credit (%) | 100 | 92 | 71 | 88 |
| Number of farmers who use manure for soil fertility (%) | 100 | 61 | 42 | 64 |
| Average frequency of plowing (No.) | | | | |
| Teff | 6 | 5 | 4 | 5 |
| Maize | 4 | 3 | 2 | 3 |
| Wheat | 5 | - | - | - |
| Barley | 5 | 3 | 3 | 4 |
| Number of farmers who use pesticides for pulses (%) | 60 | 29 | 15 | 20 |

## 5.2 Family Size and Labor Demand

### *Family size and structure*

Family is the major source of labor in which most farm households totally depend on for all farm operations. The average family size of farmers in Yilmana-densa woreda is 4.6 (Tamiru, 1998). The woreda agricultural office's estimate is about 4. This is quite low and shows a 30 percent decrease when compared with an estimate made 14 years ago (Aleligne, 1985) which was about 6 persons per household. Though the difference indicates a tendency of family size reduction over times it is difficult to explain. Extended family type is common where married boys live together with their parents for sometimes. As a result most of the households have large numbers of full time working people.

### *Source and demand of labor*

The major sources of labor are family, group work and hired labor Family is the most important labor source. During labor peaks, farmers use group work called *Webera,* where farmers work turn by turn using local drinks and foods prepared by the host farmer *Webra* is used mainly for weeding and harvesting. In cases of severe labor shortage, few farmers hire daily laborers at a rate of 2 - 4 birr +/- food per day. Better off farmers and those with less family labor use annually hired permanent laborer. Permanently hired laborers live with the family and are payed about 200 birr per year.

Using labor demand calendar, farmers indicated peak periods and slack periods. Farmers are very much tied from May to September while they have relatively spare time during dry season in December - April. During the busiest period farmers engage on planting and weeding of different crops most of which are overlapped (Fig. 6.1). According to farmers, weeding demands the highest amount of labor followed by planting and soil and water conservation works.

Regassa and Asmare (1995) indicated the available working days in each month in Northwest Ethiopia, which also includes our study area. If we compare the labor demand (Fig.5.1) and available working days (Fig 5.2), labor shortage most likely will occur in May and July when there is high labor demand and fewer working days.

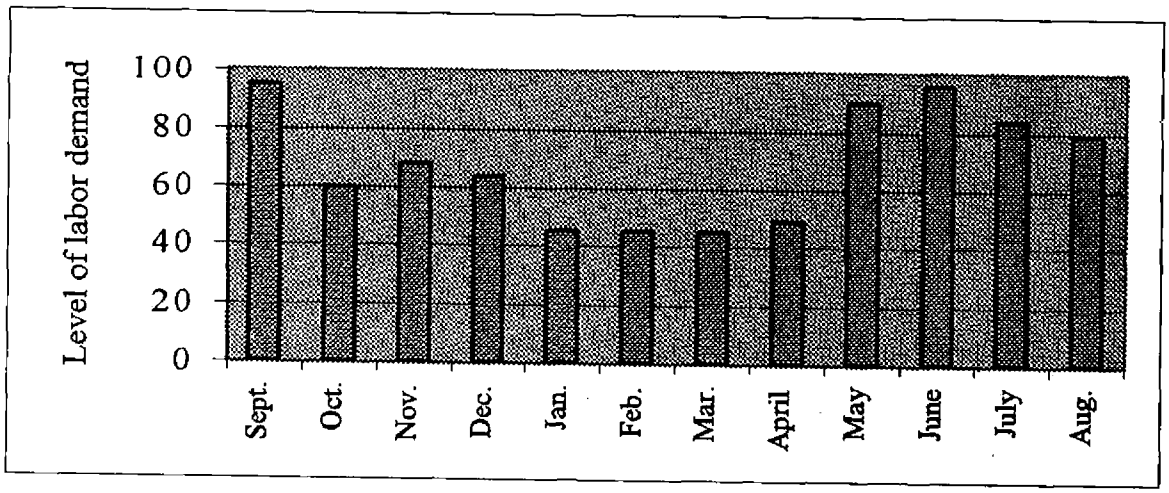



Figure 5.1. Labor demand calendar in Yilmana-Densa

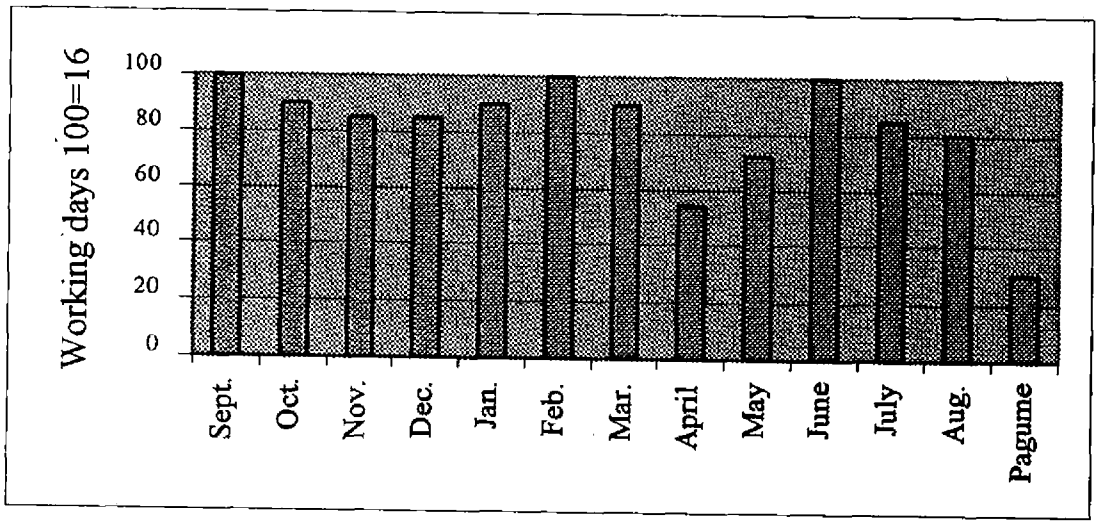



Figure 5.2. Available working days in northwest Ethiopia

## 5.3. Land

### *Farm size and fragmentation*

Arable land holding for a household in the woreda ranges from 0.25 to 3 ha with an average farm size of 1.5 ha (WAC, 1999). Owing to the recent land redistribution scheme, all farmers own farmland. As a result of the increased human population and land shortage farm size per household is very small. Land holding prior to 1994 was characterized by higher variations among households. About 8.6 percent of the household own above 3 ha, while about 21.4 percent were landless (Tamiru, 1998). Today, no household owns over 3ha. This was done following the land redistribution decree of 1997. According to WAC the distribution was not radical; rather it was an adjustment in which land was taken from previous regime bureaucrats who owened over 3 ha and given to female and young landless farmers. The distribution was not based on family size; as a result per capita land holding varies across the households. In general per capita land holding of the rural people in the study area is estimated to be 0.2 ha.

Discussion with farmers group and observation during transect walk indicates that land is highly fragmented. Land fragmentation as defined by Yohannes (1989), is the situation where a farmer land holding is broken up into a number of small separate plots often distant from each other. Farmers own up to 7 plots at different locations with an average of 3 plots. Plot size ranges from 0.13 - 0.5 ha, usually below 0.25 ha. Some of the reasons for fragmentation as mentioned by farmers are:-

- Previous villagization scheme that made farmers to own several plots
- Variation of crop fields in fertility; every farmer is expected to take several plots that have different fertility status and suitability to crops.

### *Land tenure and sharecropping*

Land is under public ownership. Farm households have the right to use, rent for some time and inherit to relatives. Farmers are not allowed to sale land. Land can be redistributed if the need arises. Young family members get land from their families. If the farmer leaves the area for whatever reasons, including death, the land will belong to his/her relatives. If he/she has no relatives, it will be given to others by the local administration. Farmers pay an annual tax for the land they use. In the past, payment was equal for all farmers (10 birr). Now, payment depends on land size but not exceeding 25 birr per household.

Some farmers lease their farms. Two types of lease system or contracts exist in the study area. These are sharecropping and rent. The most common lease system is share cropping in which both parties (landowner and Sharecropper) share the produce equally. Those farmers who have no oxen or who are females mostly sharecrop out to better-off farmers. Farmers indicated that the number of farmers who give land for sharecropping has increased due to the recent land redistribution. Because of the redistribution most female and poor farmers got lands that

they can not manage by themselves. In sharecropping agreement inputs are supplied by both and decision on the type of crops to be planted is made equally. In some cases where the land is very fertile, sharecropper is required to pay top up payment what farmers call *macha* to the landowner, usually 50 - 100 birr. Few farmers also practice renting. Here the farmer will pay some stipulated amount of money, commonly 200-400 birr/year/ha to the landowner. The farmer will then take all of the produce, use and manage the land, as he wants.

### 5.4. Gender Analysis

#### *Division of labor*

Separate group discussion with men and women enabled the team to identify the existing labor division in the community. Different tasks, which are related to soil management, were taken into account for gender analysis. The major activities identified were soil conservation both in private and mobilization work, tree planting, fertilizer and manure application, plowing, fuelwood collection, crop residue management, weeding, straw feeding and animal grazing. According to female and male farmers there is no significant difference between the responsibilities given to different sexes (Figure 5.3). Men are responsible for most activities except manure application on homestead fields for which women take the primary responsibility. Some of the reasons mentioned by farmers for low participation of females on soil conservation, ploughing and other activities are:

- They can not dig the hard and dry soils for soil bounds
- They are more tied with in-door activities which are their sole responsibility
- Cultural traditions derived from their ancestors do not allow women to plough

#### *Resource accesses and control*

The pattern of resource access and control by gender depends on the type of a household. If the household is female headed, women would have more access and control over resources. But if the household is male headed the access and control of resources by female is much reduced. Culturally, as elsewhere in Ethiopia, men have more access and control than women do in most of the resources. In order to analyze gender differentiation on access and control of resources we took a nuclear family as an example. This typical family is male headed household.

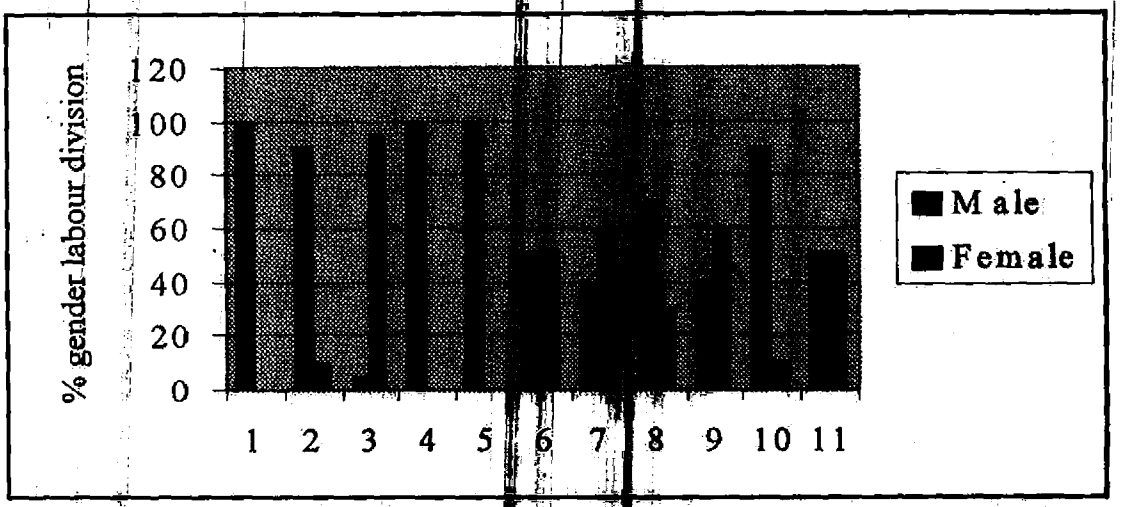
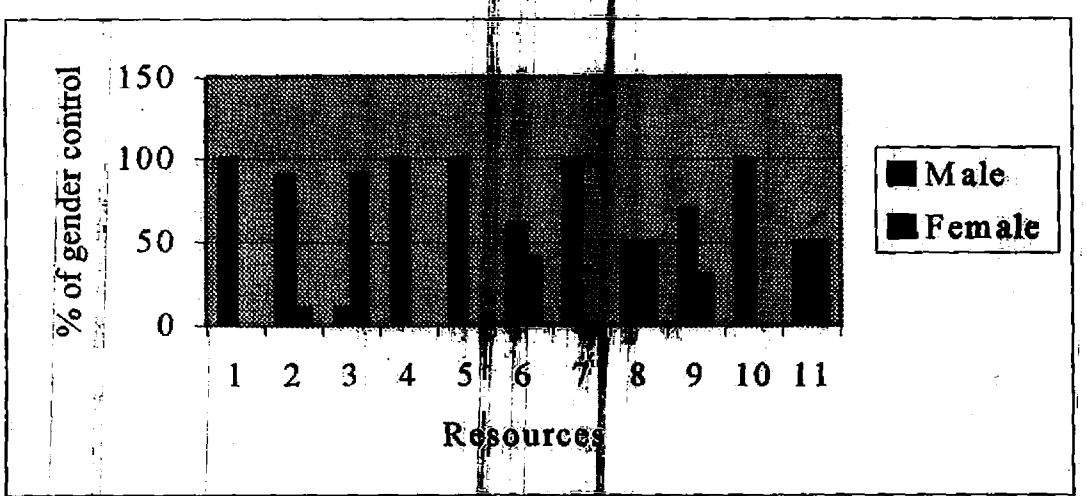



**Figure 5.3 Division of labor between men and women in soil management**

| | | | |
|---|---|---|---|
| 1 | Soil conservation | 7. Sales of grains |
| 2 | Fertilizer app. | 8. Crop residue Mgmt |
| 3 | Manure App. | 9. Fuel wood collection |
| 4 | Tree planting | 10. Straw feeding |
| 5 | Ploughing | 11. Animal grazing |
| 6 | Weeding | |




1=soil conservation work,2=fertilizer use, 3=Manure use,4=Tree planting, 5=tree uses, 6=Sales of grains,7=oxen use,8=sharecropping of land,9=Credit, 10=crops to be planted,11=crop residue use

**Figure 5.4 Gender differences in decision making, Yilmana Densa woreda, 1999**

Both men and women have almost equal decision power on land leasing, grain selling and crop residue use (though their interest varies), while only men decide on soil conservation works, whether to plant a tree or not, oxen use and type of crops to be planted in a year (Fig 5.4). According to farmers, both men and women own land, oxen, and perennial trees particularly eucalyptus. Owing to the recent land distribution policy, women have equal access to farmland and have the right to take part of the farm if they have divorced. The same is true for oxen and eucalyptus, but unlike lands, this is a long existing tradition. Men have more access to training and credit than women do. In the study villages training and credit was not given so far to women. But, women have a say on how to use the credit.

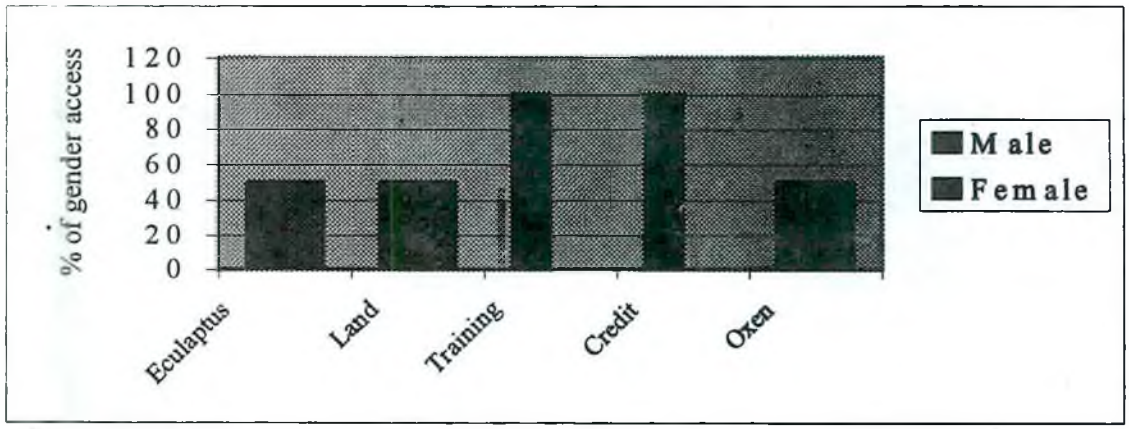



**Figure 5.5 Resource access by men and women in Yilmana Densa woreda**

### 5.5. Cash Income and Expenses

The farming system of Yilmna-Densa is subsistence in nature. Farmers, however, need cash to purchase some inputs and for routine expenses. Especially, these days when the use of external goods/inputs has increased, the availability of cash income becomes the determinant factor for the livelihood of the farmers. The major sources of cash income, as mentioned by farmers, are sales of grains mainly teff, small ruminants (sheep), poultry, eucalyptus tree, off-farm activities, honey, vegetables, *gesho* and rarely butter.

The relative importance of each income source slightly varies depending on the specific villages and farm types. Sales of grain shares the largest percentage followed by small ruminants, eucalyptus, vegetables, etc (Fig 5.6). Farmers have better financial position at harvest, though the price at that time is quite low.

The major expenses are inputs (particularly fertilizers), clothes, coffee, spices (oils, salts, pepper, etc), farm tools and fuel-wood for the household (Fig. 5.7). Some of these are seasonal while others are used throughout the year. Traditionally every household drinks coffee every morning, a crop not grown by them, hence costing farmers too much. Inputs are purchased

once a year, but with the increasing price of fertilizers, inputs become the first important expense for all farm households. Cash expenses become higher at harvest because every expense including debts are settled then. On the other hand prices at harvest are much lower and every household has to sale more quintals of grains to compensate for the low prices.

### 5.6. Food Availability and Survival Strategies

The major food types commonly consumed by the rural household are *injera* with *watt*, bread on holidays, cooked/roasted grains (*nifro/kolo*) and locally brewed drink, t*ella*. Farmers prefer tef for *injera* followed by barley, finger millet, wheat and maize. Use of maize for *injera* is a recent phenomenon that becomes popular with the increase of its production. For making *watt*, rough pea is preferred followed by chickpea, field pea and faba bean. Chickpea is mainly used for watt making as *dulet/assa* watt during fasting period. Farmers prefer maize and barley for t*ella*.

Out of the farm typologies, which are identified in the area, poor farmers (farm type C) recurrently face food shortage. Food shortage is very time specific. Most farmers are without food during the main wet period i.e., from May to September when seed demand is very high and there is no crop harvest at all.

Farmers have several survival strategies and the choice depends on the availability and possibilities of each option in the specific villages during food shortages.

The major survival strategies of farmers are:

- Use of potato, which mature earlier and widely used as hunger reliever
- Early harvest of barley
- Green harvest of maize called *eshet*
- Young leaves of rapeseed during the main rainy season (June to end of September)
- Off-farm activities such as daily laborer
- Borrowing of grains among farmers. Depending on the relationship between farmers there may be local credits with high in-kind interest rate such as labor and grains.

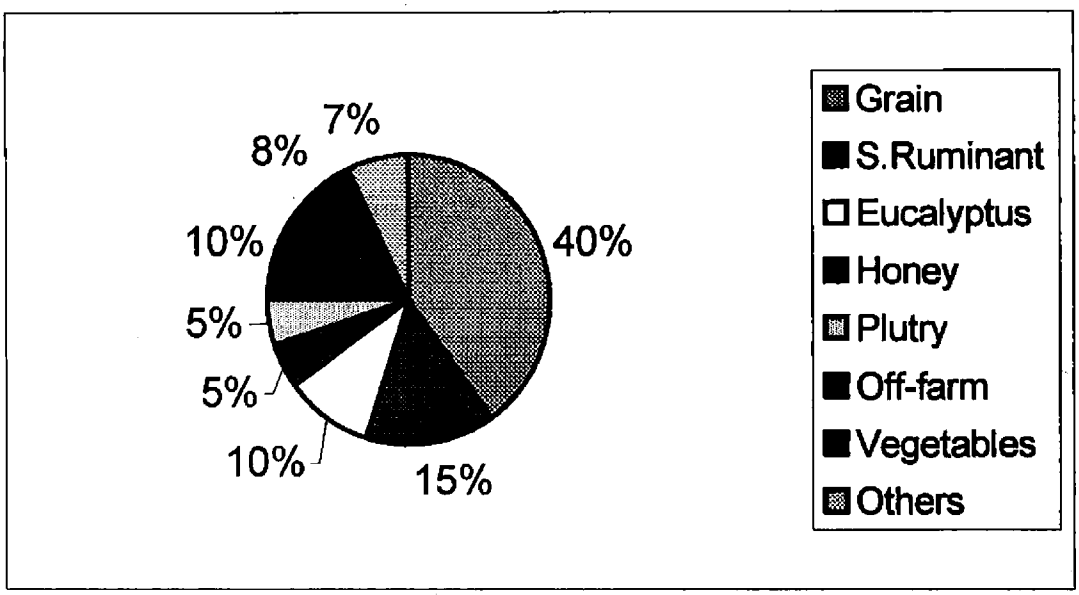



**Figure 5.6 Cash income sources, Yilmana-Densa woreda, 1999**

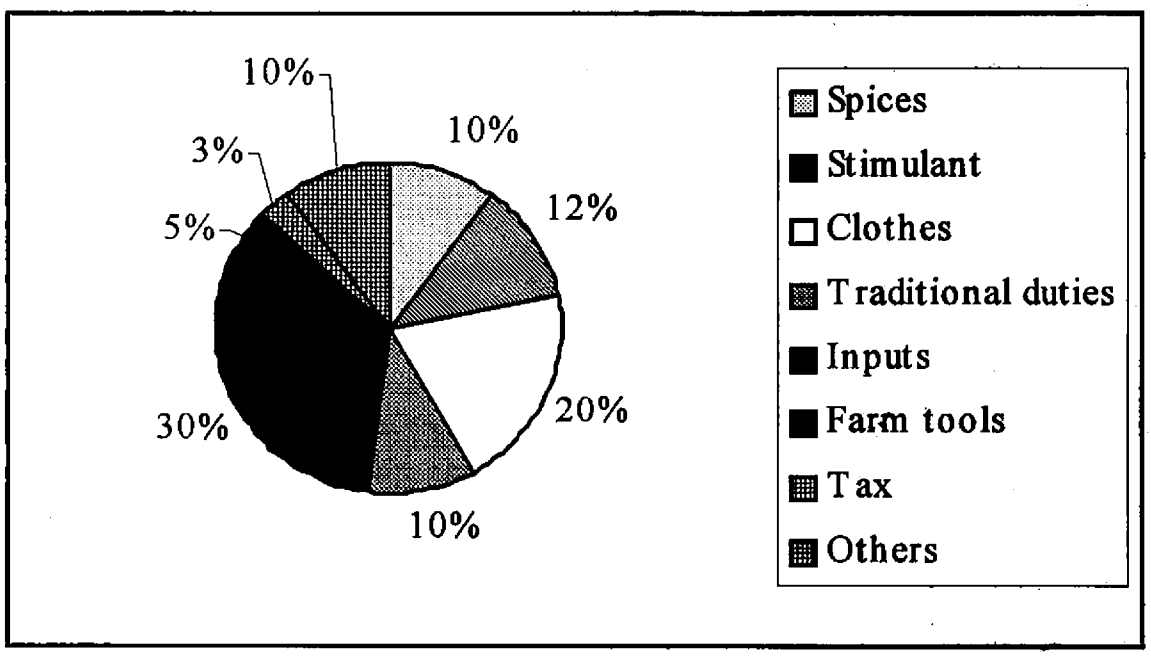



**Figure 5.7 Farmers' cash expenses**

# 6. CROP AND LIVESTOCK PRODUCTION AND MANAGMENT

## 6.1. Crop Production and Management

Although the farming system of the study area is characterized by crop-livestock mixed farming, crop production is the main stay of farmers. Farm households depend mainly on crops both for food and cash income. The area is suitable for cereals and pulses. Oil crops and horticultural crops are also grown but to a lesser extent.

Teff, barley, maize, finger millet, wheat, rough pea (*Lathyrus sativas*), chickpea, faba bean and field pea are the major crops grown by farmers. However, due to diseases and pests the production of field pea and faba bean has reduced. In some areas, their production is already abandoned. Potato is also widely grown by almost all farmers on red soils around homestead and in large fields. Others such as pepper, cabbage, tomato, carrot, fenugreek, *noug*, lentil, linseed, rapeseed are grown in some localities. According to the woreda agricultural development office teff had the largest share (29 percent), followed by barley (15 percent), maize (9 percent), wheat (8 percent) and rough pea (6 percent) (Table 6. 1).

**Table 6.1. The major crops grown in the woreda**

| Crops | Area coverage (ha.) | Percentage |
|---|---|---|
| Cereals | 41572 | 69.7 |
| Teff | 17310 | 29.0 |
| Barley | 9075 | 15.2 |
| Maize | 5044 | 8.5 |
| Wheat | 4806 | 8.1 |
| Sorghum | 3512 | 5.9 |
| Finger millet | 1825 | 3.1 |
| Pulses | 11758 | 19.7 |
| Rough pea | 3518 | 5.9 |
| Field pea | 2910 | 4.9 |
| Faba bean | 2570 | 4.3 |
| Chick pea | 2110 | 3.5 |
| Lentil | 346 | 0.6 |
| Haricot bean | 304 | 0.5 |
| Oil crop | 3292 | 5.5 |
| Noug | 2600 | 4.4 |
| Linseed | 692 | 1.2 |
| Horticultural crops | 3005 | 5.0 |
| Potato | 1079 | 1.8 |
| Pepper | 554 | 0.9 |
| Onion | 149 | 0.2 |
| Others | 30 | 0.05 |
| Spices | 1193 | 2.0 |

Source: WADO (1998/99)

## *Varieties*

Farmers grow several varieties of certain crops, which have different traits that fit various farmers' needs and circumstances. These include both local and improved varieties. Farmers use improved varieties of teff, wheat and maize. They appreciate the advantages of these improved varieties, except one maize variety (BH540) which was not good compared to the improved varieties used in 1997/1998 cropping season.

The different crop varieties currently used by farmers are shown in Table 6.2. Farmers have never used any single improved varieties of pulses, oil crops and barley. Moreover, pulses and oil crops have few alternative local varieties when compared to cereals. Barley, being harvested earlier, is the only food source for poor farmers when there is pre-harvest food deficits (July to September).

**Table 6. 2. Varieties of major crops**

| Crops' | Teff | Barley | Maize |
|---|---|---|---|
| Local cultivators | Buseye<br>Fesho<br>Murie<br>Musseie | Semereta<br>Meseno- gebs | Deme |
| Improved cultivators | DZ-01-354<br>DZ-01-196<br>DZ-Cr-37 | ---------- | Awassa 511-53 composite, Alemaya composite, BH 540, BH 660, PHB 3253 |

## *Weeds, diseases and insect pests*

Pests are one of the important limiting factors in crop production. Pests could be insects, diseases and weeds.

*Weeds*

Weed competition is more serious with excessive and early on-set of rainfall. The noxious weed types pertinent to major crops are *Enkerdad (Lolium temulentum), Asendabo (Phalaris paradoxa), Maachera (Brachiaria eruciformis), Muche (Guizotia scarba), Gorteb (Plantago lanceolata), Yebeg lat (Portulaca oleracea),Yewof gomen (Erucastrum arabicum); Lambut (Polygonum nepalense), Yekemis kulf (Anagallis arvensis), Yekoke sar (Arthraxon micans), Ageratefa (Galinsoga parviflora), Yweha ankur, (Commelina spp.) and Ameykela (Hygrophila auriculata).* Among the above major weeds reported in the study area, *Ameykla (Hygrophila auriculata)* and *Maachera (Brachiaria eruciformis)* are common on black soils and *Yewefegomen* on red soils while others are found on both soil types. More weed population is found on red soil where more plowing is practiced.

*Insect pests*

In the study area all crops are attacked by one or more insect pests (seedling, foliage and storage insects).

Shoot fly, crickets, grasshoppers, and occasionally, army worm and red teff worm are the major insect pests of teff as reported by farmers. Armyworm is a problem particularly on black soils. Shoot fly attack starts at seedling stage but farmers realize or recognize the damage at the time of pre-flowering (*'siyazerezer'*) and they call this damage as *'belehe'*. Teff is also attacked by crickets mainly between mid August and September. After harvest and before threshing the heaps of teff are also attacked by termites. Unless the heap condition is checked and improved the damage caused by termites could be very high. Unlike other crops, teff has no storage insect pests. The problem of insect pest is the same both on black and red soil types.

A soil dwelling insect locally called *Mesek* is a serious pest on barley mainly at the seedling stage in mid July. '*Meseke*' could be cutworm or shoot fly or grubs or termite. Storage pests like weevils could also attack barley in the storage if the seed is not dressed with insecticides.

The major insect pests of maize are stalk borers. They attack the crop through its different growth stages. They attack seedlings, leaves, stalks and cobs. Late sowing of maize creates a favorable condition for the stalk borer. Maize is also attacked by African bollworm (ABW). It attacks the silk and then enter the cob thereby damaging the milky seeds. Maize is also one of the crops which is highly attacked by the storage pests.

Cutworms and lepidopterous worms are the major insect pests of wheat in the field, and weevils in the storage. Field pea is highly attacked by aphids, ABW and termites; faba bean by pod borer and aphids; rough pea by pea aphids and pod borer; and chickpea by cut worm and pod borer.

## *Diseases*

Crop diseases are important in the production system of the study area. *Aremamo* (loose smut) and other foliar diseases are common on barley. Bread wheat is affected mostly by stem and leaf rust, and rarely by loose smut. Blight is common on maize, and chocolate spot, rust, root rot on faba bean; powdery mildew and rust on field pea; wilt and root rot on chickpea and rough pea are the major disease problems in the area.

## *Cultural practices*

Cultural practices such as land preparation, planting, seed rate, weeding and harvesting depend on soils, crop types and cropping systems. Tillage is done using oxen by local plow (*maresha*). The frequency of plowing is influenced by soil type, type of preceeding crops, oxen availability, oxen strength, weed infestation and on-set of rain.

Cropping calendar for the major crops is presented in Figure 6. 1. Land preparation on red soil starts in September while those farmers with black soils usually start from January - March. Priority in land preparation is given for teff and barley. Teff requires a fine seed bed preparation. The number of tillage for teff production ranges from 4 to 10 times, with an average frequency of about 6 times. When teff follows rough pea, chickpea or late-planted barley (*meseno gebs*) the number of tillage required is less mainly because the land is usually plowed twice or thrice for the preceeding crop. The average frequency of plowings for barley is about three. Two to three times plowings are common for maize. However, farmers who are in short of oxen till their maize field only once. Tillage for chick pea and rough pea start when the water holding capacity of the black soils is at maximum so as to conserve moisture for the growing period, September to February. Planting is done only after the drainage problem is alleviated i.e., in September. Most farmers use minimum tillage for faba bean, field pea and finger millet in which seed is broadcasted and the soil is plowed to cover the seed. In black soils farmers need more draft power than those having red soils for the following reasons: 1) black soils require more oxen power to draw the plow both during the dry and wet seasons. 2) Plowing on black soils starts only after the on set of rainfall and overlaps with planting of cereals (barley and maize) and pulses (faba bean and field pea).

## *Planting*

Most of the farmers use their own seed. However, starting 1996, when the new extension program has begun, farmers used to purchase improved seeds (teff, maize and wheat) and chemical fertilizers on credit. All crop seeds are broadcasted and covered by '*maresha*'. Nowadays, row planting is practiced for maize. Farmers use a wide range of seeding rates. Most of them prefer to use higher seeding rate to suppress weeds. On red soils, farmers plant their crops from May to July where as on black soils (flat areas) planting is done from July to October.

Figure 6.1 Cropping Calendar

| Crops/Activities | MONTHS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rain mil | J | F | M | A | M | J | J | A | S | O | N | D |
| Teff | | | | | | | | | | | | |
| Land preparation | | | | | | | | | | | | xxxxxxx |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | | | | | xxxxxx | | | | | | |
| Weeding | | | | | | | | xxxxxxxxx | | | | |
| Harvesting | | | | | | | | | | | | xxxxxxxx |
| **Barley** | | | | | | | | | | | | |
| Land preparation | | | | | | | | | | | xxxxxxxxxxx | |
| | xxxxxxxxxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | | | | xxxxxxx | | | | | | | |
| Weeding | | | | | | xxxxxxxx | | | | | | |
| Harvesting | | | | | | | | xxxxxxx | | | | |
| **Maize** | | | | | | | | | | | | |
| Land preparation | | | | | | | | | | | | xxxxx |
| | xxxxxxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | | | xxxxxx | | | | | | | | |
| Weeding | | | | | xxxxxxxxx | | | | | | | |
| Harvesting | | | | | | | | | | | | xxxxxxx |
| **Bread Wheat** | | | | | | | | | | | | |
| Land preparation | | | | | | | | | | | | |
| | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | | | | | xxxxxx | | | | | | |
| Weeding | | | | | | | | xxxxxxxxx | | | | |
| Harvesting | | | | | | | | | | | xxxxxxxx | |
| **Finger millet** | | | | | | | | | | | | |
| Land preparation | | | | xxxxxxxx | | | | | | | | |
| Planting | | | | | xxxxxxx | | | | | | | |
| Weeding | | | | | | xxxxxxxxxxxxxx | | | | | | |
| Harvesting | | | | | | | | | | | | xxxxxxx |
| **Field pea/ Faba bean** | | | | | | | | | | | | |
| Land preparation | | | | | xxxxxxxx | | | | | | | |
| Planting | | | | | xxxxxx | | | | | | | |
| Harvesting | | | | | | | | | | | xxxxxxxxx | |
| **Potato** | | | | | | | | | | | | |
| Land preparation | | | | | | | | | | | | |
| | xxxxxxxxxxxxxx | | | | | | | | | | | |
| | xxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | xxxxxx | | | | | | | | | | |
| Cultivating | | | | | xxxxxxx | | | | | | | |
| Harvesting | | | | | | xxxxxxxxxxxxxxx | | | | | | |

Continuation of Figure 6.1

| Black soil | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rough pea** | | | | | | | | | | | | |
| Land preparation | | | | | | | xxxxxxxxxxxxxxxx | | | | | |
| Planting | | | | | | | | xxxxxxx | | | | |
| Harvesting | | xxxxxxxx | | | | | | | | | | |
| **Chickpea** | | | | | | | | | | | | |
| Land preparation | | | | | | | xxxxxxxxxxxxxxxxxx | | | | | |
| Planting | | | | | | | | xxxxxxx | | | | |
| Harvesting | xxxxxxxx | | | | | | | | | | | |
| **Barley('*meson genes')*** | | | | | | | | | | | | |
| Land preparation | | | | | | | | | xxxxxx | | | |
| Planting | | | | | | | | | xxxxx | | | |
| Harvesting | xxxxxxxx | | | | | | | | | | | |
| **Teff** | | | | | | | | | | | | |
| Land preparation | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | | | | | | | | | | | |
| Planting | | | | | | xxxxx | | | | | | |
| Weeding | | | | | | | | xxxxxxxx | | | | |
| Harvesting | xxxxxxxxx | | | | | | | | | | | |
| **Busiest period** | | | | | | xxxxxxxxxxxxxxxxxxxxxxx | | | | | | |

## *Cropping Systems*

Crop rotation, if not always with pulse crops, is practiced in the study area. The pattern of the rotation varies with the soil type. The most common rotation on red soils is teff-fingermillet/fababean/fieldpea-barley-teff. On black soils, teff-rough pea/chickpea-barley-roughpea/chickpea-teff/barley is rotated. Cereal rotation with faba bean and field pea is rarely practiced, due to the problem of diseases and insect pests on pulses.

Double cropping is practiced on gentle slope black soils. An early maturing barley variety locally called *semereta* is sown from end of May to mid June in the main rainy season, and harvested and threshed immediately in September. Then, they usually plant the second barley locally called *mesno gebs* or rough pea in September on residual moisture and harvest in December/January. Maize - potato and rapeseed - maize intercropping is also a common practice around homestead areas.

*Weeding*

Hand weeding is the main cultural practices used by farmers to control weeds. On teff fields one to two times hand weeding, from late August to late September, is a common practice. For maize and finger millet, they use hoe cultivation followed by hand weeding done usually from June to late August. Barley, field pea and faba bean fields are not usually weeded because of overlapping activities in June and early July, i.e. cultivation of maize, land preparation and planting of teff and wheat. Most farmers are not yet acquainted with the use of herbicides, however, some farmers use 2, 4-D on teff and wheat fields to control broad leaf weeds.

## 6.2. Livestock Production and Management

In Yilemana-Densa woreda, mixed farming (crop-livestock) is the dominant production system. Livestock production system is coupled with crop production where one can not exist without the other. They are vital for crop production because cultivation is only possible if there is draft power. Crop residues are the main livestock feed source mainly during the dry season of the year.

*Livestock types and population*

Cattle, small ruminants, equines and poultry are the major livestock types found in Ahmhara region and Yilemana-Densa woreda (Table 6.3). In the study area donkey, sheep, cattle and poultry are the most important livestock types reared by farmers. The maximum livestock holding per household ranges between one for cow and donkey and four for sheep and poultry (Table 6.4). The type and the number of livestock holdings per household are very small mainly due to feed shortage. The feed shortage is a result of degradation of vegetation and low productivity potentials of the existing feed resources, financial problems and livestock diseases and parasites.

**Table 6.3. Livestock population in Amhara region and Yilemana-Densa Woreda**

| Areas | Livestock types | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ox | Cow | Heifer | Bull | Calf | Sheep | Goat | Equines | Poultry |
| Amhara region | 3071553 | 2984459 | 1359202 | 120057 | 197866 3 | 5722315 | 4169133 | 2091590 | 9548466 |
| Yilemana-Densa | 36802 | 32911 | 11420 | 958 | 22211 | 27657 | 18051 | 16104 | 124218 |

Source: BoA (1996)

**Table 6.4 Maximum livestock holdings per household in the study area**

| Pas | Livestock types | | | | |
|---|---|---|---|---|---|
| | Ox | Cow | Sheep | Poultry | Donkey |
| Gregera | 2 | 1 | 4 | 4 | 1 |
| Kudad | 2 | 1 | 2 | 5 | 1 |
| Killelt | 2 | | 2 | 2 | 1 |

## *Breed types, breeding, productivity and uses*

In the area farmers have 'nondescript' type of livestock breeds. The percentage of the known breeds compared to the nondescript types is not known except for poultry. For poultry new breeds are being distributed by the new extension system.

Farmers in the study area do not use Artificial Insemination (AI) to improve the genetic potentials of their breeds and there is no fixed time designed for livestock breeding by the livestock holders. The genetic potentials of the sires and dams used for breeding purpose are not known. Mating is random and in most cases is influenced by the availability of feed resources.

Docking (cutting the tail of female sheep) is a common cultural practice in the study area. The advantage of docking, recommended on long-tailed woolen sheep, is to minimize the heat period loss, keep their body condition clean and to reduce the incidence of blowfly strike. Docked ewes are easier to shear, have much cleaner udders and can readily be serviced by the ram. For fat-tailed sheep the dressing percentage were found to be lower than the undocked, but in deposition of fat, finish and quality the latter were superior. Docking, on the other hand, lets the fat of the tail disperse over the other parts of the body instead of being concentrated on the tail itself (Devendra and Mcleroy, 1982).

The age of first calving of a heifer ranges from 4-6 years and can give on the average 2 - 4 calf crops per life span. The only milk sources for human consumption in the study area is the cow. The lactation length of a cow is influenced by age. For instance, for cows less than 4 years old, the lactation period ends within 6-12 months. For more than 4 years old cows, the lactation period extends for more than 12 months. Usually, in the wet season, 0.25 to1 liter per day milk yield can be obtained. Nevertheless, in the dry season the amount of milk obtained is not even enough for a calf. The milk yield production potentials thus differ from season to season and is related to the availability of feed resources. Bulls have to be at least 6 years old before they are used for breeding or working purposes.

Livestock are important as source of draft power, employment, income, food (meat and milk), fertilizer and fuelwood. They are also used for threshing, trampling, reproduction purpose and transportation. The main draft power sources for land cultivation are oxen and sometimes cow

that do not give birth (undelivered cows). In general, due to poor management, nutritional and health conditions the livestock sub-sector is not fully utilized.

## *Housing, feed resources and feeding*

Farmers keep their cattle, sheep, poultry and donkey in a house at night both in wet and dry seasons. This is due to fear of theft, cold weather and their small number per household. In the dry season all livestock groups graze on the harvested fields and communal grazing lands. In the wet season, since all cultivated lands are covered with crops, grazing is done around cultivated fields, roadsides, marginal and communal grazing lands.

The major livestock feed resources are crop residues (65 percent), natural pasture (20 percent), hay (10 percent), improved forage crops (1 percent) and aftermath (4 percent) (pers communication, WADU expert). Of the crop residue wheat, grass peas, teff and chickpea straws are the most common once. Brewery by products, maize stover, natural pasture (grazing of roadside, communal land), harvested fields and grass hay are also common feed resources. There is a critical feed shortage especially from March to January (Table 6.5). Since all arable lands are cultivated and covered with food crops at this time of the year, farmers supplement their livestock with tree leaves, salt and/or local brewery byproducts ***( atela).***

**Table. 6. 5 Feeding calendar of livestock**

| Feed Types | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Communal Grazing | AA | AA | AA | AA | AA | AA | SS | SS | SS | SS | SS | SS |
| Crop residues | SS | SS | SS | SS | SS | AA | AA | AA | AA | AA | AA | SS |
| Weeds | AA | SS | SS | SS | SS | SS | SS | SS | SS | SS | AA | AA |

A- availability of feed resources
S- shortage of feed resources

## *Grazing land and their management*

WADO (1999) reported that out of the 144,707 ha of the woreda, 8557 ha are allocated for grazing purpose. Of these, 65 percent are communal and 35 percent are private grazing lands. Communal grazing lands belong to the community and every one of the community members has the right to use it. All livestock types have an access to graze on the communal grazing areas but on the private grazing land priority is given first for oxen and then for the milking cows. The available communal grazing areas include hilltops, swamps, forest margins around the church, roadsides and infertile (marginal) lands. Private grazing lands are found around the farmlands and they are productive, and used for grazing in wet season of the year through either cutting and/or grazing. The productivity potentials of the available communal grazing lands are low and can not maintain the existing livestock types mainly because of uncontrolled and constant overgrazing. Besides, overgrazing is a result of grazing of too many livestock on

too small area.

## *Health, diseases and parasites*

Taking good care of livestock health before and after being attacked by diseases and parasites helps to avoid production and reproduction losses. These are controlled through provision of good feeds and regular feeding. Farmers know that both diseases and parasites affect the normal functions of livestock. According to the farmers the major diseases are *'Mich'*, *'Gordebeta'*, *'Kurba'*, *'Abassenga'* and *'Aleket'* . Most of the time the incidence of these diseases is attributed to the shortage of feed resources. The problem of *'Aleket'* is associated with the quality of water sources. WADO (1999) also reported that helminthes, ectoparasites, infectious and other sicknesses are existing in the woreda. The morbidity rates for helminthes, infectious and other sicknesses and ectoparasites are 77.5, 13.6 and 8.9 percent, respectively. Bovine, equine and sheep are highly affected.

In the wet season cattle are also highly affected when fed with unflowered *Trifolum spp*, a lushy and fermented green forage legume. This is due to the failure to get rid of the gas in the rumen (bloating). Farmers traditionally control bloating by feeding the cattle after the legume has flowered, feeding of the legumes after it has wilted, feeding of quality roughage feed and palatable hay early in the morning. Besides, farmers also give local alcohol, liquid soap, oil and paraffin at the time of bloating. When the degree of bloating is severe they also puncture the left flank of the cattle with sharp knife so that the level of bloating decreases. Halima (1997) reported similar survey result about the problem and control measures of local annual Trifolium species around northwest Ethiopia.

**Table 6.6 Major livestock diseases and parasites around Yilemana Densa woreda**

| Major livestock Diseases & parasites | Type of animal affected | Animal affected in % |
|---|---|---|
| Helminthes | Bovine<br>Equine<br>Sheep | 44<br>0.5<br>33 |
| Infectious & other sickness | Bovine<br>Equine<br>Sheep<br>Poultry | 6<br>0.6<br>4<br>3 |
| Ectoparasites | Bovine<br>Equine<br>Sheep | 6<br>0.1<br>2.8 |

Source: WADO (1998)

## *Constraints and opportunities*

Cultivation of grazing lands for arable lands, feed shortage both in wet and dry seasons, bloating due to feeding of Trifolium species, lack of feed resources conservation, management and utilization techniques are the major problems related to livestock feed. Low production potentials, high prices of improved livestock breeds, livestock diseases and parasites, draught power shortage, lack of AI services, lack of livestock research and development policies are another major constraints for livestock production in the study area.

The possible opportunities to solve the existing farmers problems are zero-grazing, introduction of improved forage pastures through forage development strategies, screening of less toxic, palatable and more nutritious Trifolium species through deliberate cross breeding techniques and demonstration of feed resources conservation, management and utilization techniques. Moreover, introduction of dual purpose cross breed animals, AI and veterinary services will assist to solve the draft power shortage, the high prices of improved breed livestock diseases and parasites.

# 7. FORESTS, RURAL ENERGEY SOURCES AND COMMON PROPERTY MANAGEMENT

## 7.1. Forest Cover and Trend of Deforestation

According to village elders about fifty years ago large portion of the woreda was covered by closed high forest. The highlands were covered by *Juneprus procera* and *Cordia africana*, while the lowlands were covered by *Acacia abyssinica*. *Ficus species* were also found along river-banks and fertile valleys. The existing small patches of natural closed highforest remnants found around churches are good testimonials. A good example of this is the *Olea junipers* closed high forest surrounding Weneba Saint Michael church in Killelte peasant association. This forest belongs to the church. Due to religious Taboo the people do not cut the trees for production of fuelwood or other purposes. An overwhelming number of farmers recognized the crucial role of those trees and forests to their livelihood.

They were producing surplus amount of feed for the animals. Those natural forests had already disappeared or deforested through the course of time. But still there are remnant trees scattered on crop lands, around houses and on some degraded lands that mainly include *Juniperus procera, Cordia africana, Croton macrostychs, Acacia abyssnica, Ficus* and *Vernonia* species. As farmers explained, the major causes of deforestation include increase of human population that leads to agricultural land expansion, land fragmentation, and high demand for fuelwood and fodder. A diagram showing cause and effect relatioship of deforestation is presented in Figure 7.1.

In addition to the above-mentioned factors, frequent government changes and land redistribution policies had contributed to the escalation of deforestation in the study area. Land distributions were carried out without paying compensations for the tree owners. Moreover, forests and trees were without any protections during transition periods. The lack of security on land tenure has resulted in lack of interest to invest on soil conservation structures, planting trees, forest protection and improvement of grazing lands. Lack of land use and land tenure policies are also other major factors that greatly aggravated deforestation and soil erosion by water and wind. Therefore, WADO has no legal ground to control the farmers who miss manage their land and contribute for the intensification of soil erosion. To date, there is no tree tenure policy at regional or at national level. Farmers have lost their trees at the time of land redistribution. They have lost not only their trees but also the good will to plant trees.

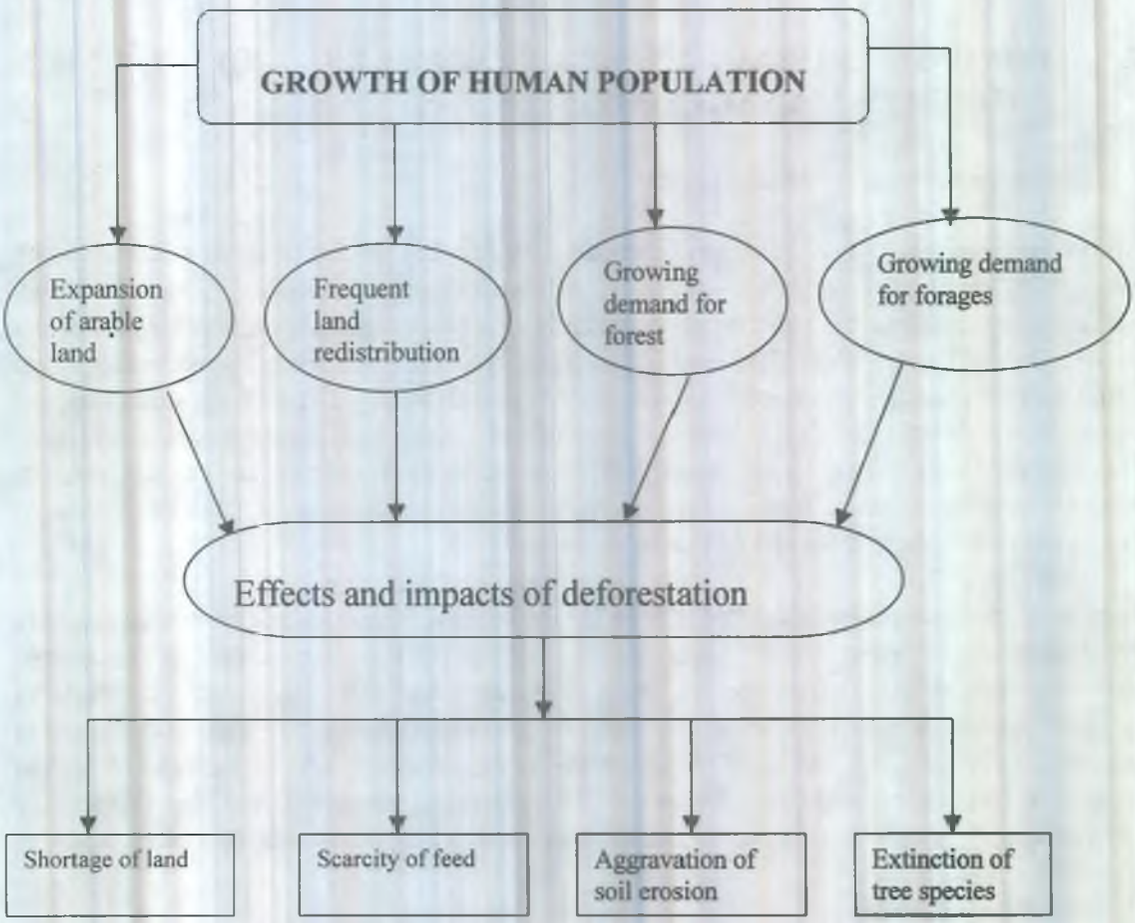



**Figure 7.1 Causes and effects of deforestation**

## 7.2. Agroforestry and Farmers' Perception

Like other tropical or sub tropical farmers, the farmers of Yilmana Densa woreda had been practicing agroforestry since the beginning of this century. They still have some trees such as *Croton macrostachys, Cordia africana, Acacia abyssyinica, Ficus* and *Vernonia* species on their farms. The woreda agricultural development office had intensified planting of *Eucalyptus* trees thorough reforestation program during previous regime, particularly in the 1970s. Within a period of ten years farmers had planted many *Eucalyptus* tree seedlings around their houses, along farm boundaries and by the roadsides, without considering the negative effect of *Eucalyptus* trees on their crop. Few farmers, who have better land size, had planted only on the degraded lands and in or around gullied spots. According to WADO (1999), since 1995 farmers received more than 2.7 million seedlings, mainly *Eucalyptus*, from currently active 4 government owned nurseries. The seedlings were given free of charges. In addition, split of Vetiver grass, seed of *Sesbania* and *Lueceana* species were distributed for the farmers with the aim of stabilizing soil conservation structures and production of supplementary feed for the animals. During the field study the team tried to observe the survival of Vetiver grass and other trees grown by farmers within the last few years. Unfortunately, the team could not come across any type of Vetiver grass or other multipurpose trees grown on the soil conservation structures. Even the old structures are not existing in the farms. According to WADO experts, this inappropriately designed program, which did not address the interest of small holder farmers, was a misuse of meager resources.

Nowadays, agro-forestry is the most common concept among agriculturists, foresters and politicians. They believe that agroforestry can make farmers self-sufficient in terms of crop production, fuelwood and animal feed in spite of their land holding differences. Due to this wrong concept, development workers advice farmers to plant more trees without giving due attention for the basic need and interest of farmers. At present agroforestry is one of the packages promoted at national and regional level. As defined in the package document (MoA, 1998), agroforestry includes all practices that involve a close association of trees and shrubs with crops, animals, and /or pasture. The association can be both ecological and economic. It can involve a combination of practices in the same place at the same time (inter cropping and related practices) or practices in the same places but at a different times (rotation practices).

On going agroforestry package has the following major objectives:

- conserve and maintain soil fertility
- reduce or minimize erosion
- create sustainable agricultural production and
- maintain the ecosystem/sub ecosystem of the woreda.

Since 1996, the agroforestry package had been launched in order to strengthen the soil conservation activities carried out by the community through planting of multipurpose trees. At present, farmers have succeeded in raising *Eucalyptus* seedlings in their own nurseries along streams. Farmers usually practice farm boundary and homestead planting with the aim of soil

fertility maintenance and economic benefits. Soil fertility maintenance using tree planting in the study area is called "*keellez*", vernacular language of the farmers'. Farmers explain that leaves dropping from *Acacia*, *Cordia* and *Croton* trees play a major role for soil fertility maintenance of their farm. *Eucalyptus* tree products are also the major source of revenue for the local community. Brief information on the use of four common agroforestry trees in the study area is given in the following pages.

## *Eucalyptus trees*

These tree species are the most dominating trees planted along the farm boundaries, on degraded spots and highly gullied places. They are the main source of fuelwood, construction poles and major parts of the traditional farm implements. It generates good amount of revenue for farmers and is sold in different forms (Table 7.1 and 7.2). Even though there is no cultural barriers to plant trees, all the activities related to seedling raising and planting were done only by men. They are planting as many trees as possible in a unit of land in order to get different products at different growth stages. Further more, farmers are already aware of the negative effects of planting Eucalyptus trees on croplands. A good example of farmer's perception on the importance of Eucalyptus tree planting is stated as:

"*Eucalyptus* plays a great role in our daily life. It is our major source of fuelwood. We produce many parts of our agricultural implements from it. We can not build our houses without *Eucalyptus* tree. Despite the negative effect of Eucalyptus trees, which burn the crop that grow beneath it, we will continue planting on degraded and unproductive sites. In the future, we will not plant it on our fertile crop farms. We will plant it only on degraded area or around our houses in order to minimize its damaging effects".

Other farmers share the idea of this farmer regarding the negative effect of Eucalyptus tree species on crop production. On the basis of their long experience, farmers said that land found on both sides of the trees with equal distances as the height of the trees do not produce the same amount of crop yield as adjacent farms.

## *Cordia africana*

Actually farmers do not plant *Cordia africana* seedlings from nurseries on their farm. They had just left some selected trees on their land when they were clearing the natural forests or in some cases might have acquired them through naturally germinated new seedlings.

They use the leaves of the tree as a supplementary fodder particularly when there is feed shortage. They make many household goods like doors, tables, wooden seats, bowls, boxes and agricultural implements from the timber of *Cordia* trees. The timber has also the highest market price compared to other tree species. It generates about Birr 40-50/cub.m. In addition to this farmers believe that *Cordia* tree greatly contributes to the maintenance of soil fertility which they call *keellez* (Table 7.1). The number and density of trees per unit area vary from one farm to another. The highest number reach up to 50 trees/ha. The hardness of the seed coat

limits the germination of the seeds under normal farm conditions. This in turn had affected the density and number of seedlings of *Cordia* trees.

### *Croton macrostachys*

*Croton* trees grow on most lowland farms. The wood is mainly used for making yokes because of its lightweight and high workability. Local carpenters can easily bore and reshape the timber of *Croton* tree during the production of household goods and farm implements. The number and density of *Croton* trees per unit area is relatively higher than *Cordia* trees. *Croton* is light demanding and can easily adapt and control any open land. Besides, the germination of *Croton* seed is very high even under the normal farm condition. Farmers lop the tree just before sowing crops in order to minimize its negative shading effect on crops beneath it.

### *Acacia abyssinica*

The most preferred tree by the local community is *Acacia abyssinica*. Farmers call it "tree of life" because of its versatile use and key roles that it plays in their livelihood. The wood is used for making ploughshares that hold the plough in tight positions from both sides of the handle. It is the only long lasting hardwood that resist against friction and abrasion with the soil during land tilling. The bark is also the most common type of tying material all over the rural area at the time of house construction, beehive making and production of other important goods at household level. The bark can be stored for a long time under dry condition. The dried bark can also be sold and bring good additional income. Whenever they want to use the reserved dried bark from *Acacia* tree, farmers rinse the bark in cold water for few days and use it for desired purpose. In addition, the nitrogen fixation and litter production ability of *Acacia* tree is much higher than all other trees grow in the study area (Rocheleau, 1988). Fresh and soft leaves of *Acacia* tree are highly palatable for animals and serve as supplementary feed in the dry season. Exemplary farmer's perception, regarding the importance of *Acacia* tree is stated as follow:

"*Acacia abyssinica* is our life. It produces the best wood for making ploughshares (*deger*). The ploughshares made of *Acacia* wood are more durable than any other ploughshares. It also maintains our soil fertility (*kellez*). The bark from this tree is the best tying material used at the time of our house construction. The contribution of *Acacia* to our life is so versatile and indispensable".

## *Sesbania sesban*

It is usually planted around farmer's houses or in the school compounds. The major objective of planting *Sesbania* seems production of feed for the animals and conservation or restoration of soil fertility. Farmers were not advised when to cut *Sesbania* inorder to get the best feed or material for green manure production. Unknowingly, they left the plant till it became a big tree that developed large crown not tolerable by the crop grown beneath it. Whenever the tree is getting taller in height, the plant will lose its capacity of sprouting or coppicing much fresh shoots that can be used for the above indicated purposes. Due to this experience about the negative shading effect of tall *Sesbania sesban* trees on their crop, farmers do not want to plant it any more along the terraces or inside their farms. This precedence has created a gap between farmers and extensionists and hindered the integration of other multipurpose trees into the farms.

## *Other introduced trees*

Very limited number of *Acacia decurrence*, *Cupressus lussitanica* and other important tree species were planted or grown in the backyards and on sites along the roadsides. These trees have insignificant influence on the soil fertility maintenance of the area.

In order to have clear understanding about the above descriptions, the following two preference rankings were made by better-off and poor farmers. The ranking of these most important trees was made using farmers' criteria. The result suggest that *Eucalyptus* and *Acacia* trees are the most preferred once (Table 7.1 and 7.2).

**Table 7.1 Direct-matrix tree preference ranking made by better off farmers Gergera PA, at Yilmana-Denba woreda, 1999**

| Italian tree names | woodfuel | Farm implements | Construction wood | Soil fertility | Sales | Total points | Rank |
|---|---|---|---|---|---|---|---|
| *Cordia* tree | 3 | 4 | 2 | 1 | 1 | 11 | 2 |
| *Eucalyptus* tree | 2 | 1 | 1 | 4 | 2 | 10 | 1 |
| *Acacia* tree | 1 | 2 | 3 | 2 | 4 | 12 | 3 |
| *Croton* tree | 3 | 2 | 3 | 4 | 4 | 16 | 4 |

**Table 7.2 Direct- matrix tree preference ranking made by poor farmer group in Killelt PA at Yilmana-Densa, 1999**

| Italian Tree names | Wood -fuel | Farm-implement | Constr. wood | Restore soil fertility | Sales | Total points | Rank |
|---|---|---|---|---|---|---|---|
| *Acacia* tree | 1 | 1 | 1 | 5 | 2 | 10 | 1 |
| *Cordia* tree | 3 | 3 | 2 | 3 | 1 | 12 | 3 |
| *Croton* tree | 4 | 2 | 4 | 3 | 5 | 18 | 4 |
| *Eucalyptus* tree | 3 | 1 | 3 | 1 | 3 | 11 | 2 |
| *Vernonia* tree | 3 | 5 | 5 | 3 | 5 | 21 | 5 |

### 7.3 Major Rural Energy Sources

The major energy sources in the area are fuelwood, cow dung and agricultural residue like stalk from maize and sorghum (Figure 7.2). Wood from *Eucalyptus* trees is the major source of energy through out the dry season. During the rainy season or cropping season farmers have difficulty in cutting trees and even if they do cut the trees drying the wood takes longer time. Because of this, women are forced to use cow dung and agricultural residue during the four months of the rainy season (June - October). There is no data that indicate the fuelwood consumption at woreda level. But the average national annual consumption of fuel wood in Ethiopia is about 1.1cub.m/person/year (SIDA, 1974). This figure may help to determine the future tree planting in the study area. Some of the farmers can produce this amount of fuelwood from already existing trees on their farm or backyards. Unless all group of farmers produce sufficient amount of fuelwood they will continue to use cow dung and agricultural residue as source of energy and will have nothing to reserve for organic fertilizer production. Women are still using the traditional energy wasting stoves to cook food. No efforts have been done to introduce energy saving stoves by responsible institutions. Hence, without breaking this vicious circle the possibility of using organic sources as soil fertility maintenance will be a difficult and expensive task.

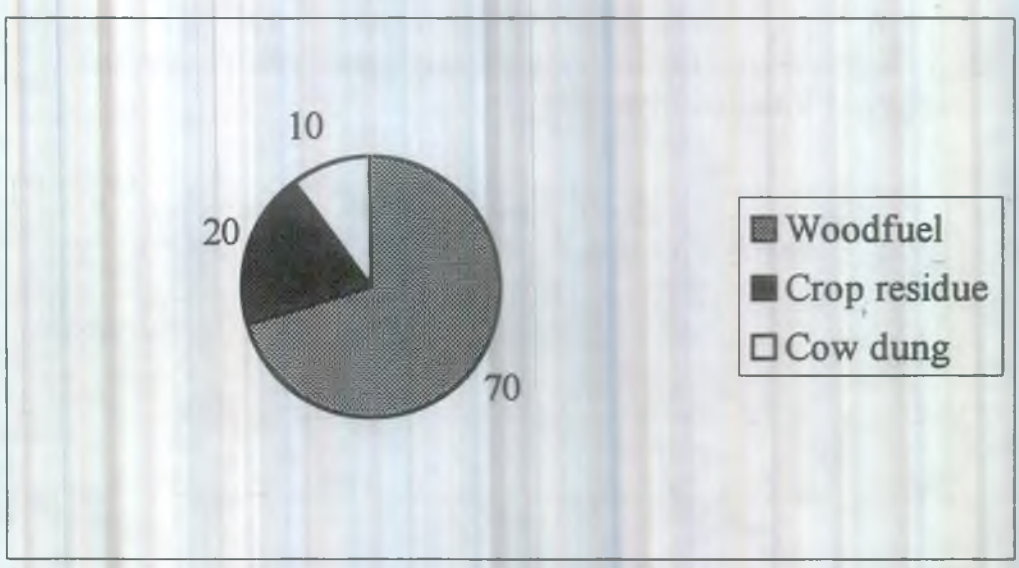



Figure 7.2 Sources of rural energy

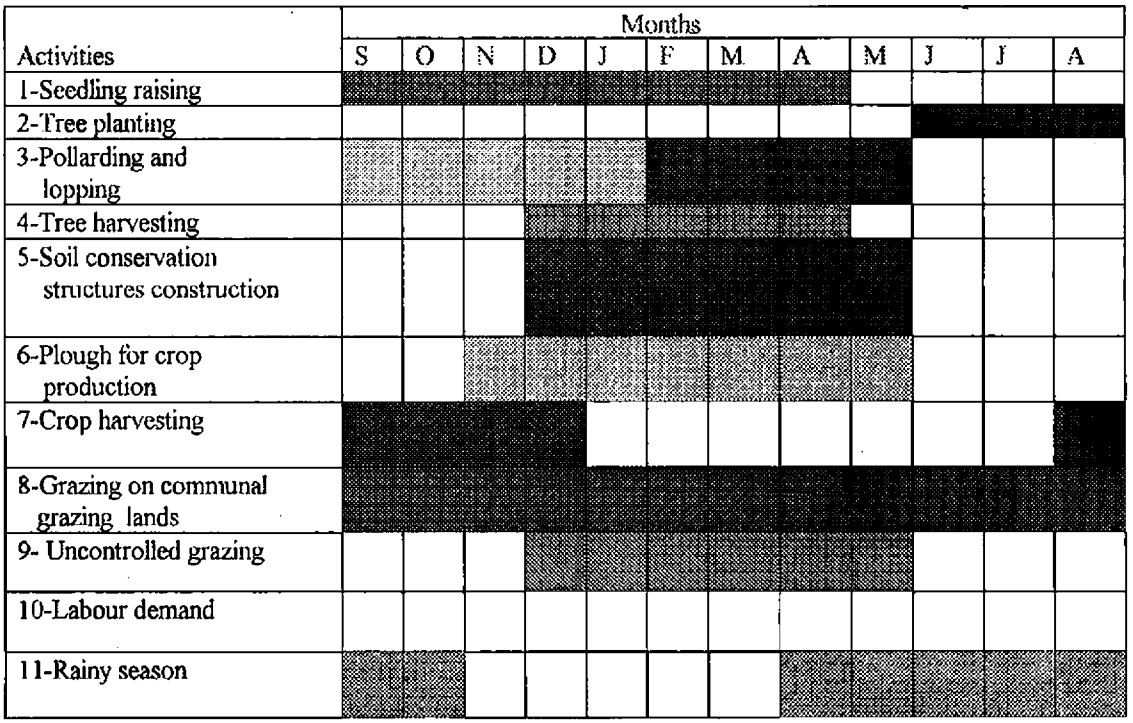
### 7.4. Communal Property Resources Management

The communal resources known in the study area include grazing lands and water resource points or streams. The grazing lands are very small in size and scattered all over the peasant associations. The PA leaders protect communal grazing lands from illegal encroachers. In most cases the grazing lands are found near the watering points or at central places to be accessed by all households who have the right to graze their animals on that specific grazing land. The size of the grazing land ranges between 0.25-3 ha. There seems a discrepancy in the land to animal ratio. Actually, more than 75 households with estimated average holdings of 4-5 animals/household are sharing the same grazing land. As such, there is no need of making sophisticated calculation to know the discrepancy between number of animals and supply of forage from these fragmented so called grazing lands. The ill-fed skinny animals' physical and health condition can simply reveal the worst situation regarding the scarcity of feed shortage in the study area. The animals could not find anything to graze on it. Without much exaggeration, animals are sequestrated in a small grazing land that can be considered as a daytime safe kraal. Even today, either the farmer or experts from WADO have not tried to improve the grave conditions facing the animals. Both the owners and responsible institutions have limited themselves only on counting the population of the animals and fighting against animal diseases. Because of overgrazing that was going on for such a long time, the area has lost the genetic diversity of the various plants. This in turn depleted the nutrients in the soil due to the loss of organic matter production from ground covering vegetation. As a result of this, the bare soils became more susceptible to soil erosion.

Springs and streams are also the main sources of drinking water for both the animals and the people living in the area. Like the grazing land, these resources are also highly neglected. The water sources are good for sustaining a large number of leaches rather than supplying clean drinking water for the animals. They can be considered as a sort of aquarium or trough for producing leaches. Farmers are well aware of the problem and they have tried all indigenous

means to eradicate the leaches from the springs and streams. Unfortunately, they did not succeed in eradicating the leaches.

The general view about seasonal activities of natural resource management interventions in the study area is shown in seasonal calendar for Yilemana-Densa woreda ( Fig 7.3). The busiest period lies between March and December. Seedling raising activities are carried out during September up to April, while construction of soil conservation structures are taking place from December to May. Other farm activities such as tree planting, pollarding, lopping and ploughing for crop production are also conducted in different months 0f the year. Other such important information are incorporated in the seasonal calendar.




**Figuer 7.3 Seasonal calendar of forestry and soil conservation activities in Yilemana Densa woreda 1999**

### 7.5. Core Stumbling Problems and Opportunities

Major constraints that hindered the promotion of natural resources conservation and management programs in the woreda, both on farms and along soil conservation structures can be summarized as follows.

1. Most farmers have very small size plots that usually lies between 0.25-1.5 ha. Under current farming practices, farmers can not get sufficient amount of crop yields that meet their basic need such as food and cash. Therefore, farmers faced a dilemma of planting or not planting trees by reducing their cropland. On the other hand, while farmers were hesitating to decide under such complex circumstances they had continued loosing their fertile topsoil at alarming speed. To day farmers are suffering from shortage of tree products.
2. Lack of land tenure and land use policies had also delayed tree planting and soil conservation activities.
3. Lack of training about multipurpose tree species management through extension programs had created gap between the extension workers and the farmers. This in turn resulted in poor acceptance of planting trees that minimize the scarcity of feed and other tree products.
4. Farmers were not convinced about the advantages of making soil conservation structures before commencing the intervention. Thus, as a negative response, farmers removed or destroyed the structures in the following season without making new once. These problems were also highly inter-linked with shortage of land and improper technical applications at the time of constructions of soil conservation structures.
5. Satisfactory efforts were not made to introduce new multipurpose tree species that can improve fertility of the soil and provide diverse products for the farmers.
6. No trials had been done to improve the productivity of small sized and deteriorated grazing lands. So overgrazing caused soil nutrient depletion and genetic erosion of plant diversity.
7. Planting and soil conservation structures development activities were not properly integrated. In most cases large gullies and already constructed soil conservation structures appear without trees or any type of vegetation cover.
8. Due to shortage of money most poor farmers apply chemical fertilizers below the recommended rates and this resulted in low yield production. The poor farmers with low income would not have physical and mental preparedness to conserve the soil on their farm. On the other hand, farmers have already developed good skill of seedling raising and planting on certain tree species. They are also well aware of the critical shortage of animal feed in their living area. They have long experience about the use of indigenous tree species growing on their farm. They also showed great interest of participating in most extension training programs. These fertile grounds might create good opportunities for any future interventions.

# 8. STAKEHOLDERS AND THE AGRICULTURAL KNOWLEDGE INFORMATION SYSTEM (AKIS) ANALYSIS

## 8.1 Stakeholders and Their Roles

In the study area there are several actors operating in agricultural research and development, and business activities, with varying interests and objectives. Some are public institutions that provide service to farmers, while others are private business enterprises. Despite such differences they create linkage and interact to attain their objectives. Linkage and information flows among these actors make AKIS functional in the area.

Agricultural knowledge and information system of an area greatly affects the generation and use of agricultural innovations. As explained by Rolling (1990), AKIS is the 'set of organizations and/or persons (stakeholders) and the links and interactions between them that are engaged in, or manage such process as the anticipation, generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of the agricultural knowledge and information, which potentially work synergistically to support decision making, problem solving, and innovation in agriculture or a domain there of'.

The team and the woreda administrative council identified all relevant stakeholders. A thorough discussion was made with each actor about their activities, roles and linkages in soil productivity management.

### *Farmers*

Farmers are the primary stakeholders. They are the final users of soil and natural resource management, research and development interventions. Farmers play significant role in the evaluation and implementation of research and development programs. Their primary objective is to increase production that can feed and sustain their family.

### *Woreda Agricultural DevelopmentOffice (WADO)*

WADO is the responsible governmental organization for technology dissemination. In collaboration with regional and zonal agricultural departments it introduced several technology packages including soil management technologies. The office has rural development stations at PA level, where development agents are based. WADO is mandated for extension and regulation of activities in the agricultural sector. The extension service includes demonstration, introduction and monitoring of agricultural technologies and farmers training. With regard to soil management Packages agroforestry, soil and water conservation, chemical fertilizers and improved varieties were demonstrated using the current extension program. The office also undertakes monitoring of natural resources, animal products and controlling of crop pests and animal diseases.

## *Adet Agricultural Research Center (AARC)*

AARC is directly involved in agricultural research and the generation of appropriate technologies. Soil management research is one of the major programs in the centre. The center is mandated to address northwest Ethiopia including Yilmana-Densa woreda where it is located. It has different functional divisions and disciplines that are responsible for problem identification, technology generation and demonstration. Different projects have been carried out both on-stations and on-farm with the involvement of farmers and other clients. Some of the activities on soil management are research on agroforestry, fertilizer rates and types, and soil conservation and characterization. Other programs that have a direct impact on soil productivity include identification of forage crops and grasses, and development of improved pulse varieties. The center also gives training for subject matter specialists and farmers, and assesses farmers adoption of the technologies transferred to farmers.

## *Credit Institutions*

Amhara credit and saving institute (ACSI) and Woreda cooperatives development office are the major actors, which provide credit to farmers. ACSI is a private rural micro-finance organization that is providing credits for the poorest of the poor. It gives credits both for rural and urban poor. Credit is given for inputs, especially chemical fertilizers, small ruminant fattening program, small trades, handcrafts and irrigation development with training and close supervision. It also encourages and collects savings as there is no commercial bank in the area.

The primary interest of the woreda cooperative development office is assisting farmers' service cooperatives. Currently, it is involved mainly on credit provision to cooperatives. It facilitates input supply (chemical fertilizers) through credits and revolving funds from government so that every cooperative can provide credit for their members. It is also responsible for organizing new cooperatives and assisting them in management and auditing.

## *Input Suppliers*

For the rural farmers the sources of inputs are Agricultural Input Supply Enterprise (AISE), Ambasel, Ethiopian Amalegamet Pv.Co. and Ethiopian Seed Enterprise (ESE). Their primary motive is profit through provision of quality services. All of them supply the inputs at woreda level in collaboration with woreda agricultural development office. These organizations are now subject to competition so that farmers are able to get the least possible prices and the maximum possible services. Some suppliers started to provide inputs at village level. The major input that is supplied by all agents, except ESE, is chemical fertilizer. But all are expected to supply pesticides and others if there can be adequate demand. So far only AISE supplies pesticides. ESE is the only organization that provides seeds. ESE provides the seed to the bureau of agriculture which in turn supply the seed to famers through the participatory agricultural demonstration extension and training system (PADETS) program.

## *Market organizations*

Private traders and Ethiopian grain marketing enterprise (EGME) are the two important actors that play significant role in purchasing agricultural outputs. Private traders are motivated to maximize their profit while EGME is mandated to stabilize grain price fluctuations. EGME buys all types of grains and gives guaranteed price for all crop types. It buys with higher price when price goes down and sells with lower price when price rises up just to safeguard consumers. It provides pesticide treatments for storage pests in warehouses. It also serves as source of marketing information that may have impact on agricultural development in general and soil management in particular.

**Table 8.1. Task matrix: identification of actors and the degree of their involvement on AKIS at Adet**

| List of Stakeholders | Tasks | | | | | | |
|---|---|---|---|---|---|---|---|
| | Extending Technology | Input supply | Technology Generation | Training | Credit | Purchase of Agricultural products | Policy |
| Woreda Agr. Office | ++ | + | + | ++ | 0 | 0 | + |
| Agricultural Research Center | + | 0 | ++ | + | | 0 | 0 |
| Traders | 0 | + | 0 | 0 | | ++ | 0 |
| Service cooperatives | | + | | | ++ | 0 | 0 |
| Ambasel | + | ++ | 0 | 0 | 0 | + | 0 |
| Amalgameted | + | | 0 | 0 | 0 | + | 0 |
| AISE | + | ++ | 0 | 0 | O | 0 | 0 |
| ACSI | + | 0 | 0 | + | ++ | 0 | + |
| Farmers | + | + | + | 0 | + | + | 0 |
| Woreda council | + | + | 0 | + | 0 | 0 | ++ |
| EGME | 0 | 0 | 0 | 0 | 0 | ++ | 0 |

0 = No involvement
+ = Involved in the task
++ = Very much involved in the task

## 8.2 Linkages and Information System

Linkage is an essential tool to achieve the stated goals of each stakeholder. Information system exists if and only if there is strong linkage between metaphors that would share common problems. Soil management is a complex, time taking and sensitive issue that could not be achieved with fragmented efforts. Several soil management related development activities were carried out ranging from simple chemical fertilizer application to diversified soil and water conservation practices. But, at least at the national level, these activities have never been successful as expected. The reasons could be many but limited collaboration and linkage among the different actors is the one stated repeatedly. It is important to look into the existing linkages thoroughly so that recommendations can be drawn for future research and extension activities. To analyze the existing linkages and information system, the team raized the issue at individual stakeholder discussions and during the mid-term workshop.

**Table 8.2 Stakeholder matrix: Summery of interests, importance for soil management and resources owned**

| List of Stakeholders | Interest/ needs | Importance/ Influence | Resources potentials |
|---|---|---|---|
| Woreda Agr. Office | Achievements of extension plan targets<br>Feasible soil and water technologies to demonstrate<br>Watershed management approach | ++++ | Better staffs and structure at farmers level |
| Agricultural Research Center | Generation of technologies through participatory and development oriented research | ++++ | Specialized manpower, laboratories, and good contact with external institutions |
| Traders | Profit maximization<br>Demands quality product | + | |
| Service cooperatives | Serving rural cooperatives | ++ | Warehouses, shops |
| Input suppliers | Profit<br>Increase market share | ++ | Inputs in bulk |
| ACSI | Profit<br>Increase repayment rate<br>Training on credits and saving | +++ | Loan |
| Farmers | Cheaper and simple alternative technologies | ++++ | Indigenous strategies<br>Labor |
| Woreda council | Public image<br>Fair income distribution<br>Society stability | ++++ | Administrative personnel at village level and public says |
| EGME | Profit and price stabilization | + | |

Although the degree of linkage strength varies, the team foundout that tnere exist both formal and informal linkages between and among stakeholders (Fig 8.1). For a better understanding of linkages with regard to soil management activities it seems logical to examine relations among major stakeholders.

## *Research-Extension linkage*

In general, both research and extension in Ethiopia have given due attention in order to achieve the national and regional development goal, viz, food self-sufficiency. A number of forums were organized to link their activities. The major forums that link researchers and extensionist in the study area are extension packages development and evaluation workshop at regional level and research program review and evaluation meeting at regional and center level organized by research-extension liaison committee. Because these forums are restricted at higher level, the woreda extension experts do not have the chance to participate. At woreda level the linkage is limited to problem identification using farming system surveys, and on-farm technology verification and demonstration. Even this linkage becomes very minimal as we go down to the PA level where development agents are located. Formal communication mechanism where researchers and extensions evaluate and plan research and extension activities at woreda and PA level are still lacking. At the same time, because of limited soil management surveys and on-farm demonstrations, woreda experts and researchers did not have significant collaborative work in soil management. But informal communication still exist if one group needs information.

## *Research-farmers linkage*

In the 1970s, when FSR approach came to picture, agricultural research institutions in Ethiopia begun to involve farmers at different stages of technology generation. Researchers and farmers started to interact directly without going through extension agents as done previously. Farmers are now involved in problem identification and technology evaluation during on-farm verification and demonstration. Sometimes they are invited to research centers to look into research activities. Researchers continue to make contacts during adoption of technologies and during feedback assessment after technology dissemination. But the linkage is not as expected. This is mainly because of the limited capacity of the research centers to cover all their mandate areas. Most farmers of Yilmna-Densa Woreda where the center is located are aware of the activities and interests of the research center but farmers say the contact with researchers is limited. An overview of the existing agricultural research system indicates that farmers have less role in research planning and implementation. The linkage is loose and the problem is more serious with regard to soil management. The research center conducts limited problem identification and technology verification and demonstration trials as far as soil management is concerned.

### *Extension-Farmers linkage*

A direct link between farmers and extension agents is expected through the development agents at PA level. Extension message flows directly from the regional bureau of agriculture via zonal, woreda and PA level agricultural departments. Development agents at PA level live with farmers and convey the message to farmers. Sometimes there can be direct contact between farmers and higher-level extension agents, especially with the woreda agricultural experts. Their contact is related to technical advise, monitoring and program evaluation. Based on the new extension program-PADETS, packages are formulated at regional level whereas farmers with the help of development agents initiate planning at village level. But, sometimes farmers planning process is affected by higher officials desire to achieve the five years plan target set some three years ago. This is particularly true in soil and water conservation practices where there is a strong imposition on farmers and lower level extension agents.

The linkage between farmers and DAs depends on the relevance of technologies or messages to be disseminated to farmers. If the technology performs well, farmers contact DAs directly and ask for their advice and assistance. For example in case of fertilizers and improved varieties, farmers ask DAs to assist them to get these inputs. If the technology or message do not perform well it is the development agent who encourages and/or sometimes forces farmers to participate and involve in the activity. A case in point is the soil and water conservation practices where the DA supervises the activity closely. Under such conditions, activities or technology is given to each farmer by quota. This exercise definitely affects the relationship between farmers and development agents.

### *Farmers-other stakeholder linkage*

Other stakeholders include input suppliers, credit institutions and market organizations. These actors have direct contact with farmers but there can be variation in the extent of the linkage. Since the interest of such actors is profit they try to attract farmers through provision of quality services. Such linkages, due to limited awareness by farmers on the existence of these institutions, are rather directed by other officials. Moreover, due to limited capacity of these organizations they use others such as BoA staffs to initiate the contact with farmers. These institutions have now stations at Adet town and are trying to contact farmers as their important clients. Except credit institutions, which lend in-group, others have direct contact with individual farmers but the linkage is not yet strong.

### *Extension-Other stakeholders linkage*

Because of government emphasis to extension, input suppliers, creditors and extension agents have established good linkage. A committee established both at the regional and zonal level facilitates the linkage. They also get together during the annual program evaluation meetings. Hence, input suppliers and credit institutions get feedback about their services. Informal information flows do exist among these organizations.

*Research-other stakeholder linkage*

Except administrative relation and informal information exchange there is no any forum to date that links research with input suppliers, credit institutes and market organizations. But, they need to develop a closer relationship in the near future.

### 8.3 Linkage Gaps and Problems

Analysis of the existing linkages among stakeholders revealed that there is linkage gaps between and among actors. Some of the gaps identified in the study area are:

Limited linkage between woreda extension staffs and researchers particularly in soil management activities. Researchers do not have information on the existing soil and water conservation works performed by extension staffs. Similarly, extensionists have very limited information and involvement on soil management research.

Limited involvement of farmers in research planning and implementation: under the existing agricultural research systems, research proposals are planned based on farmers' problems and circumstances that are explored during farming system surveys. But, their involvement in research agenda setting and actual field implementation is very minimum. Farmers being the final users of the technologies they have to evaluate and review research agendas and experiments in the field as partners to researchers. Currently, this process is missing in the research system.

Limited participation of farmers in soil management extension activities. As indicated earlier, farmers have their own attitude and suggestion regarding the current soil and water conservation practice now introduced by the extension department. Farmers' opinion and ideas have not been considered. Even if farmers' awareness of the advantages of the practice is limited, they must be convinced to participate in the planning of such an activity.

Limited contact between farmers and input suppliers and credit institutes that lead to misunderstanding of farmers need and lack of farmers awareness about inputs and credits.

Very limited linkage between Adet Research Center and other stakeholders (except extension and farmers) is observed. This may affect (technological) information flow.

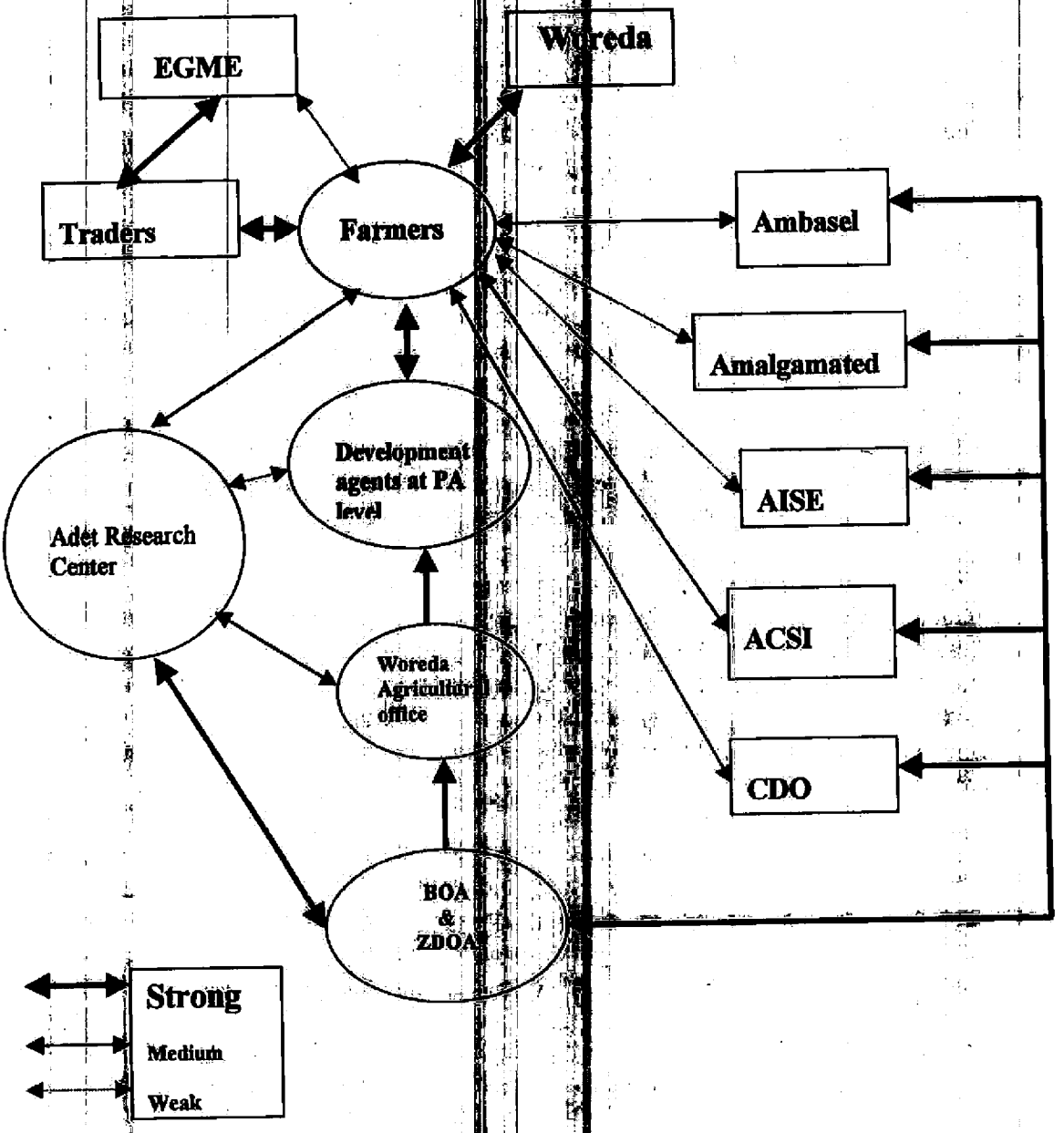



Figure 8.1 Stakeholders' linkage

# PART III

# 9. AN OVER VIEW OF THE SOIL DEGRADATION SITUATION AND FARMERS' COPPING STRATEGIES

## 9.1 Historical Trends and Causes of Soil Degradation

Until approximately 1960s part of the area was covered with forests, population was sparse and availability of cultivated land was high. During that period fallowing was practiced in an unprecedented scale, partly due to the favorable climatic conditions and partly to the relatively high level of soil fertility that resulted in considerable crop production on the small unit of land. Crop production activities were limited to the most plain and level areas. Since then, the gradual increase in both human and livestock population have put great pressure on the land resources. Population pressure, leading to increasing land shortage and increasing demand for wood resulted in deforestation. Overgrazing is often the result of high livestock population, over stocking and decrease of pastureland. These coupled with inappropriate farming practices resulted in soil erosion and land degradation.

In 1974, when the Derg regime came into power, land distribution had taken place and the traditional land tenure system was altered. According to farmers, the collapse of traditional land tenure system and associated land fragmentation have led to the resurgence of indigenous soil and water conservation practices (e.g. *dinber*). Following this the government imposed farmers to be organized in producers cooperatives, which were geared towards mechanized large-scale farming. This situation has forced those farmers who did not join the cooperatives to move to the most degraded and non-productive marginal areas. It was not uncommon to see large gullies even on plain and gentle slope fields owned by the cooperatives mainly because of poor management resulting from the tragedy of the commons.

According to farmers, the change in climate, particularly in recent years, has brought diseases and pest incidence on cool season food legumes. As a result legume production is almost abandoned in the farming system. Due to the increase in population and productivity decline of the already cultivated lands, fallowing is no more practiced. Continuos cropping without rotation with legumes has led to nutrient mining and led to a steady decline in the productivity of farmlands. Pressure on land resources had continued to increase. This had led to increased risk of degradation, and more use of marginal land, particularly medium and low potential land, and steep land (Fig. 9.1).

## 9.2 Forms, Extents and Consequences of Soil Degradation

### *Forms of soil degradation*

Farmers are aware that depletion of nutrients and soil organic matter, waterlogging and erosion are the principal forms of soil degradation. Scarcity of arable land and disappearance of legumes in crop rotation have resulted in continuous cropping particularly on red soils. Soil erosion by water is most pronounced in sloppy and hilly areas, while waterlogging is a problem of black clay soils. Both forms of soil degradation, nutrient depletion together with loss of soil organic matter and soil erosion, are processes that are closely linked in the area. Nutrient-poor soils do not produce enough biomass to cover the ground and protect the soils from the erosive forces of water. And erosion, in turn, causes losses of nutrients and soil organic matter. It has been reported that nutrient losses due to uptake by crops, erosion, leaching and volatilization (only N) are only partially compensated (30 to 50 percent) by crop residues, manure weathering and atmospheric deposition (Pieri and Steiner, 1993).

### *Extent of soil degradation*

Soil degradation is both a national and a regional problem. But, in Yilmana-Densa the situation at present is very serious. It is estimated that almost all potentially arable lands are affected by different forms of human-induced soil degradation, of which 14, 008 hectares are already highly degraded (WADO, 1999). Particularly, the hilly and mountainous areas, representing 74.4percent of the total surface are seriously affected. And almost 20 % of the total area is affected by water logging.

### *Consequences of soil degradation*

Currently there is an imbalance between human demands on the natural resources for survival, and the capabilities of eco-systems to meet the demands placed on them. Declining of soil productivity forces farmers to cultivate marginal and fragile lands, such as slopping lands and shallow iron crusted soils. Because of settled agriculture without significant changes in farming practices, low yields and limited crop residue available for the purpose of soil fertility maintenance, the disappearance of forest resources that favored the use of cattle manure for fuel, and poor availability and high costs of inorganic fertilizers are experienced by farmers. And the nutrient reserves of the soils are being steadily depleted. This process induces a downward spiral of low input-low yields-declining yields- low income.

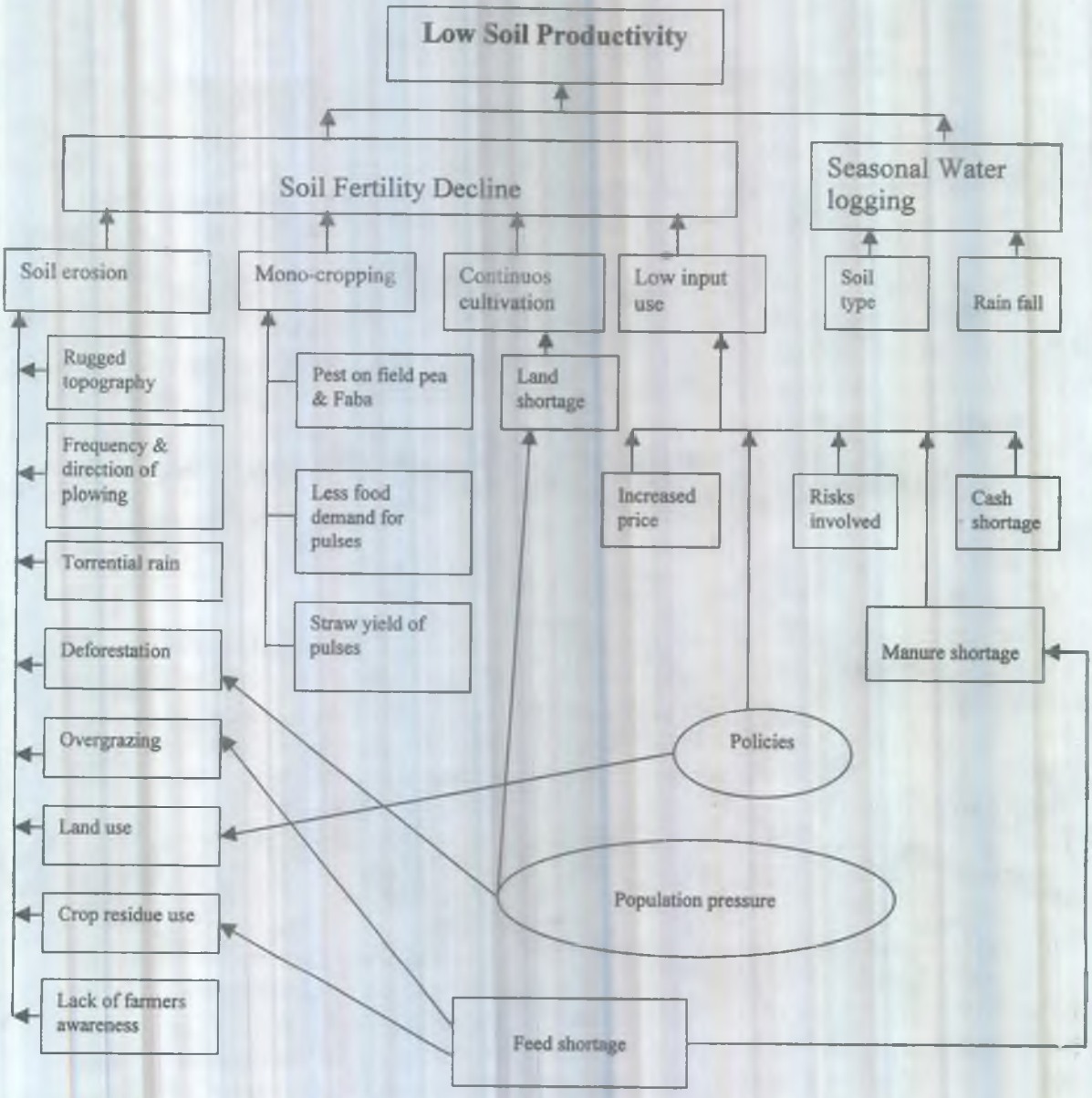



**Figure 9.1 Cause-effect diagram for low soil productivity in Yilmna-Densa Woreda**

## 9.3. Farming Systems and Soil Degradation

### *Crop management and soil degradation interrelationship*

Many of the existing cultural practices are also the direct causes of soil productivity decline. These practices include continuous cropping without fallowing, total crop residue removal and rapid loss of the organic matter in the soils. The traditional tillage system for teff production involves multiple plough passes over 5 - 6 months before sowing. During the next period this finely tilled soil will be exposed to heavy rainfall that results in runoff, which leads to accelerated soil erosion. Besides, excessive mechanical manipulation resulted in deterioration of soil structure, reduction of organic matter and consequently a reduction of crop yields. On flat Vertisols the productivity of the soil is also very low because of water-logging problem and lack of improved drainage technologies. As a result of these drainage problems, farmers could not be able to practice double cropping system.

To alleviate the decline of soil productivity, farmers practice crop rotation, application of chemical fertilizers on field crops and manure around homesteads. Crop rotation practice on red soils is mostly cereal - cereal rotation system, because most farmers stopped production of faba bean and field pea, due to insect pests and diseases. Thus, maintenance of soil fertility using pulse crops is highly reduced. The cereal Vs cereal rotation systems do not adequately restore fertility, particularly nitrogen as compared to the cereal Vs pulses rotations system. Cereal - pulse rotation system is common on black soils and the pulse crop is sown on residual moisture. Due to insufficient moisture pulse crops may not fix N as much as they could in the main rainy season.

Farmers are well aware on the use of chemical fertilizers to alleviate soil fertility problem. However, they are unable to apply the recommended rate, because of limited capacity to purchase the required amount of fertilizers.

### *Livestock management and soil degradation interrelationship*

The main feed resources for livestock are obtained from crop residues, communal grazing lands, harvested fields and marginal lands. Due to feed shortage, the communal grazing lands and harvested fields are intensively and continuously overgrazed. This leads to the removal of vegetative soil cover leaving the land easily exposed to wind and/or water erosion.

In the study area, about 65 percent of the livestock feed sources are crop residues. This is because of declining grazing lands due to high human population and the need for high arable lands. Crop residues, thus, are not applied for fertility amelioration. Besides, overgrazing of the land accelerates the soil nutrient depletion, decline in soil organic matter content, loss of soil physical structure and reduction of livestock feed productivity potential.

Due to land shortage farmers cultivate the grazing lands from time to time. Productivity of the available communal grazing lands is also low even for the maintenance of the existing livestock types because of uncontrolled and constant overgrazing. Overgrazing is a result of grazing of too many livestock on too small area. About 13 cattle, 2 equines and 5 small ruminants graze on the currently available small communal grazing lands.

To ameliorate the problems of foil fertility some of the possible solutions include N-fixing multipurpose tree plantation and introduction of cut and carry system feeding practices.

### *Socioeconomic factors and soil degradation interrelationship*

Analysis of the existing socioeconomic setting of the area revealed that several socioeconomic factors greatly affect soil degradation. Some of these factors are high prices and risk of fertilizer use, low level of cash income, land fragmentation, oxen power shortage, insecure land tenure policy, farmers' awareness, training of female farmers and extension service coverage.

### *Fertilizer price and risk*

Commercial fertilizers are the major inputs so far used for soil fertility maintenance. Farmers have already realized that they can not get a harvest on some crops with out fertilizers. Most farmers, however, do not apply the recommended rate of fertilizers mainly because fertilizer prices have increased two to three folds. Farmers assume that the increase in price of fertilizers is not as proportional as the gains in crop yields and some farmers even hesitate about its profitability. The extension people claim, however, that the use of fertilizer particularly on cereals is profitable. The major reason for not using the recommended rate is fear of debt accrued to them, if there is risk of crop failure. The most likely risks are hail, pests, dry spell after crop planting and reduction in prices of agricultural produce during debt payment. Actually, these risks occur less frequently, even then farmers are worried about them. They also site friends who lost their assets (oxen and other animals) in order to pay fertilizer debt and others who migrated to other places in search of cash for oxen purchase.

Because of these risks and price rise, crop fields receive very little amount of fertilizers. Data from the woreda agricultural office indicates that the use of fertilizers especially DAP has reduced in recent years (Fig. 9. 2) because of its increased price that resulted from the removal of subsidy.

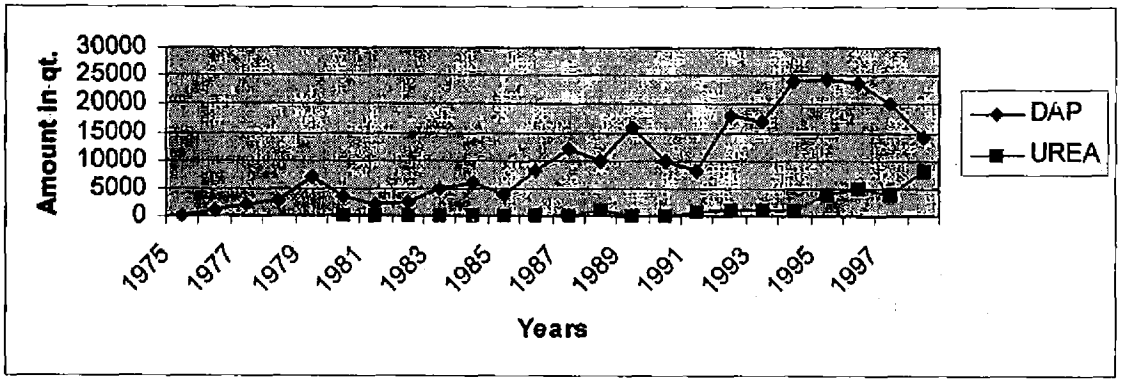



**Figure 9.2 Fertilizers use by farmers since 1975**

## *Land fragmentation*

The ever-increasing population causes resource competition particularly for arable land. Farmlands are fragmented and becoming scarce. Extreme land fragmentation (up to 0.13ha.) hinders conservation practices and use of other technologies. Moreover, fragmentation of land was made along slopes which otherwise could have served as conservation structure.

## *Land tenure and land use policies*

Since land does not belong to farmers, there is a feeling of insecurity. It could be taken over by others. Though land belongs to the public, there is no clear legal land tenure policy in the region on how long they can own and how they should use it. Hence, farmers hesitate to plant perennial trees, properly care and manage their farms. As a rule there can be policies and guidelines that give security for farmers to invest on their farmers. But the recent redistribution of land and banning the sale of land forever made them reluctant to manage it as their own resources. It is known that crop-livestock farming is less sustainable than tree based land use system that can not be achieved by the existing policies. An appropriate land tenure policy is required to encourage farmers to use inputs like fertilizers, construct check dumps and plant on-farm trees.

## *Low level of cash income*

In order to ameliorate soil fertility farmers are expected to use external inputs. The extent of use of such inputs mainly depends on the purchasing power of farmers. However, farmers do not have any significant cash income sources. This is one of the reasons for low level of fertilizer use in the area. Because they grow only food crops, they receive lower prices. Though some farmers have the potential to grow some cash crops like vegetables and spices, they are not widely grown because of lack of seeds and awareness.

*Farmers awareness*

Farmers complain about the existing soil conservation programme. They said they are forced to construct soil bounds by quota. Every year large hectares of land were covered by soil bounds but after one cropping season all were destroyed. One of the reasons given is the low participation of farmers and their views and needs in design and planing of soil and water conservation activities were not considered. Farmers are well aware of the causes and effects of soil degradation, but not its extent and long term effect. They know it can reduce their yields but they are not convinced of how much yield can be reduced in the future and how much soil can be eroded from their farm lands every year. They need to be aware of the possibility of reducing the use of fertilizers by proper care and management of their soils.

*Training for female farmers*

Though they are the principal actors in the use and management of manure to alleviate the problem of soil fertility, female farmers do not yet have access to training.

*Draft power*

Most farm households of the study area own only one ox. Significant numbers of them do not own any, but they have farm lands which they can lease out for better-off farmers. Land and soil management of leased lands is not the same as those of the non-leased lands. Those farms managed by sharecroppers are not properly and efficiently managed. Though there can be agreement between the two parties, in practice, some farmers observe variations in soil fertility maintenance between leased and non-leased farms.

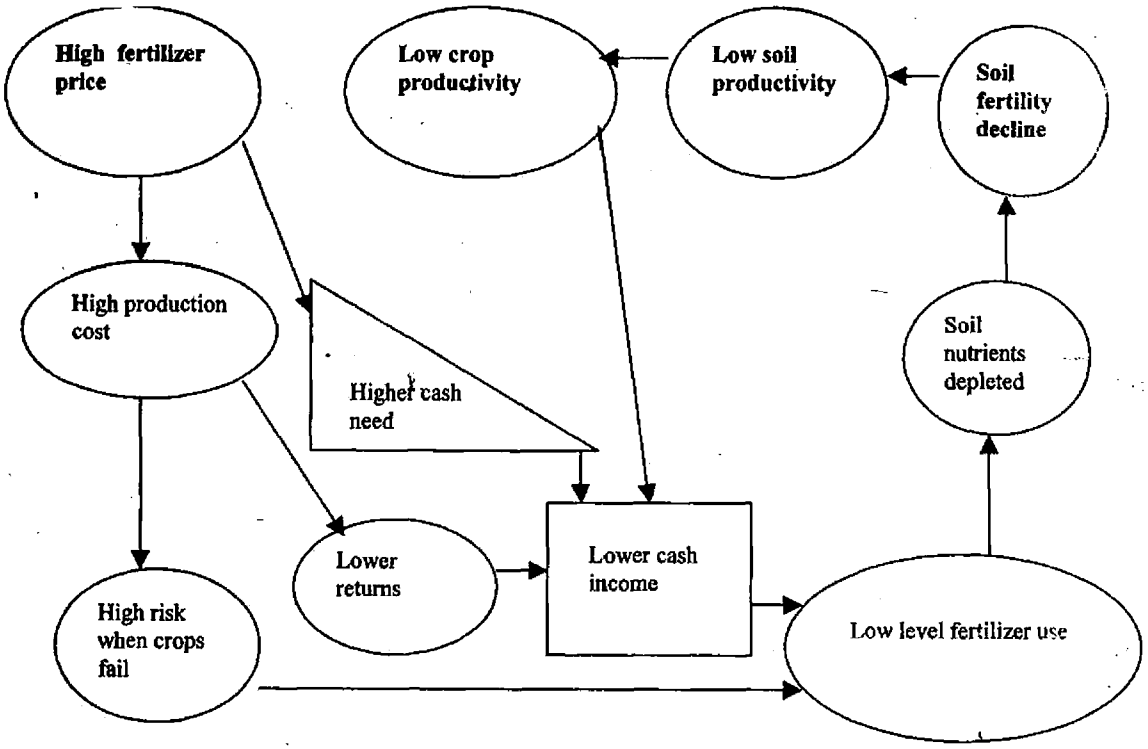



**Figure 9.3 Effects of fertilizer price on soil productivity**

## 9.4 Farmers' Indigenous Knowledge and Copping Strategies

Traditionally farmers over years of experience have found ways of controlling soil erosion, improving soil fertility and draining excess water. The techniques are classified as agronomic and structural both adapted to the type of soil and its physical characteristics, which provide a set of constraints to be tackled by specific measures.

### *Agroforestry*

In seeking to improve soil fertility particularly on red soils, farmers rely heavily on the natural regeneration of trees growing both around and scattered in the fields. *Croton macrostachys* and *Acacia albida* are the two most common soil enriching species traditionally protected by farmers. Other trees such as *Cordia* is also protected because of its economic value and the shade it provides. Farmers in the area have considerable experience in protecting the young shoots of trees in the fields.

## *Crop choice and management*

Farmers' crop selection and management practices have both positive and negative implications for soil management. Although not perceived by farmers, a move from teff to barely leads to improved ground cover and thus reducing erosion hazard. Early planting is also important to provide quick cover. On black soil, soil fertility maintenance is chiefly achieved by crop rotation i.e., rough pea/chick pea - barley/tef rotation. Seasonal fallowing or late planting at the end of the rainy season is one means of copping waterlogging problem. Planting relatively waterlogging tolerant crops such as tef is also the most common means of overcoming the problem.

## *Manuring*

Manuring is not given the attention it deserves, but some farmers realizing its value have been using it on their backyards.

## *Structural measures*

Increasing rate of land degradation, waterlogging and deteriorating natural conditions make it essential to use structural measures in almost all cultivated fields. Some of the measures may not be fully effective, but can be essential component to control runoff and reduce damage from gulling and sedimentation. These measures include cut-off drains, mounding, trash lines, *dinber* and traditional ditches.

*Cut-off drains* are constructed above the crop field and aimed at protecting the field against run-off from a natural or artificial water-ways. It is usually made of big stones and soils and the structure is very sturdy and well maintained in most of the cases.

*Mounding* is small conical structure formed during weeding to protect the field from sheet erosion. It is used to protect traditional ditches from changing in to gullies. Another advantage of mounding is it provides plant biomass to the field.

*Trash lines* are crop stables and tree branches put in line across the contour to protect the field from sheet and gully erosion.

*Dinber (literally earthen ridge)* is a technique used to demarcate two neighboring fields. It protects the crop field from sheet and rill erosion especially when the orientation is across the contour. It is the most solid long-lasting and common structure built of stones/soil and then re-enforced by allowing grasses to grow on it. As a rule, *dinber* is made in line along the borders of two farmers' fields, and both farm owners add stone and weeds every year. In many cases, however, the orientation of *dinber* is along the slope as fields are partitioned the same to minimize variability in fertility between neighboring fields.

*Traditional ditches* are temporary water-ways constructed every year to dispose run-off water from the field to water ways, thereby protecting the field from rill and sheet erosion. They are usually made diagonally immediately after sowing on every crop field. On black soils it is made along the slope so as to achieve effective drainage of excess water. After the end of the cropping season, it may develop in to medium sized gullies.

### 9.5 Past and Present Research and Extension Interventions

The track record of agricultural research with regard to natural resource management (NRM) in Ethiopia in general and in the region in particular is very disappointing. It is worth noting the reasons for this poor record. First, because of political pressures to focus on short-term productivity, agricultural research has tended to marginalize the long term environmental effects. Given the focus on the crop field and at best at farm level, long term environmental effects on soil fertility and the regenerative capacity of natural vegetation have not usually been given sufficient consideration. Conventional research and extension activities have contributed to an overall increase in the national food production but have brought little benefit to the conservation and management of the natural resources. At times even worsened the situation by introducing nutrient demanding new crops and varieties. Second is the institutional structure of research departments. In Ethiopia, the institutional structures are inherited or copied from Europe where the pattern was developed to meet the needs of commercial farming and the various farm operations are treated independently. In research stations there are departments of livestock, pasture, food crops and so on. In subsistence farming all of these activities occur simultaneously and on the same piece of ground that can not be improved by independent piecemeal advances of the components.

The scientific approach to soil conservation and management is a recent phenomenon (late 1970s). Even then, soil and water conservation initially concentrated in severely degraded areas with reclamation measures and tree planting (Aregay and chadhokar, 1993). Research achievements in the areas of natural resources management are insignificant compared to the degree of the problem. Drainage of vertisols using broad bed maker was tested and recommended to the surrounding farmers but the adoption is insignificant because the implement is heavy to be pulled by oxen. As the major focus was on reclaiming degraded lands and Yilmana-Densa was considered productive and surplus producing, little attention was given even to simple preventive measures.

Physical conservation was the only measure so far practised to control soil erosion, and it is now being promoted largely as one component of the extension package. And yet, farmers have strong resistance against the way it is implemented (not the practice) particularly on the spacing of bunds as it decreases the cultivable land area and creates difficulty to turn the oxen during ploughing. Farmers also complain about the unavailability of water-ways in short distances for the disposal of run off water.
Subsistence farmers are unwilling to give up what ever benefit they get from the immediate production and shift to perhaps complicated and costly practices that might ensure long-

term benefits. Farmers prefer simple and less costly techniques that can be easily integrated with their traditional farming practices. The soil has already reached to a state of low level equilibrium where humus and nutrient levels remain constant and crop yields have stabilized at low levels. Inorganic fertilizers are now accepted almost by all farmers and it has become the major component of the government's extension package. But due to the problem of cash shortage farmers do not apply fertilizers on all crop fields.

Agroforestry package is another component of the extension programme, but due to farmers limited knowledge on the management aspects of the agroforestry species, its acceptance by farmers is very low. Despite their appreciation of the problems of fuelwood and feed shortages they have developed a negative attitude towards agroforestry trees due to the shading effect. Croplands and grazing lands are all suffering from poor land management resulting in rapid land degradation. Soil conservation *per se* is not a priority goal for most farmers. Their biggest problem is how to maintain and increase production (of food crops) on sustainable bases for the benefit of their family using the limited resources (land, labor, capital, equipment and management skill available to them). Currently, Adet Research Center is undertaking an extensive research in the areas of soil fertility, soil and water conservation and drainage of excess water that leads to better management of land and water.

**9.6 Problems and Opportunities**

## *Major soil related problems*

- soil erosion
- waterlogging
- continuous cultivation
- monocroppiong

## *Opportunities*

- almost all farmers know the benefit of fertilizer for soil fertility maintainance
- the presence of varied indigenuous soil and water conservation measures
- almost all farmers know the benefit of manure for soil fertility maintainance
- almost all farmers apreciate the importance of crop rotation and the role of legumes in soil fertility restoration
- most farmers are aware of the problem of soil erosion and practice soil and water conservation activities
- favourable regional economic development policy that enhances natural resources conservation and development
- all farmers are aware of the importance of fallowing
- the presence of different legume crops
- the suitability of the area for growing different crop types

- the presence of different stakeholders (in put suppliers, research institution. etc.)
- farmers awarness on the root causes of soil degradation (i.e. population pressure) and their current attempt for family planning
- the presence of crops for double cropping purpose and farmers awarnes of the importance of double cropping on black soil
- farmers' use of traditional drainage ditches to drain excess water
- the current aggressive extension system
- village level participatory planing system during extension package preparation
- the current attempt to shift from conventional research and extension system to more client oriented research and extension system

# 10. PROBLEMS AND RECOMMENDATIONS FOR RESEARCH AND DEVELOPMENT

## 10.1 Problem Prioritization

Farmers identified and listed several problems that are related to either the farming systems or to specific soil management issues. For comparison and ranking purposes the team grouped them into two sets.

a. General farming system problems: These are soil related soil degradation problems such as soil fertility decline, soil erosion and water logging.

b. Strategic problems in soil management. These are considered strategic because these problems directly affect strategies of soil degradation improvement. They are socioeconomic issues that affect adoption of improved soil management practices.

Although there is a relationship between and within these two groups, it was possible to rank them by different groups of farmers, extension staffs and researchers. Prioritization with farmers was done using pair-wise ranking technique at three villages. Since there was no significant variations of rankings among the three villages, they are summarized as one. The way in which different stakeholders perceive problems greatly varies. The ranking of the problems by different stakeholders clearly indicates how farmers priority does not match with that of extensionists and researchers. Soil fertility decline, for instance, is ranked third by farmers, while it is given high priority by researchers and extensionists (Tables 10.1). Similarly, such differences was also found for the strategic problems (Table 10.2).

**Table 10.1 General farming system problems in Yilmna-Densa woreda as prioritized by farmers, extension agents and researchers.**

| Problems | Farmers' rank | Extension Rank | Researchers' rank | Cumulative |
|---|---|---|---|---|
| Soil fertility decline | III | I | II | I |
| Soil erosion | IV | II | I | II |
| Pests on crops | IV | V | IV | V |
| Animal feed shortage | I | IV | III | III |
| Lack of improved varieties | VI | VII | V | VI |
| Water-logging | VIII | IX | VIII | VIII |
| Fuel shortage | VII | X | IV | VII |
| Animal disease | V | VI | VII | VI |
| Draft power shortage | II | III | VI | IV |
| Land shortage | III | III | II | III |

**Table 10.2 Strategic problems in soil management**

| Problems | Farmers' Rank | Extension Rank | Researchers' rank | Cumulative |
|---|---|---|---|---|
| High fertilizer price | II | VIII | VII | VII |
| Lack of cash income | II | IV | IV | III |
| Acceptability of soil bound terraces | V | III | V | IV |
| Pesticide price | IV | IX | VII | VIII |
| Manure shortage | I | VI | VIII | VI |
| Late delivery of credit for fertilizers | III | V | VI | V |
| Insecure land tenure policy | -- | II | II | II |
| Absence of land use policy | -- | I | I | I |
| Farmers Awareness | --- | VII | III | VI |
| Absence of improved seed supplier for food legumes and horticulture | | | IX | IX |

## 10.2 Participatory Research and Development Options

For prioritized soil related problems several research, extension and policy recommendations are given by stakeholders and the team during the mid-term workshop. Then, during the focussed questionnaire survey, recommendation options were evaluated with farmers and those that fit farmers' conditions were identified. Recommendations are

given for each discipline in relation with soil productivity. The major problem areas considered for solutions are soil fertility decline, soil (gully) erosion, water-logging, agronomic problems, crop pests, animal feeds shortage and stakeholder linkages.

## I. Natural resources management

- Verification of the already available soil and water management technologies
- Efficient use of crop residues and cowdung
- Study on nutrient balances, SOM, indigenous based nutrient supply systems
- Develop strategies to reduce nutrient losses in animal based nutrient supply systems
- Review of past soil and water management R&D attempts
- Problem of adoption of the current soil and water management practices
- Study on the vertical interval of the currently used soil and water conservation structural measures
- Inventory of indigenous soil and water management practices
- Improvement of indigenous soil and water management practices
- Participatory integrated soil and water management practices
- Screening of multipurpose trees and shrubs (MPTs) for soil fertility maintenance, soil and water conservation and organic matter management
- Develop appropriate animal drawn implements to drain execs water on vertisols
- Reduce the frequency of ploughing
- Fertilizer response for field and horticultural crops in both red and black soil types

## II. Crop management and production

- Develop early maturing and high yielding varieties
- Cultural and biological control measures against pests and diseases
- Inventory and improvement of indigenous pest control measures
- Introduction of horticultural crops
- Encourage farmers to grow crops using irrigation in the off season
- Screening of varieties for disease and insect resistance
- Screening of chemicals for pest control
- Screening of water logging tolerant varieties
- Design appropriate small scale mechanization
- Encourage the use of integrated pest management
- Multiple cropping system

## III. Livestock production and management

- Relay cropping of forage crops with cereals
- Introduction of improved forage legumes and grasses
- Improving natural pastures through undersowing
- Improving the feeding systems of animals

Introduction of dual purpose animals
Provision of veternary services
Small scale mechanization
Introduction of improved breeds with their management practices

**IV. Socioeconomic and Policy recommendations**

Analyze policy issues on the management and use of natural resources
Appropriate policy on land use
Look for alternative income generating activities
Create awareness on the long term effects of soil degradation
Appropriate policy on grazing system
Rules and regulations on communal property resources management
Favorable policy on input and credit supply systems
Appropriate policy on subsidy at time of risks
Study on the use of energy source and selection of energy saving stoves
Family planning
Encourage commercial and small scale seed producers

**V. Stakeholder Participation and linkage recommendations**

Create an institutional linkage to solve the problems of soil degradation
Strengthen and institutionalize the research-extension-farmer linkage

## 10.3 Research Proposal

*Title: Indigenuous farmers' soil and water conservation and management Practices in Yilmana-Densa woreda.*

*Background and Justification*

Many traditional farming practices were sustainable for centuries in terms of their ability to maintain a continuing and stable level of production. These systems have had to cope with particularly rapid changes of technology in agriculture, increased population pressure; changes in social and political relations. Hence providing farmers with the means to make improvements in their land management practices in accordance with the changing conditions is much more beneficial than concentrating efforts on promoting conservation measures that seek to combat erosion and runoff once they have begun. Likewise, identifying which of the farmers` existing conservation practices are beneficial and which are not, and their reasons for pursuing them, will provide the basis for developing improved soil and water management and conservation practices. Farmers` land use practices are strongly influenced by the policy environment in which they operate.

Therefore, an additional outcome from the analysis of the existing soil and water management and conservation situation may be a set of policy recommendations.

*Objective(s)*: to identify existing soil and water conservation and management practices and the problems associated with the practices.

## *Title: Participatory evaluation of improved drainage and early planting on the productivity and soil erosion problems of Vertisols.*

*Background and Justification*

Vertisols are agriculturally important soils in the Ethiopian highlands. They occupy nearly 19% of the major soil classes of Ethiopia in general and 27% of northwestern Ethiopia in particular. As the second most common soils next to Nitosols, they clearly represent the major soil resources in the region. Some of the major limitations of Vertisols are poor internal drainage, difficulty of seedbed preparation, and their poor structures making them inherently susceptible to water erosion resulting in low fertility. Dry Vertisols have high infiltration rates, but once cracks have closed during the rainy season they become impermeable and overland flows occur quite within very short time resulting in the formation of rills. Ones rills are formed it develops in to gullies in one season due to their mass movement. These soils are generally regarded as rather marginal for arable cropping.

There are significant hectars of vertisols in Yilmana-Densa woreda with waterlogging problems. Waterloging is a problem well understood by farmers. Hence, farmers often leave the land fallow in the main rainy season and grow crops on residual moisture. Traditionally, farmers grow relatively tolerant low yielder varieties of crops on these soils by making inefficient drainage furrows. In fact, some farmers also plant early maturing barely in the main season for double cropping but most prefer to leave the land fallow. In all of these cases the yields of monocroped crops are very low and hardly exceeds 9 q/ha. This is due to root suffocation and poor fertilizer response as a result of water logging in the main season and moisture stress at the end of the rains.

*Objectives*: to evaluate the effect of improved drainage and early planting on the productivity of vertisols and see the advantage of early planting on soil erosion.

*Tiltle: Integrated participatory soil and water conservation in degraded and fragil areas of Yilmana-Densa woreda*

*Backgrownd and Justification*

In many parts of the world, agricultural productivity and profitability are constrained more by the quality of the available natural resources than by the production potential of crops being grown. Moreover, for many of the world's population especially the poor, survival depends on exploiting natural resources. Due to centuries of agricultural use, or rather misuse, the soils of Yilmana-Densa are already degraded and are under further degradation. In degraded and fragile areas the way farms are managed have a marked influence on the degree to which soil fertility is improved, soil and water are conserved and land productivity is increased. Physical conservation measures (stone and soil bands) are the most common techniques currently used. Often these techniques are not efficient alone and demand extra more labor annually. Therefore, integrating both biological and physical measures would help stablize the physical measures. The biological measures, plants grown on the structures, apart from stabilizing the structures provide organic residues to the soil by increasing porosity and infiltration capacity of the soil and by checking the surface runoff. Also, the vegetation (trees or grasses) can lead to higher production per unit area sown which may compensate for the loss of yield on the parts of the field occupied by the bunds through the production of food, wood and fodder.

The wide gap that exists between different research disciplines and between research-extension-farmer has resulted in the development of inappropriate technologies and hence to low adoption rate of technology. In order to address this concern, farmer participatory research approach in the planning, implementation and evaluation of the technology has to be promoted as a component of on farm research. Soil conservation *per see* is not a priority goal for most resource poor farmers. The biggest problem is how to maintain and increase production (of corps, livestock, tree and so on) on sustainable basis for the benefit of their family, using the limited resources. Hence, maintaining adequate level of soil organic matter accompanied by an increase in soil fertility and improved soil structure would address some of the major factors that lead to an ever-increasing land degradation. This is only possible through the incorporation of plant residues and animal manure in the agricultural fields.

*Objectives:* to increase production and productivity of farms by minimizing soil and nutrient losses.

# 11. CONCLUSION

The three-soil degradation forms: soil erosion, soil fertility decline and waterlogging greatly affect the production and productivity of agriculture of Yilmana Densa wereda. The study revealed that farmers are aware of the causes and effects of soil degradation and as a result they use several introduced and indigenous strategies. But, farmers are not well aware of the long-term effects of soil degradation, particularly soil erosion. Significant measure has not been taken at least to minimize the ever increasing and widening gullies caused by water erosion. The problem, however, becomes severe and is more than what an outsider can expect. No effective research and development program was designed to reduce gully erosion. Because of increasing soil loss that resulted in soil fertility decline, the use of chemical fertilizers has increased. Nowadays, it becomes impossible to grow cereals without the use of fertilizers.

To alleviate these constraints, particularly soil erosion and soil fertility decline, a holistic and participatory approach is required. Every stakeholder must come together and contribute either in creating mass awareness or by involving in the technology development process. As has been indicated earlier, the problems are very complex, caused by different socio-economic and biophysical factors. This calls for integrated efforts from all directions. The participation of farmers in the process is indispensable so that every body contributes to bring effective and sustainable changes. Otherwise, the effort will be fruitless as being witnessed in the existing soil and water conservation practices, which are being introduced every year but destroyed soon after.

Research and extension of soil management practices is an immediate need. But, soil management research activities must be development oriented, integrated with extension program and address farmers' real condition. Moreover, land tenure and land use policies favourable for natural resource conservation must be implemented immediately. Favourable policies and farmers' awareness through farmers' training are the two important and appreciable strategies needed to maintain the natural resource base to sustain agriculture and environment in the long run. When farmers are aware of the long-term effect of soil loss, backed by appropriate policies, they themselves will take care of the problem of soil degradation.

Finally, from this field study, the team concluded that previously listed research and development recommendations can be implemented effectively if due emphasis is given from all directions. The problem will then be reversed or at least enough attention will be created.

## 12. REFERENCES


Abebe Kirube. 1985. A review of rodent pest management research in Ethiopia. PP 585-602. In: A review of crop protection research in Ethiopia. Abate T. (ed.). IAR: Addis Ababa, Ethiopia

Alelign Kefyalew. 1987. Initial results of informal survey. Working paper No. 2/87. IAR, Addis Ababa.

Alelign Kefyalew. 1989. Adet mixed farming zone diagnostic survey report. Research report no. 4/89. IAR, Addis Ababa

Alemayehu Woldeamanuel, Getachew Fenti, Million Teshome and Merid Kumsa. 1995. Rodent control demonstration in Tigray, Gonder and West Gojam. Pp.25-34. In Proceedings of the third annual conference of the crop protection society of Ethiopia. In: Eshtu Bekele, Abdurahman Abdulahi and Ayenekulu Yemane (eds.). 18-19 May 1995. Addis Ababa, Ethiopia. CPSE, Addis Ababa\

Alemneh Dejene.1984.Environment Famine and Politics in Ethiopia

Ann Stroud and Chris Parker. 1989. Weed infestations guide for Ethiopia. Food and agriculture organization of the United Nations. Rome, Italy

Aregay, B. W and P. A. Cadhokar. 1993. Soil conservation an Ethiopian experience. In Hudson, N. and Cheatle, R. J. (eds.). Working with farmers for better land husbandry. Intermediate technology publication. UK.

ARTP. 1998. Resaerch-extension-farmer linkage project implementation manual. Revised draft. V. II. Federal Democratic Republic of Ethiopia, Addis Ababa.

Belay Ijigu.1996.Assessment of current popularization activities in the agriculture sector. Proceedings of the workshop on capacity assessment in S&T popularization organized by the Ethiopian Science and technology Commission (ESTC) in collaboration with the United Nations Development Programme (UNDP). July 18-19, 1996. Addis Ababa, Ethiopia.

Berhane Mewa. 1996. R & D and popularization in the private sector. Proceedings of the workshop on capacity assessment in S&T popularization organized by the Ethiopian Science and technology Commission (ESTC) in collaboration with the United Nations Development Programme (UNDP). July 18-19, 1996. Addis Ababa, Ethiopia.

Central Statistical Authority. 1990. Facts and figures. Addis Ababa. 170p.

Chester K. Star.1950. Nature and prevention of plant diseases. 2nd ed. Mc Graw Hill books company, Inc. USA. Pp.94-209

CSA. 1994. The population and housing census of Ethiopia results for Amhara region Volume I, Part I: statistical report on population size and characteristics

Devendra C. and Mcleroy G.B. 1982. Goat and sheep production in the tropics. Intermediate tropical agricultural series.

Ethiopian Forestry Action programme. 1994. Ministry of natural resources development and environmental protection. Volume III-Issues and Actions. Final report.

IAR.1983. Crop protection progress report for 1978/79. IAR, Addis Ababa

ICRAF. 1993. Integrated natural resources management research for the highlands of east and central Africa. Report on the consultative workshop held 6-8 January 1993 at Lake Victoria Hotel, Entebe, Uganda. ICRAF. Nairobi, Kenya.

ICRAF.1997. Soil and Water Conservation Manual

ILCA.1987. Management of vertisols in Sub-Saharan Africa

Halima Hassen. 1997. Trifolium species in northwestern Ethiopia: Advantages and Consequences. IAR Newsletter of Agricultural Research, Vol. 12, No. 2 April -June 1997, pp.11-12

Melaku Wale. 1997.Adet agricultural research center annual report of 1995/96

MoA.1998. Agroforestry Package.

MoA. 1998. Soil and Water Conservation Package.

Pieri, C. and Steiner, K. G.1997. The role of soil fertility in sustainable agriculture with special emphasis to sub-Saharan Africa. Agriculture + rural development. 4:22-25

Regassa Ensermu and Asmare Yalew.1995. Factors influencing crop enterprise choice by small holders: A case study of Bahir Dar and Yilmna Densa areas. Working paper No.14, IAR, Addis Ababa, Ethiopia.

Rocheleau. ICRAF.1988. Agroferstry for Dry Land Africa, ICRAF-3

SIDA.1974. Woodfuel Survey in Ethiopia

Sutuma Edessa. 1993. The decline of forests and natural resources in Ethiopia. Ecology(Bratislava), vol. 12, No. 2, 215-222, 1993.

Tamiru Sebsibe. 1998. Farmers' perception to introduced soil conservation measures in Yilemana-Densa woreda, west Gojam demonstrative zone, Ethiopia. M.Sc thesis The Agricultural university of Norway, Norway.

West Gojam Planing and economic Development Department. 1993. Natural resources assessment and conservation strategies of west Gojjam, Bahir Dar, Ethiopia.

# 13. APPENDICES

## APPENDIX 1 . Field study terms of reference

TERMS OF REFERENCE FOR A JOINT ADET ARC-EARO-ICRA FIELD STUDY IN YILMANA-DENSA WOREDA, AMHARA REGION, ETHIOPIA

### Institutional framework

The study will be conducted as a joint activity of the Adet Agricultural Research Center (ARC), the Bureau of Agriculture (BoA) of the Amhara National Regional State (ANRS), the Ethiopian Agricultural Research Organization (EARO) and the International Center for development oriented Research in Agriculture (ICRA). ICRA and the Netherlands Government have a special interest to further strengthen client-oriented research efforts. Thus, the study will be undertaken within the framework of a broader collaborative program involving EARO, ICRA and the Netherlands Embassy. It is expected that the study will result in a number of R & D proposals to be incorporated in regular annual work plans of the barley, the cool-season grain legume and the vertisol projects that are supported by the Netherlands.

ADET ARC will host the field study. It has a regional mandate to address agricultural production constraints in all the agro-ecological zones of Gojam and Gondar. Adet ARC has good infrastructure and a well-equipped guesthouse.

### Timing

The field study will be carried out from 28 February to 8 May 1999 while the course work is from 11 January to 27 February 1999 and from 9 to 15 May 1999.

### Geographical area

The study will be conducted in Yilmana-Densa woreda situated some 45 km south - east of Bahir Dar on the road to Addis via Mota. The woreda□s altitude varies from 1500-3200 masl. The relief features are categories as flat; mountainous; valley and undulating, each covering 16%, 20% and 64% respectively of the total area. About 54% of the land area constitute slopes greater than 15 percent. The major soil types are black and red. Land use is divided into the following categories: cultivated areas (41.4%), flooded and swampy areas (48%), and grazing/forest/residential areas (10.9%). The population density is 170 persons/km2.

## Topic

Improving soil productivity for increased and sustainable crop production in Yilmana-Densa woreda, North-western Ethiopia

## Justification

Soil degradation and land productivity decline are two of the pressing development issues in the region and are likely to remain for a considerable period of time. The main causes for land degradation are identified to be deforestation, overgrazing and improper farming practices. According to diagnostic survey reports (Aleligne, 1988) the ecological crises and productivity decline of land in the highlands of Yilmana-Densa woreda are indeed immense. Declining land productivity caused by soil erosion and continuous cropping has gone from bad to worse and has resulted in serious food shortages. Crop residue and cow dung, the principal sources of livestock feed and soil fertility, respectively are now used as sources of energy for cooking. Waterlogging is another major constraint limiting crop production. Vast areas of marginal lands are used extensively producing low yields, necessitating long fallow periods which are no longer affordable because of population pressure (Aleligne, 1989). Emphasis on cereal staple crops has resulted in a slow disappearance of legumes from the crop rotation. The socio-economic situation in the rural areas has forced people to use their environment in an inappropriate way thus inducing land degradation. This in turn has reduced the productive potential of the land and thus has led to decreased yields, crop failures, and consequently to poverty and underdevelopment. Due to centuries of agricultural use, and recently misuse, the soils have already degraded or are under degradation.

## Overall objective

To analyze soil productivity constraints of the farming systems from a dynamic perspective, to better understand cause-effect relationships and to identify opportunities for research and development (R&D) efforts using a system-oriented, integrated and participatory approach.

## Specific objectives

- Describe and understand the system and its major soil types and toposequences/catenas
- Identify both the problems the system presents and the opportunities it offers
- Identify the major soil related production constraints
- Identify the major causes of declining soil productivity
- Define research priorities by involving all actors and beneficiaries
- Formulate participatory R&D programmes that are targeted on finding solutions which are suited to the environment, compatible with the existing system and geared to farmers' concerns
- Suggest policy recommendations

**Outputs of the study**

The primary output of the field study will be a final report with proposals for priority R & D activities and with recommendations for strengthening farmers' involvement in these activities. As a secondary output two workshops will be organized.

**Intended stakeholders, beneficiaries and clients**

| Stakeholders | Beneficiaries | Clients |
|---|---|---|
| Adet ARC | Adet ARC | Adet ARC |
| EARO | EARO | EARO |
| ICRA | – | ICRA |
| Netherlands Embassy | – | Netherlands Embassy |
| Field study team | Field study team | – |
| Regional BoA* | Regional BoA | Regional BoA |
| Zonal/Woreda BoA* | Zonal/Woreda BoA | – |
| Farmers | Farmers | – |
| NGOs | NGOs | – |
| Input suppliers | – | – |

*: BOA: Bureau of Agriculture

The main beneficiaries from the field study are Adet ARC, the Bureau of Agriculture (BoA) at all levels, and NGO's working in the study area. Therefore, the team will regularly interact with the above institutions during the field study period.

## Main research questions

| No. | Questions | Products |
|---|---|---|
| 1 | Are there different agro-ecological systems in the woreda? | Identify relevant criteria and indicators for zonation.<br>Relevant zonation to delineate target area |
| 2 | Are the three selected constraints (soil erosion, soil fertility, waterlogging) similar throughout the target area or does the impact of these constraints vary according to the situation of a farm/field in the soil toposequence? | Refined and more detailed zonation taking into account the toposequence concept<br>Criteria and indicators for field type differentiation |
| 3 | What are the major causes of soil erosion according to farmers? | List of the major causes of soil erosion<br>Participatory analysis of the factors that contribute to the soil erosion |
| 4 | What are the major practices for soil and water conservation practices in the area? | Inventory of indigenous technologies<br>Description of management practices |
| 5 | Have there been shifts in soil and water conservation practices in the last decades? What caused them? Are all farms and fields similarly affected? | Historical calendar<br>List of the major causes and effects and their relationship<br>Farm and field typology |
| 6 | What are the major causes of soil fertility decline according to farmers? | List of the major causes of soil fertility decline<br>Participatory analysis of the factors that contribute to the soil fertility decline |
| 7 | What are the major practices for soil fertility maintenance in the area? | Inventory of indigenous technologies<br>Description of management practices |
| 8 | Have there been shifts in soil fertility maintenance practices in the last decades? What caused them? Are all farms and fields similarly affected? | Historical calendar<br>List of the major causes and effects and their relationship<br>Farm and field typology |
| 9 | What are the major causes of waterlogging according to farmers? | List of the major causes of waterlogging<br>Participatory analysis of the factors that contribute to the waterlogging problem |
| 10 | What are the major practices for waterlogging prevention in the area? | Inventory of indigenous technologies<br>Description of management practices |
| 11 | Have there been shifts in waterlogging prevention strategies in the last decades? What caused them? Are all farms and fields similarly affected? | Historical calendar<br>List of the major causes and effects and their relationship<br>Farm and field typology |
| 12 | What technologies and recommendations have research, extension, NGO's, and other stakeholders developed to address the three constraints (soil erosion, soil fertility, waterlogging)? | Inventory of R&D activities by different stakeholders, their impact and lessons learnt from the experiences<br>Priority matrix for different stakeholders |

| | | |
|---|---|---|
| 13 | How do farmers perceptions on constraints (soil erosion, soil fertility and waterlogging) compare to the perceptions among the different R&D institutions? | Comparison of perceptions of farmers with those of R&D institutions |
| 14 | What are the existing linkage mechanisms among research-extension-farmers and other relevant stakeholders? Can they be improved? | Linkage map or diagrams of information exchange process |
| 15 | Have research and extension made sufficient use of the knowledge and potential of the farmers and other actors? How can farmers' involvement in the technology development and dissemination processes be improved? | Recommendations for strengthening the participation of farmers and other actors to increase effectiveness and efficiency of R&D endeavors. |
| 16 | How can Adet ARC and BoA/MoA and NGO's further increase the effectiveness of R & D contribution to improve the current practices? | Proposals to translate past research results in to useful recommendations for extension and farmers<br>Proposals for new R&D activities aimed at integrated management of soil productivity constraints using a participatory, inter-institutional approach |

## Team composition

The team will be composed of four staff members (agronomy, crop protection, feed and nutrition, natural resource management) from Adet ARC, one forester from MoA and one research (Agricultural economist) from Sirinka research center. All of the team members speak the local language.

## Form of final product

The team will produce a report as an outcome of the training. The main text of the report should not be more than 80 pages including figures and tables.

## Other outputs/result from the field study

The majority of research and extension efforts have been organized under the assumption that these are specialized activities that require the unique talents and training of research scientists and professional extension personnel. Although there is some feedback from farmers to extension specialists and to research scientists in the conventional research-extension system, the roles of the participants have been relatively clearly defined and interaction is often limited at best. Planning of research activities at Adet ARC start by identifying farmer's problems through diagnostic surveys (informal and formal) undertaken by multidisciplinary teams. Farmers are participating individually or in a group to provide information but they do not participate in research planning and priority settings. The extension staff also has limited participation in the research priority setting

and planning process through the research and extension liaison committee (RELC) meetings.

It is hoped that this study will help to reorient the planning approach in all research undertakings and strengthen the weak linkages that exist between and among the participating institutions through:

- Better links between research, extension, farmers and NGO's
- More sustained interactions across disciplinary lines, both within and between institutions
- More productive relations between NGO's, BOA and research centers
- More fruitful interactions between research and development institutions working in the region
- Proposals for COR research and development activities

After the accomplishment of the field study programme, priority R & D proposals formulated by the team will be refined into project proposals. They will be presented to Adet ARC, the National Barley and Cool-Season Grain Legume Improvement Programs and the Vertisol Development Program for incorporation into their Work Plans for the year 2000. It is expected that future Netherlands support to these programs will depend on effective integration of these proposals in their regular annual work plans for the year 2000 and onwards.

**Field study process**

Initially, a crude zonation will be made on the basis of secondary data on soils and topography for the choice of representative "pilot research locations". The zonation will then be validated through informal field surveys that will include field observations. Once a representative target area has been identified and broadly characterized, 3 representative locations (Peasant Associations) having both black and red soil types will be chosen. More detailed information on the areas will be collected by direct observations and interviews (using SSI, PRA and RRA techniques) which bring to life the problems of farmers as well as the existing opportunities for improvement.

At the beginning of the study, the team will present the work plans to the participating organizations for comments and adaptation. About mid-way through the field study period the team will organize a mid-term workshop to present the preliminary results of the analysis and proposed options in the presence of farmers representatives involved in the study and of the participating organizations. At the end of the study the team will present final report containing the detailed proposal on COR activities and for the improvement of the research-extension linkages and between the respective institutions.

**Field study responsibility**

The team is responsible to implement the field study within the limits specified in the terms of reference(TOR). The team is collectively responsible to Adet ARC and to ICRA/EARO for respecting the TOR and for the use made of the resources which the Adet ARC, the BoA and ICRA/EARO provide for the implementation of the field study. The team will maintain regular contacts with the EARO and ICRA training coordinators at Nazareth Research Center. An EARO/ICRA field study tutor will join the team on a part-time basis (3 x 10 days) during the field study period. The zonal BoA and Adet ARC will each appoint a contact person for interaction with the team.

## Appendix 2. Research questions

| CENTRAL QUESTION | SECONDARY QUESTIONS | TERTIARY QUESTIONS |
|---|---|---|
| What are the main constraints and their causes to low soil productivity ? | | What are the natural factors that affect soil productivity? |
| | | What are the major land uses and their effect |
| Which actors are most concerned about soil productivity issues? | | How different actors perceive on soil productivity problems? |
| | | What are the role, interest and importance of each actor on soil fertility maintenance? |
| What are the potential soil management interventions? | | How is the feasibility of agroforestry, soil conservation, drainage practices, the use and management of inorganic and organic fertilizers and other potential solutions? |
| Are there any differences in soil productivity, constraints and potential solutions across farming systems, household typology in the area? | | What are the dominant farming systems and their features of the area? |
| | | What are the household typologies of the area? |
| | | What are the different field types of the area? |

## Appendix 3. Checklist

| Checklist item |
|---|

### Farmers' circumstances

Geographical information (Location & boundaries)
Climate(temp, rainfall, altitude)

Terrain(slope, rivers & streams, gullies)

Land use (cultivated, grazing, forest, water, logged, unproductive land, uncultivated.)

Human population ( number, density, sex. age)
Settlement pattern
Input supply, major inputs (sources, trends)

Marketing & infrastructure (center, channels, products & goods, prices)
Identify farmers' circumstances that have effect on soil productivity are opportunities for soil productivity improvement

**Household resources and gender analysis**
Family size, composition, age, occupation
Sources of labor and availability

Labor uses and calendar/activity calendar,
Household mobility

Division of labor ( at household, farm, soil fertility management, social works, institution)
Resource access and control
Wealth ranks of the households

Farm size & tenure system

Livestock holding
Source of cash & expense

Identify socio-economic factors that have effect on soil productivity? Are opportunities for soil productivity improvement

**Crop production**

Crops (area, variety, productivity, harvesting, pest management, threshing & storage)
proportional piling
Crop management practices (land preparation, planting, weeding, seasonal calendar)
Crop calendar
Crop residue management
Cropping system (rotation, multiple cropping, crop type, reason, schedule )
Identify agronomic practices that have effect on soil productivity? Are opportunities for soil productivity improvement

**Natural resource management**

Communal resources (type, location, management, uses, problems)

Sources & consumption of energy

Agroforestry (type, location, management, practices, purpose)
Soil types, coverage, productivity, crop suitability

Soil fertility management
.Farmers perception on soil fertility status,
.Use and availability of manure, compost, inorganic fert
(source, time, rate, method, crop type, field/soil type)

Soil and water erosion (farmers perceptions, fields affected,
Measures taken , type & effectiveness)
Identify natural resource management that have effect on soil productivity are opportunities for soil productivity improvement

**Livestock**
Livestock (type, number, purpose of keeping, outputs,
diseases & parasite control measures)

Feeds & feeding (source, type, availability, time, feeding system)

Grazing land ownership and management
Identify livestock management practices that have effect on soil productivity? Are opportunities for soil productivity improvement

**Soil degradation**

Historical trends

Causes and effects of soil degradation (problem-cause diagram, farmers' view)

Farmers' indigenous knowledge and copping strategies
Past and present Interventions
(farmers attitude towards the interventions)

**AKIS**
List of actors, their activities, linkages
Farmers attitude about the services provided by each actors

## Appendix 4: Questionnaire for in depth study of Yilmana-Densa woreda farming systems

**Resources**

1. Labor

1.1 Household head type A. Male headed B. Female headed

1.2 Family size ----------Male--------Female-------

1.3 What are the major sources of labor you used for farm operations?
A. family labor only B. Use hired labor C. Others

1.4 What activities do.you do other than farming?
A. daily laborer B. Hand craft C. Trade D. other (specify)----------

2. Land

2.1 How many hectare of land do you own ----------

2.2 Of which how much is homestead----------

2.3 How many fields or plots do you have---------- and what is their size

2.4 From the total farm you own how many hectare is black soil and red soil
Black soil----------ha. Red/brown soil ----------ha.

2.5 Do you have private grazing land ?--------. If yes, How many hectare -------

2.6 What is the fertility status of each field you have?
Fertile-------ha.
Medium---------ha
Poor ----------ha

2.7 Is your farm attacked by soil erosion? A. Yes B. No

2.8 Is your farm exposed to waterloging A. Yes B. No

2.9 Have you leased in farm land ? a, yes B. No

2.10 If yes, for how long? --------year and What was the agreement
A. sharecropping B. Rent

2.11 Have you leased out your farm land a. Yes B. No

2.12 If yes for how long----------year and what was the agreement?
A. share cropping B. Rent

3. Capital

3.1 Area/ number of eucalyptus trees you owned----------ha/#

3.2 Number of animals you have
Oxen-------. Cow-------- Sheep----------, Goat----------
Donkey---------- Hen----------. Bee hives----------

3.3 Do you grow cash crops ( gesho, vegetables, spices and other fruits)?
A. yes B. No

3. 4 Have you taken credit last year ? A. yes B. no

3.5 If yes, source, amount and purpose?
Source----------
Amount----------
Purpose----------

3.6 If you were borrowed for fertilizer how did you pay it?
A. Sales of crops B. Sales of Small ruminants C. Sales of oxen
D. Sales of cow E. others ( Specify)

3.7 Have you ever encountered credit shortage? When? For what purpose?

**Soil related management practices**

1. Fertilizer

1.1 Do you used fertilizers? A. yes B. no

1.2 If yes, for what crops and soil types
Crops----------,
Soil types----------

1.3 What was the rate you used last year?

1.4 If not the recommended rate Why?

1.5 How is your fertilizer demand (amount farmers used) for the last 5 years?
a. Increased B. decreased C. The same

2. What is the productivity of your farm land per hectare?

| | Tef | Barley | wheat | Maize | R. pea | F.pea | noug |
|---|---|---|---|---|---|---|---|
| With fertilizer | | | | | | | |
| Without fertilizer | | | | | | | |

c. Crop rotation: Can you tell me crops planted in your black soil field and red soil field

| for the last three years? | 1988 | 1989 | 1990 |
|---|---|---|---|
| Black soil field | | | |
| Red soil field | | | |

4. How many times do you plow your field to plant :
Tef----------, Maize----------, Wheat----------, Barley----------
Rough pea----------, Noug----------, Field pea--------, Potato---------- Millet---

5. Did you plant trees on your farm? A. yes B. no

5.1 If yes, what type?

5.2 If no, why?

5.3 Do you think trees increase your soil fertility? How?

5.4 Does redistribution of land discourage from planting trees in your land?
A. yes B. no

5.5 Which Type of trees do you want to plant in the future?

6. Do you practice (cut-of drain, ditches check-dumps) soil and water conservation activities in your farm?
A. yes B. no

6.1 If yes, what type?

6.2 If no, why?

7. Do soil or stone bunds were constructed in your farm?

7.1 Are they existed now? A. yes B. no

7.2. Have you ever planted trees and shrubs and grass on terraces? A. yes B. no

7.3. If not, why they are destroyed?

7.4 Would you like to construct it privately? A. yes B. no

7.5. If soil bund is not good, What is the problem with it?

7.6. What should be done to improve it?

8. Do you use manure to your farmland? A. yes B. No

8.1. If yes, to which crops ---------- and fields----------

9. Where do you graze your livestock? ----------

9.1. For communal grazing:
Area of your communal grazing land?----------
Number of households and their livestock, who have the right to graze on that land?
Who administer the grazing land?

9.2. Have you ever plant trees, forage crops for livestock feed? What type? How do see the advantage?

10. Have you used insecticides for the last two years? A. yes B. no

10.1 If yes, for which crop and insect? Crops----------, insects----------

10.2 If no, Why?
1. I don't know insecticides
2. Lack of insecticides
3. High price of it
4. Lack of cash to buy it

## Appendix 5. Site selection criteria at different level

| Level | Criteria | Selected |
|---|---|---|
| Agro-ecological zone | High area coverage | |
| | High human and livestock population | Mid altitude |
| | Accessibility | |
| Peasant association for visit | Soil type | Geregera |
| | Accessibility | Kililt |
| | | Dewaro |
| | | Kudad |
| Sample peasant association | Soil type | Geregera* |
| | Level of soil degradation | Kililt** |
| | Conservation practices | Kudad* |
| Village | | Lula Dur |
| | Representatives | Atmo |
| | | Weyra lay |
| | | Jankeber |

*** One village is selected (red soil)**
**** Two villages are " ( black soil)**

## Appendix 6. Itinerary

| Date | Activity | Participant | Location | Contacted with |
|---|---|---|---|---|
| 1-2/3/99 | Travel | All team member | Adiss-Adet | |
| 3-5/3/99 | Secondary data collection & analysis<br>Schedule refinement<br>Utensils and materials purchase | All team members<br><br><br>Yeshanew | Wereda ag. office<br>Zonal planning<br>BOA, ARC<br><br>Bahir Dar | |
| 6/3/99 | Market days/rest | All team members | ARC | |
| 7/3/99 | Recognizance survey | All team members + Mulugata + field assistant | Yielmana Densa | |
| 8/3/99 | Planning workshop | All team members +ARC staffs + WAO staffs | ARC | |
| 9/3/99 | Village selection & characterization | Team + 2 field assistants | Kudad, & Geregera, | PA representatives |
| 10/3/99 | Village selection & characterization | Team + 2 field assistants | Two villages at Kililt | PA representatives |
| 11-12/3/99 | Transect walk, mapping Wealth ranking | Team +2 field Assistants | Selected villages | Key informants |
| 13/3/99 | Visualization and team discussion | Team | ARC | |
| 14/3/99 | Appointment to Luledur village<br>Checklist refinement and job sharing | Team | ARC | |
| 15-16/3/99 | Discussion with farmers | Team + 1 field assistants | Killit and Geredera | |
| 17/3/99 | Rest because of market day | Team | ARC | |
| 18-19 | Discussion with farmers | Team + 2 FA's | Killit and Kudad | Farmers group |
| 20/3/99 | Brain storm | Team | Adet | |
| 21/3/99 | Discussion with females group<br>Team meeting to revise activities schedule | All team members<br><br>All team members | Geregera<br><br>Adet | Females leader |
| 22/3/99 | Draft report writing | All team members | Adet | |
| 23/3/99 | Draft report Writing | All team members | Adet | |
| 24/3/99 | Draft report writing<br>Checklist preparation for stakeholders | All team members<br><br>Getaw | Adet<br><br>Adet | |

| Date | Activity | Participant | Location | Contacted with |
|---|---|---|---|---|
| 25/3/99 | Discussion with ACSI, Ambasel, AISCO, Amalgamated, EGME | All team members | Bahir Dar | Ato Tadesse<br>Ato Chernet<br>Ato |
| 26/3/99 | Draft report writing<br><br>Discussion with Coop., ACSI | Silesh, Yeshanew, Minale, Halima<br>Birhan, Getaw | Adet<br><br>Woreda offices | |
| 27/3/99 | Problems summery for prioritization and discussion about the workshop | Team | ARC | |
| 28/3/99 | Problem prioritization's | Team | Geregera | Farmers |
| 29/3/99 | Problem prioritization Team Discussion on preparation for mid-term workshop | Team | Killilt | Farmers |
| 30-4/4/99 | Preparation and report editing for workshop | Team | Adet | |
| 5/4/99 | Mid-term Worksop | Farmers, Researchers, Extension staffs and other stakeholders | Adet | |
| 6-7/4/99 | Incorporation of comments and planning for the next activities | Team | Adet | |
| 8-9/4/99 | Editing of draft report Preparation of questionnaire | Individual and in group | Adet | |
| 10-20/4/99 | Focused formal survey & farmers' workshop | Team and enumerators | Study PAs | |
| 21/4/99 | Incorporation of results | Team | Adet | |
| 22-30/4/99 | Final report writing and editing | Team | Adet | |
| 1-5/5/99 | Preparation for workshop | Team | Adet | |
| 6/5/99 | Final workshop | All stakeholders | | |
| 7-8/5/99 | Reviewing and incorporating comments from the workshop | Team | | |

**Appendix 7. Transect Walk Diagram at Luliedur – Kelilet PA**

| | | | |
|---|---|---|---|
| Soils | Besele (Litosol) "Serbola" Loam "Sheda" (Cambisol) | (Cambisol) Serbola | (Vertisol) Walka |
| Crop | Field pea Maize, potato, tef | Tef, barley, faba bean | Grass pea, chick pea, tef, fingreek, vigetables |
| Trees | Vernonia, Eucalyptus, croton | Croton, Eucalyptus, Accacia | Accacia, Cordia |
| Problems | Soil erosion | Gullys | Water logging |
| Opportunities | Diversification of crops | Diversification of crops | Vegetable along the river |

**Appendix. 8. Transect Walk Diagram at-Weyra Lay – Geregera PA**

| Soils | Red (Borebore) (Nitosol) | Redish and rocky (Litosol) | Red Nitosol / Red brown (Cambisol) |
|---|---|---|---|
| Crop | Tef, faba bean, barley, maize | Tef, field pea, finger millet | Tef, Wheat, Maize, Faba bean |
| Trees | Eucalyptus, caroton, Accacia | Eucalyptus, Cordia, Croton | Eucalyptus, Accacia, Croton |
| Problems | Gullys | Soil erosion | Gullys |
| Opportunities | Wood lot | | Growing vegetables, wood dot |