Nature and causes of land degradation in the Oromiya Region: A review

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Bezuayehu Tefera, Gezahegn Ayele, Yigezu Atnafe, M.A. Jabbar and Paulos Dubale

International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

Ethiopian Agricultural Research Organization
P.O. Box 2003, Addis Ababa, Ethiopia

Oromiya Natural Resources Development and Environmental Protection Authority
P.O. Box 8770, Addis Ababa, Ethiopia

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Authors' affiliations

Bezuayehu Tefera, Oromiya Natural Resources Development and Environmental Protection Authority, Addis Ababa, Ethiopia
Gezahegn Ayele, Ethiopian Agricultural Research Organization (EARO), Addis Ababa, Ethiopia
Yigezu Atnafe, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia
Mohammad A. Jabbar, ILRI, Addis Ababa, Ethiopia
Paulos Dubale, EARO, Addis Ababa, Ethiopia

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Summary and conclusions

The purpose of this literature review is to use available information to characterise the nature and extent of land degradation in Oromiya region, assess the causes of land degradation, identify knowledge gaps and develop some testable hypotheses about the possible pathways for overcoming land degradation problems and improve agricultural productivity in the region.

Land degradation can be triggered by various processes that lower potential productivity leading to long-term, sometimes irreversible, deterioration of land. These processes are numerous but for the purposes of this paper, primary focus is given to soil erosion and biological, chemical and physical degradation as forms of land degradation in the Oromiya region. Empirical evidence on these various forms of degradation in the region is scanty. However, a review of available information reveals the following picture.

Soil erosion is the most widespread form of land degradation in the region and most research on understanding the degradation process and finding a solution to combat it has concentrated on this topic. The average erosion rate for agricultural land has been estimated at about 40 t/ha but there is wide variation between different parts of the region and between production systems. Several factors contributing to erosion include:

- Rugged topography with steep slopes and a thin soil layer makes many areas in the region vulnerable to erosion. Increased agricultural activities have enhanced erosion rates on these types of lands. For example, in one community, the length of gullies increased 14 times over a 40-year period following expansion of crop production on medium and steep slopes by replacing pasture and woodland.
- A large part of the region receives a high amount of rainfall concentrated in a limited period during the year, which also contributes to erosion as rainfall intensity is a more important factor than rainfall amount in causing erosion. For example, at one research site 64% of an annual total of 1082 mm of rainfall was recorded in three months and at another site, 86% of 1654 mm of rainfall was recorded in four months. At these sites 50–60% of the soil loss occurred in those intensive rainy periods. The effect of the rainfall pattern on erosion has been exacerbated by traditional cultivation practices in which land is tilled before, and left bare and loose during the main rainy season.
- Some of the major soil types in the region, e.g. Vertisols and Inceptisols, are susceptible to high erosion rates due to their inherent characteristics. Other soil types such as Nitosols and Luvisols may not be naturally very susceptible to erosion but the uses of inappropriate agricultural practices have made them erosion prone.
- Loss of forest and other vegetation cover over time due to population pressure and expansion of farmland has contributed greatly to enhance erosion rates over a large part of the region. Recent estimates suggest that the rate of deforestation is about 3.1% per annum due to expansion of farmland, shifting cultivation, commercial agriculture, fuel wood collection, commercial logging, urbanisation and poor management of natural forests. In some areas, vegetation loss leads to termite infestation, which enhances erosion and contributes to further vegetation loss that eventually makes the land unusable.
- Excessive tillage for some crops, e.g. teff (the main grain crop in the region), tilling sloping land, reduction of fallow and crop rotation practices and overgrazing of pasture and cropland are some of the agricultural practices that also have enhanced erosion.

Biological degradation or the decline of the humus content of soil through mineralisation has been increasing rapidly mainly due to increased continuous cultivation and reduced nutrient cycling, particularly inadequate or no use of manure and ploughing in crop residues. Most of the dung is used as fuel in the face of reduced availability of woody biomass, which again is the result of increased deforestation.

Chemical degradation or nutrient depletion has been increasing due to more intensive cultivation without adequate replacement of nutrients. It has been estimated that over 40 kg of Nitrogen (N) is being lost annually from cropland. Others say about 100 kg is being lost, and that the negative balance has been on the rise. How much of this loss is due to erosion versus chemical degradation is not known. Information about the loss of other principal nutrients is not available. Application of organic manure is declining and that of inorganic fertilisers is increasing but that is not enough to make a significant impact on arresting the degradation process.

Physical degradation due to compaction, sealing, reduced aeration and permeability is also a problem. Such degradation occurs due to excessive tillage for land preparation, overstocking and overgrazing both pasture and cropland and overuse of certain cattle routes and watering points.

The immediate impact of land degradation has reduced crop yield and productivity. For example, at a test site, barley yield was found to have declined by 72% over a 15-year period due to erosion. Annual productivity losses in the Ethiopian highlands, including the Oromiya region, is estimated to be 0.12–2.0%. Another estimate indicates an equivalent of 3.5% of the 1985 GDP was lost annually during 1985–95 due to erosion-induced losses in crop and livestock production. Land degradation in the region also adversely affects water resources through increased sedimentation, drying up of lakes, water bodies and springs in some cases and flooding downstream areas in others. All of these losses ultimately affected the welfare of the population.

Land degradation or conservation is an outcome of many proximate and underlying causes. The current status of land resources and its use patterns are the result of many highly inter-linked factors including natural, socio-economic, policy and those related to agricultural practices. A review of the policies, programmes and institutions indicate that in the region, within the framework of the national economy, the general government agricultural development policies and programmes were implemented in limited areas of the region due to financial, material and human resource constraints. Such programmes were principally focused on improving productivity, giving little direct attention to natural resource management and conservation. Where conservation efforts have been made, the focus has been on building physical structures through food-for-work programmes implemented through Peasant Associations. Such schemes provided some incentive for people to participate. However, the structures have not been maintained and many of them have been destroyed especially in recent times for cultivation in an increasingly land scarce situation. In a few cases, some forms of biophysical intervention for conservation have been experimented with but not widely adopted. Farmers appear to be reasonably aware of the problem of land degradation and its principal causes and consequences. However, both household and higher level factors including labour constraints, cash constraints, lack of appropriate conservation technologies, high costs and inaccessibility of inputs such as fertilisers and better seeds and land tenure appear to be responsible for the continued land degrading practices and poor or non-adoption of conservation measures. Unlike in Tigray and Amhara regions, there has been no land redistribution in Oromiya region after the major distribution in the mid-1970s. Consequently land has become a scarce resource. Many newly formed households are landless as they have not been allocated any land by the Peasant Association. On the other hand, there are many who cannot cultivate all or part of the land allocated to them and others cultivate more than they have. Because of these reasons, several informal mechanisms such as renting, share-cropping, leasing and borrowing have emerged for such people to access and exchange land. The long-term consequences of the past tenure systems, both during the feudal period and the Derg period, and the newly emerging informal tenure systems on productivity and conservation are yet to be adequately empirically established.

Technologies and institutions in a society evolve partly through people's responses to emerging problems and opportunities (indigenous technologies and institutions) and partly through the introduction of technologies and institutions generated by formal research and development efforts. People's choice of production and conservation technologies is primarily influenced by profitability or comparative advantage, which is a function of many factors. Among others, three main factors thought to determine comparative advantage are agro-ecology or agricultural potential, population pressure and market access. The highlands of the Oromiya region are divided into three agro-ecological zones or domains of agricultural potential: high and low potential cereal zones and perennial zone. Population density and market access (measured by density and quality of the road) vary widely within and between the domains of agricultural production. Three domains of agricultural potential and high and low levels of population density and market access gives 12 domains in the region. Theoretically, each of these domains would be expected to follow specific paths in terms of production system choice, production and conservation technology use and input intensity. These choices would be expected to be determined by initial resource conditions and household and community responses to changes in markets, prices, and local and higher level institutions and policies.

Some of the possible production enterprises, technology use and input intensity levels that might emerge in the 12 domains, both as natural responses by people and through external interventions, are listed. For example, in high potential cereal areas with a high population density and good market access, farmers would be expected to adopt high input cereal production for the market. The efforts of the government and NGOs in the region through infrastructure development, provision of inputs and extension, credit and other services would be expected to be focused in this domain to produce marketable food to achieve the region's food self-sufficiency as well as produce surplus to export to deficit areas. In low potential areas with a high population density and high market access, subsistence food production would be a major goal. In perennial zones with a high population and market access, intensive production of perennial crops for market may be a major enterprise but subject to availability of suitable land. High input cereal for subsistence and market may also be pursued.

In each of these domains, people's incentive for investment in conservation measures would vary. For example, in high potential cereal zones with high population and market access, a move towards private control of land instead of communal control might emerge particularly in common grazing and forest land management, and associated local and norms might also emerge. Such developments also might induce increased investment in productivity enhancement and conservation. In low potential cereal zones with low population and market access, degradation may be an on-going process but labour scarcity may be a major constraint to embark on conservation investment.

From the literature, it could not be assessed or established if the expected land use, production and conservation practices have actually been emerging in the various domains. A detailed sample survey is being conducted among households and communities in representative *woredas* in each of the twelve domains to understand the actual land degradation processes, identify the types of production systems and associated practices that have evolved in these domains, and identify the factors that have facilitated or constrained the processes.

1 Introduction

Land degradation, defined as a temporary or permanent decline in the productive capacity of land, or its potential for environmental management, has significantly contributed to the low yield of crops and livestock of the Oromiya region. Land degradation, either natural or induced by humans, is a continuous process. It has become, however, an important concern affecting food security and the wealth of nations, and has an impact on the livelihood of almost every person on this earth. The degradation of land resources may be attributed partly to the failure of the rural population in taking due care of these resources and remaining unaware of the long-term consequences.

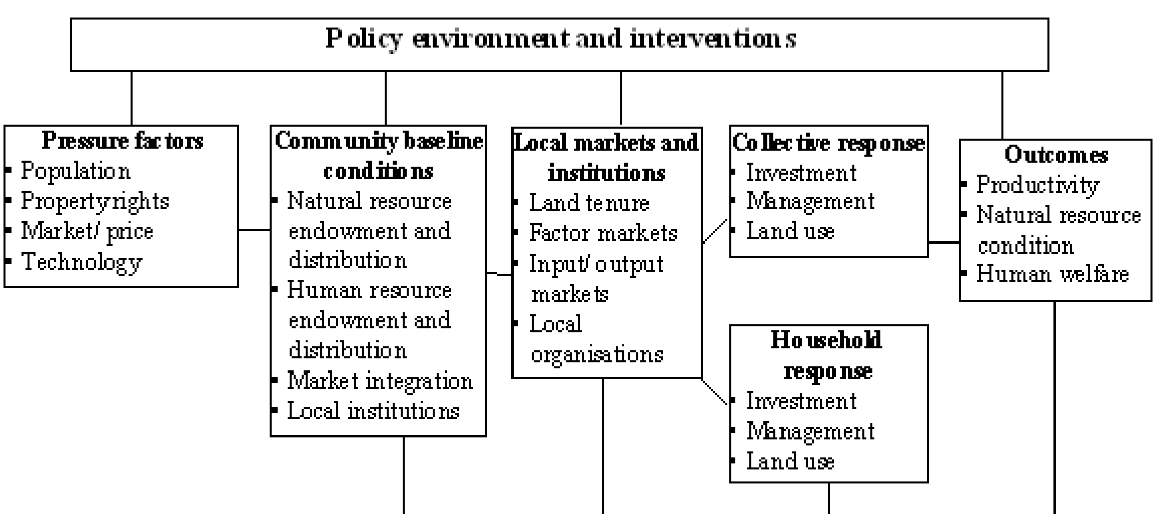
Hurni (1988a, 1993) describes land degradation due to soil erosion as one of the elements leading to the decline of the civilisations of Lalibela in the 14th century, of Gonder in the 17th century and of Shewa in a subsequent period. More recently, the downfall of the Haile-Selassie Regime had a lot to do with the frequent incidence of famine due to drought and general land degradation. The 1973–74 famine claimed the lives of 100,000 people and expedited political change. The 1983–85 famine was even more devastating. Close to one million people died and a considerable number were displaced (El Wakeel and Abiye 1996).

There were and still are fundamental natural, political, and socio-economic factors responsible for the degradation of land resources including soil (Thomas 1991). A few attempts have been made in the past to arrest land degradation mainly through technical interventions such as constructing terraces and bunds on sloping lands, and indirectly through policy support such as supplying subsidised inputs to improve soil fertility and productivity. However, these attempts were disjointed, covered only a small part of the region and were not based on an adequate understanding of the real causes of degradation. Without a proper understanding of the causes and consequences of land degradation, it is difficult to devise appropriate technology and policy interventions. The purpose of this literature review is to use available information to characterise the nature and extent of land degradation in the Oromiya region, assess the causes of it, identify knowledge gaps and develop some testable hypotheses about the possible pathways of overcoming the problem to improve agricultural productivity in the region.

2 A conceptual framework

The conceptual framework earlier used for similar analyses of the Tigray and Amhara regions is also used here (Fitsum et al. 1999; Lakew et al. 2000). The framework is derived principally from theories of agricultural intensification, which explain changing management systems in terms of changing microeconomic incentives facing farmers as a result of changing relative factor endowments, such as land and labour (Boserup 1965; Hayami and Ruttan 1985; Binswanger and McIntire 1987; Pingali et al. 1987; Templeton and Scherr 1997). Additional variables believed to be important determinants of resource management have been included. These were inspired by theories of collective action (Olson 1965; Ostrom 1990; Baland and Platteau 1996), market and institutional development (North 1990); rural organisation (Bardhan 1987) and agri- cultural household models (Singh et al. 1986; de Janvry et al. 1991).

Figure 1 illustrates this conceptual framework. 'Pressure' factors operating at a broader national or regional level (e.g. population growth, changes in national market prices, development of new technologies, changes in official property rights) are assumed to induce, within individual communities, shifts in local market structure, prices and/or local institutions (e.g. local labour or land tenure arrangements). The nature of these shifts will be conditioned by community characteristics that help to determine local comparative advantage (e.g. their human and natural resource endowments, market linkages, and local knowledge of natural resource management). The shifts at the community level induce responses in natural resource management (NRM) at both the household and collective levels. At the household level, responses may take the form of changes in land use, product choice, investment, and/or land management (intensity, input mix, and conservation practices). At the community level, responses may take the form of collective land investments, collective self-regulation of private resource use, changes in management of communal resources, or changes in formal or informal rules of access to natural resources. The net results of these changes in NRM are changes in natural resource conditions, productivity and human welfare. Both the responses themselves and the changes in the outcome variables can have feedback effects on community baseline conditions and local markets and institutions, thus contributing to further change and innovation at the local level.



Source: Scherr et al. (1997).

Figure 1. *Conceptual framework.*

Public policies may influence this temporal process at various levels: through the pressure factors (e.g. agricultural research programmes, sector price policies, resettlement policies); by directly influencing community conditions (e.g. restrictions on natural resource use, infrastructure investment); by intervening in local markets or institutions (e.g. land tilling programmes, local credit programmes); by influencing household or community responses (e.g. through technical assistance programmes); or by directly intervening in outcome variables (e.g. nutrition programmes or direct forest management by the state).

Currently available information is not adequate to understand the dynamics of the process and does not provide policy makers with much guidance about which of these intervention points will be most effective in promoting positive outcomes or the mix, or the most appropriate sequencing of policies. Most public action aimed at improving natural resource management on fragile land focuses on influencing household, and to some extent, community responses. Yet, it may be more effective to influence local markets and institutions or to invest in community infrastructure, since these may largely determine household and community response factors. However, we have very little empirical evidence that elucidates the relationship between these different levels of policy action and their actual effects on the key outcome variables. Finding such empirical evidence is one of the main objectives of this project.

3 The resource base and production systems

It has been shown in the conceptual framework that outcomes at a point in time in terms of productivity, natural resource conditions and human welfare are based on the past resource base and their use by households and communities in response to market, policy and other rules and norms. Therefore, the natural resource base and production systems in the Oromiya region are described briefly to provide the context for understanding the problems of land degradation, its evolution and causes.

3.1 Physical and climatic features

Oromiya region is located in the central part of Ethiopia extending from 3°20' N to 10°35' N and from 34°05' E to 43°11' E with a total land area of 353,690 km^2 (Figure 2). It constitutes about 31.15% of the total land size of the country making it the largest of all the regions. The region is divided into 12 administrative zones and 180 *woredas* (*annaas*).

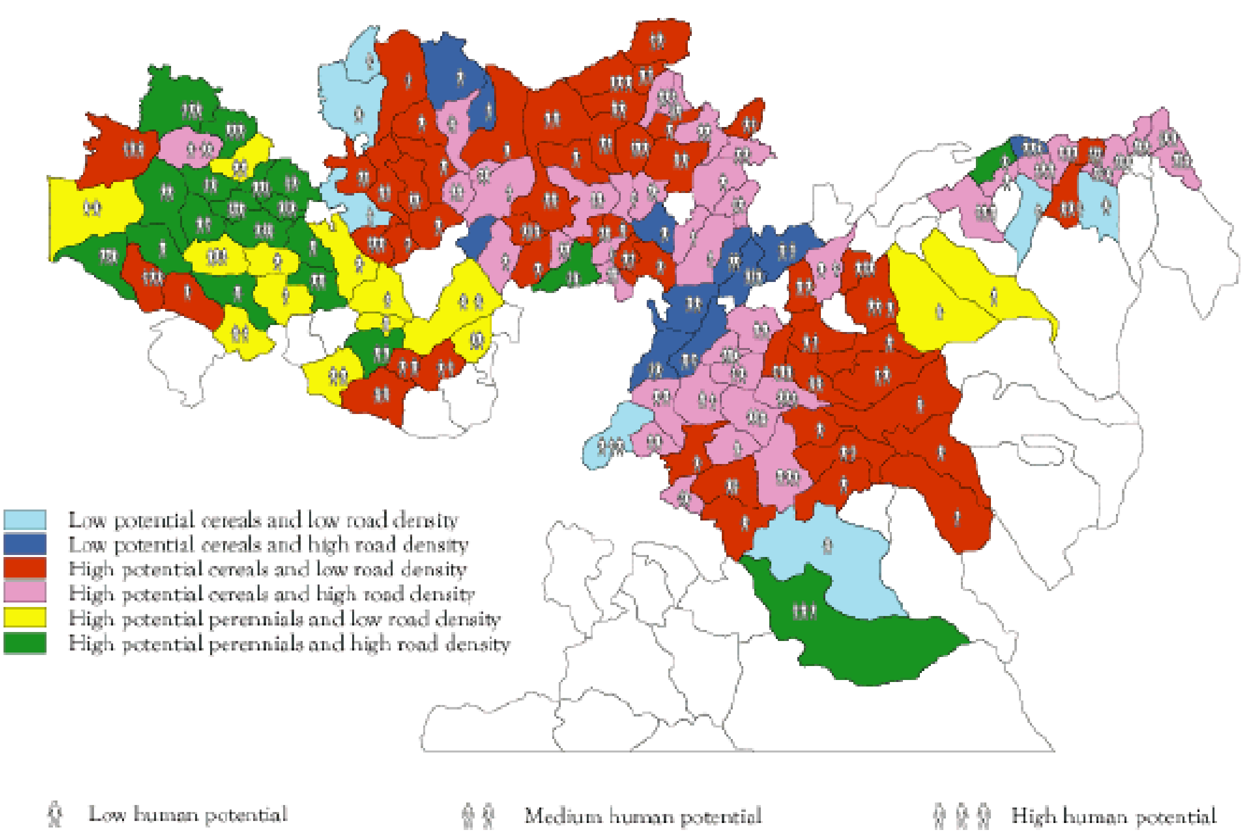


Figure 2. *Regional State of Oromiya (including agro-ecological zones)*.

The region has common borders with six national regional states, Sudan and Kenya. It shares the longest border (1860 km) with the Southern Peoples' Nation and Nationalities Regional State followed by the Somali Regional State (1410 km) (see Figure 2).

Oromiya region's topography consists of a high and rugged central plateau and the peripheral lowlands. From a topographic point of view, the region can be divided into three parts namely:

The Eastern Plateau: This part of the region, which also includes the associated lowlands, gradually slopes down from the edge of the eastern escarpment of the Rift Valley and extends to the Somalia region. The administrative zones of West Hararghe, East Hararghe, Bale, Arsi and Borana are included in this plateau.

The Rift Valley: This is part of the Great African Rift Valley extending from Jordan in the north through Ethiopia, Kenya and Tanzania to Mozambique in the south.

The Western Plateau: This part of Oromiya region extends westwards from the edge of the western escarpment of the Rift Valley to Benishangul and Gambella regions. This area is made up of a wide plateau, mountains of medium height dissected by the Awash, Baro, Gibe and Abay rivers and their associated tributaries. North Shewa, West Shewa, East Wellega, West Wellega, Illubabor and Jimma zones are included here (Berhanu et al. 1998a).

Elevations in the region range from less than 500 to over 4300 meters above sea level (masl). The highest plateau includes mountains such as Batu in Bale (4377 masl), Kaka in Arsi (4245 masl), Chilalo in Arsi (4170 masl), Arba Guna in Arsi (3625 masl), Mul'ata in Hararghe (3405 masl), Selalle in North Shewa (3544 masl), and Wenchi in West Shewa (3387 masl). The highest mountains are concentrated on the Eastern Plateau of the region.

The highlands (>1500 masl) constitute about 48% of the region's total area while areas between 1000 to 1500 masl constitute 38% (OBPED 1997a). The highlands are home to more than 80% of the total human population and 70% of the livestock population of the region and account for over 90% of the cropland. Almost 90% of the region's economic activities are concentrated in the highlands (Haile-Yesus 1996).

In terms of climate, highlands in the region are cool and the lowlands are warm. The most prevalent agro-climatic conditions in the highlands, although there are considerable variations from locality to locality, are tepid to cool temperature and moist to sub-humid humidity. The lowlands have a semi-arid to arid climate (Berhanu et al. 1998a).

Spring (March–May) and summer (June–August) are periods of high solar radiation. However, in the western flank and highland portion of the eastern flank, because of high humidity and frequent cloud cover, temperatures are lower in summer. Spring is the warmest season with May being the warmest. Autumn (September–November) and winter (December–February) are seasons of relatively low sunshine with cool winds from the northern hemisphere reducing temperatures in winter with December being the coldest month (Berhanu et al. 1998a). In general, temperature is inversely related to elevation: the mean annual temperature in the highlands is between 10°C and 22°C, while it is between 22°C and 30°C in the lowlands.

The major rainy season extends from June to September and covers most parts of the region while October to May is normally dry. However, an entirely different atmospheric circulation system takes place in some parts of the region during March and April when the East African low-pressure system moves south and pulls moisture-bearing winds from the Indian Ocean which induces some precipitation. These small rains are sufficient for the 'belg' crops in some areas and are a relief from the long dry season in other areas. This characteristic seasonality in the rainfall distribution pattern needs the classification of its regimes based on the designation of a month to be either rainy or dry. [1] Furthermore, the whole region is grouped in two rainfall regimes: Rainfall regime 1 is characterised by one rainy season with only one dry season. The number of rainy months varies from 7 to 10. It is the type of rainfall, which characterises part of the Rift Valley and the whole western flank of Oromiya. Rainfall regime 2 is characterised by two rainy seasons (double maximum). It characterises the areas in the eastern flank of Oromiya in which the number of rainy months varies from 5 to 8 (Table 1).

1. This classification involves the calculation of the rainfall coefficients for each month for selected representative stations. The rainfall coefficient is the ratio between the mean monthly rainfall and one twelfth of the annual mean. Those with rainfall coefficients of 0.6 and above are categorised as rainy and the rest as dry (OBPED 1997b).

Table 1. *Rainfall regimes in Oromiya region.*

Regime and type	Rainy months	Rainy period		Maximum rainfall seasons	Rainfall station(s)	Zones (areas)
		High	Low			
1-A	8	March, October	–	Single	Gore, Jimma	Illubabor, South Shewa, Lakes region
1-B	9–10	March, August	January, September	Single	Wendo	Lakes region
1-C	7	March, September		Single	Haro Maya, Harar	Hararghe
1-D	7	May, September	April, October	Single	Nejo, Gimbi, Nekempte	Wellega, Illubabor
1-E	7	June (part), September (part)	September, April, May, June	Single	Bako, Weliso, Addis	West Shewa, central Shewa
2-A	8	February, May, July, August	June, September	Double	Yabelo	Borana
2-B	7	February–April, June–September	February (part), July	Double	Diredawa	East Hararghe
2-C	6	June (part), September	March, June	Double		North Shewa, East Shewa
Source: OBPED (1997b).						

Reliability of rainfall is important in the region because the livelihood for the rural population is based mainly on rain-fed agriculture. In general, the annual average amount of rainfall decreases from west to east. The highest amount is in Gore (2122 mm), while the lowest is in the eastern border area (200 mm). This annual pattern is about 70% and 30% reliable in the highlands and lowlands, respectively (OBPED 1997b).

3.2 Physiography, soils, land and water resources

The major physiographic divisions of tectonic structures in the region that resulted from past geologic activities are summarised in Table 2. About one-half is covered by laval highlands and massifs. Ancient crystalline rocks cover about 24% of the region: 13% in the highlands of north-western Borana and central South Bale and 11% in the lowlands of south-western Borana.

Table 2. *Physiographic divisions of tectonic structures of Oromiya region.*

Physiographic divisions	Arial coverage		Location
	km^2	%	

Transitional scrap slopes	7430	2.1	Slope of the Rift in north-eastern E. Shewa and north-eastern East and West Hararghe
The young lava plain	14,500	4.1	Mainly the lower middle Awash Valley
Aggradational plain and depression	3,890	1.1	In the rift lakes area
The central lava highlands and massifs	173,660	49.1	All highland plateaux of Oromiya
Highlands within ancient crystalline rocks	44,920	12.7	North-western Borana and Central South Bale
Lowlands within Ancient crystalline rocks	39,970	11.3	Mainly in south-western Borana
The Harar plateau	10,610	3	Highlands of East Hararghe
The South-East low plateau	27,940	7.9	Eastern Bale and southern E. Hararghe
The South-East lowlands	30,770	8.7	Extreme eastern Bale, eastern Borana and southern E. Hararghe
Total	353,690	100	
Source: OBPED (1997b).			

In general, there are 21 main soil units recognised in the region (Table 3). The major soil groupings in the region are Vertisols, Nitosols, Luvisols, Acrisols, Cambisols and Phaeozems. Each of these has properties, to be discussed later, that affect soil degradation differently.

Table 3. *Major soil types, their area coverage and distribution in Oromiya region.*

	Spatial coverage		
Soil type	km2	%	Location
Orthic Acrisols	37,491	10.6	Mainly in humid section of western sub-region
Chromic and Calcic Cambisols	37,137	10.5	Central and western Bale, south-western West Hararghe & Arsi
Dystric and Humic Cambisols	6720	1.9	Blue Nile Valley in East Wellega and central West Bale
Vertic Cambisols and Vertic Luvisols	3537	1	South-eastern North Shewa and north-western East Shewa
Rendzinas and Haplic and Luvic Phaeozems	35,723	10.1	Eastern East Shewa and northern West Shewa
Lithosols	1415	0.4	North-eastern East Shewa
Calcaric and Eutric Fluvisols	24,758	7	Western Borana, Dawa Valley, eastern Bale, western West Wellega
Chromic and Orthic Luvisols	37,845	10.7	Southern North Shewa, western West Shewa, slopes of Harerghe plateaux
Dystric Nitosols	48,455	13.7	Mainly in humid West and part of high land Borana
Euric Nitosols	2122	0.6	Southern Arsi
Cambic Arenosols	8135	2.3	Rift Valley
Calcaric and Eutric Regosols	1415	0.4	Upper Rift scrap of Hararghe plateau
Humic Mollic and Vitric Andosols	8135	2.3	Rift valley
Chromic and Pellic Vertisols	50,224	14.2	Central Shewa, Arsi, Bale and southern slopes of Hararghe plateau
Haplic, Calcic and Luvic Xerosols	14,855	4.2	Eastern Bale and southern Borana
Gypsic Yermosols	1061	0.3	Eastern extreme Borana
Gleyic and Orthic Solonchaks	1061	0.3	Eastern extreme Bale, eastern Borana
Lithosols Regosols	24,051	6.8	Eastern Borana
Lithosols and Yermosols	2830	0.8	Southern Borana

Lithosols Andosols	1061	0.3	Northern extreme East Shewa
Andosols Cambisols	1061	0.3	East Shewa
Others	1768	0.5	Localised
Lakes	2830	0.8	
Total	353,690	100	
Source: OBPED (1997b).			

Out of the total land area of 353,690 km^2, vegetation cover accounts for 67.5%, while cultivated land accounts for 29.5%. Grassland, water bodies, urban and built up areas and wastelands constitute the rest (Table 4). The land use pattern varies significantly across zones due to differences in physiographic conditions and population density. Over time, cultivated area has increased while other types of land like forest and bush land have decreased.

Table 4. *Land use pattern by zone in the Oromiya region, 1993.*

Zone	Percent (%) by use category								
	Total land, (km^2)	Cultivated land	Grassland	Forest	Wood land	Bush/Shrub	Wet land	Lakes + Reservoirs	Others
Arsi	23,060	60.5	0.63	7.6	7.32	12.94	0.16	1.03	0
Bale	66,430	6.5	4.83	14.1	39.2	34.97	0	0	0.37
Borana	95,290	3.3	2.86	3.4	35.51	54.51	0.21	0	0.18
E. Hararghe	24,610	30.8	2.36	0	22.57	43.63	0	0.07	0.53
W.Hararghe	17,230	21.7	0.75	0.93	24.06	52.52	0	0	0
Illubabor	15,870	45.6	0	38.9	9.43	6.14	0	0	0
Jimma	18,490	47.7	0	25.08	20.99	6.27	0	0	0
E. Shewa	13,860	60.6	4.4	0	11.48	13.11	0.51	7.98	1.91
N. Shewa	11,290	73.6	0	0.82	4.98	19.96	0	0	0.62
W. Shewa	21,600	74.5	0	2	7.95	15.49	0	0.07	0
W. Wellega	23,980	40.6	0	2.66	25.43	29.37	0.19	0	0
E. Wellega	21,980	49.4	0	0.48	5.46	42.66	1.28	0.32	0.37
Oromiya (Total)	353,690	29.5	2.02	7.2	25.03	35.28	0.32	0.39	0.28
Source: OBPED (1997b).									

The climatic condition of the region results in high precipitation during the rains which in turn causes stream flows. However, as precipitation is seasonal, the volume of discharge of rivers is also subject to seasonal fluctuations. There are seven major drainage basins in the region, the largest being Genale covering 32% of the area followed by WabiShebelle (21%) and Blue Nile (16%). High rainfall in the highlands also results in high runoff. Annual run off rates vary from under 50 cm/h to over 600 cm/h (Table 5).

Table 5. *Annual runoff in the Oromiya region.*

Ranges of annual runoff in cm/ha	Spatial coverage		Zones and localities
	km2	%	
0–25	37,519	10.6	Eastern Bale, N.E. Borana, East Hararghe
50–125	188,654	53.3	Almost all eastern sub-region and rift valley system, eastern Wellega

125–400	53,558	15.2	Southern Arsi, eastern Bale, and N.E. Borana, Shewa, eastern East Wellega and central West Wellega
400–600	43,895	12.4	Jimma, central East Wellega, central West Wellega
Above 600	30,064	8.5	Almost the whole Illubabor, Didessa valley
Total	353,690	100	
Source: OBPED (1997b).			

Preliminary estimates by water resources master plan studies conducted for twelve basins show that there is 2.9 billion cubic m of ground water resources in Ethiopia. Out of this, 2.0 billion cubic m is within the Oromiya region. The region is also endowed with large quantities of surface water capable of producing large amounts of electricity and able to irrigate vast areas of land. The source for most of the hydroelectric power generated in Ethiopia are the following rivers in the region: Qoqa, Fincha'a, Malka-Wakena and Gilgel Gibe. Out of the total of about 377 MW of hydropower currently produced in the country, 366 MW is produced in Oromiya region. There are several naturally occurring lakes and man-made reservoirs of variable sizes and irrigation potential. Some of the lakes are Zuway, Langano, Shala, Abiyata, Haro Maya, Wancii, Abbaya, Bushoftu, Hora, Fincha'a, Qoqa and Gafarsa. The irrigation potential of the region, suitable for large-scale development, is estimated at about 800 thousand hectares, though only 7% of the potential has been developed and is in use (Berhanu et al. 1998a).

3.3 Economy and production systems

Oromiya region has predominantly an agrarian economy. Agriculture, services and industry account for about 70%, 24% and 6% of the regional GDP, respectively. Also, these sectors account for 92.2%, 6.5% and 1.3% of employment, respectively. The region accounts for about 51% of the total major crop production in Ethiopia and is considered the source of the country's agricultural surplus. It is also the major source of food supply for the country's major urban centres and deficit areas. Oromiya also produces 63% of the national exports and is a major source of raw materials for domestic industries (Berhanu et al. 1998a).

The region is generally divided into three main zones according to agricultural production potential which is based on agro-climate, soil and production systems: high potential cereal zone, low potential cereal zone and perennial zone (Figure 2). Out of 146 highland *woredas* in the region, 93 are located in the high potential cereal zone, 18 in the low potential cereal zone and 35 in the perennial zone. Forty-four *woredas*, including most located in low potential areas, have recently been identified as food insecure and there is widespread malnutrition and chronic food insecurity in many rural areas of the region.

Within each zone there are various subsystems of production but there are two broad categories: The mixed crop–livestock farming system and the pastoralist system. Oromiya region has the largest livestock resource base in Ethiopia. Cattle, sheep, goats, donkeys and camels are the major types of animals reared and there are about 18.8 million tropical livestock units (TLU) in the region. The mixed crop–livestock farming system of the highlands carries 70% of the total livestock resource base while the remaining 30% is owned by pastoralists in the arid and semi-arid lowlands. Pastoralists of the lowlands almost totally depend on livestock. They are a multipurpose resource providing draught power and manure for crop production and food (meat, milk, butter and cheese) and other by-products and are also the principal form of saving. Livestock also provide manure for fuel and serve as a living bank and insurance during crop failure. At medium to high altitudes (>500 masl), about 90% of crop production is carried out by using draught power (Berhanu et al. 1998a).

The mixed crop–livestock farming system can be further divided into four sub production systems. These systems (discussed below) have implications for how the land resource is used and the resulting effects on degradation.

- The enset–coffee–cereal–livestock production system: This production system occurs along the Wolliso to Jimma region. Coffee and enset are grown in home gardens at altitudes below 2200 masl while on the main fields are planted cereals. Enset is the main food crop in the system. Maize and sorghum are the main cereals followed by teff, wheat and barley. Pulses (haricot and lima beans) are grown as garden crops. Prominent root crops are taro, yam, and sweet potato. Although crop rotation (alternating cereals with pulses) is practised, legumes cover about 11% of crop area. Fertiliser use is also low. Fallowing is practised on hilly and extensively cultivated parts where population pressure is lower. Crop residues from teff, sorghum, maize and enset are used as fodder.
- The forest coffee–enset–cereal–livestock production system: This production system is practised in parts of Jimma zone and in the highlands of Borana. Enset is grown in home gardens and cereals on fields. Coffee is normally grown under shade trees in the forest. The forest undergrowth is occasionally cleared as an agronomic practice to promote coffee growth and development. The coffee plants are mostly wild but with selection and management some improvement is taking place. The rainfall is as high as 2200 mm and the region has a bimodal rainfall pattern.The most important cereal crops are maize, sorghum, teff and millet. The importance of cereals is less compared to that under the enset–coffee–cereal–livestock production system. Pulses include haricot and faba beans, chickpeas, lentils and pigeon peas. Oil crops include noug, linseed, rape seed and castor beans. Some vegetables, root and tuber crops and spices are also grown. Fallowing and crop rotation are practised and cattle manure is mainly used for crops grown in the home gardens (enset, maize etc.). Fertiliser use and other soil conservation practices are not common, and crop residues are used as fencing and cementing materials. Cultivation is mainly with hoes and ox ploughing is limited because of widespread trypanosomosis.
- The mixed cereal–livestock production system: This is the prevalent production system in almost all zones in the region. Among the crops, teff covers the largest area (31%), followed by wheat (18%), maize and sorghum (11%), barley (8%), oats and finger millets (5%), pulses (10%), oil crops (6.5%) and other crops (10.5%). In Hararghe, in areas such as Garamuleta and Chercher, inter-cropping is widely practised. Beans are usually mixed with crops such as sorghum and maize, and chat fields are inter-cropped with sweet potato. Ox ploughing is prevalent in these parts of Hararghe although hand ploughing, locally called *dongora culture*, is practised by certain groups of farmers in preparing land with either steep slopes, stones or wood stumps. Farmers practice *dongora* often in groups. Fallowing is not practised under this production system and soil fertility is traditionally maintained through crop rotation (cereals with pulses). Chemical fertiliser application is common in Shewa and Arsi zones but not in other areas. Terracing is practised on the hilly slopes of the eastern and north-eastern highlands of the region. Crop residues are used as fodder, construction material and fuel.
- The barley–wheat–livestock production system: Arsi, Bale, East Wellega and North Shewa zones practice this production system. Compared to the mixed cereal–livestock production system, this one is generally practised at slightly higher altitudes. The crops grown include barley, wheat, oats, faba beans, field peas, lentils and oil crops with barley covering about 54% of the total production area. Home gardening is not common except for rape seed and maize. The temperature in the regions which practice this system limits the number of crop types grown. Ox ploughing is more common than hoe culture. Fallowing is practised the area. Soil fertility is maintained through crop rotation and the use of cow dung as manure is minimal due to the high dependence of the communities on it for fuel. The use of chemical fertilisers is not common except in some parts of Shewa and Arsi. Crop residues are used as fodder, construction material and

fuel.

4 Land degradation: Form, extent and related factors

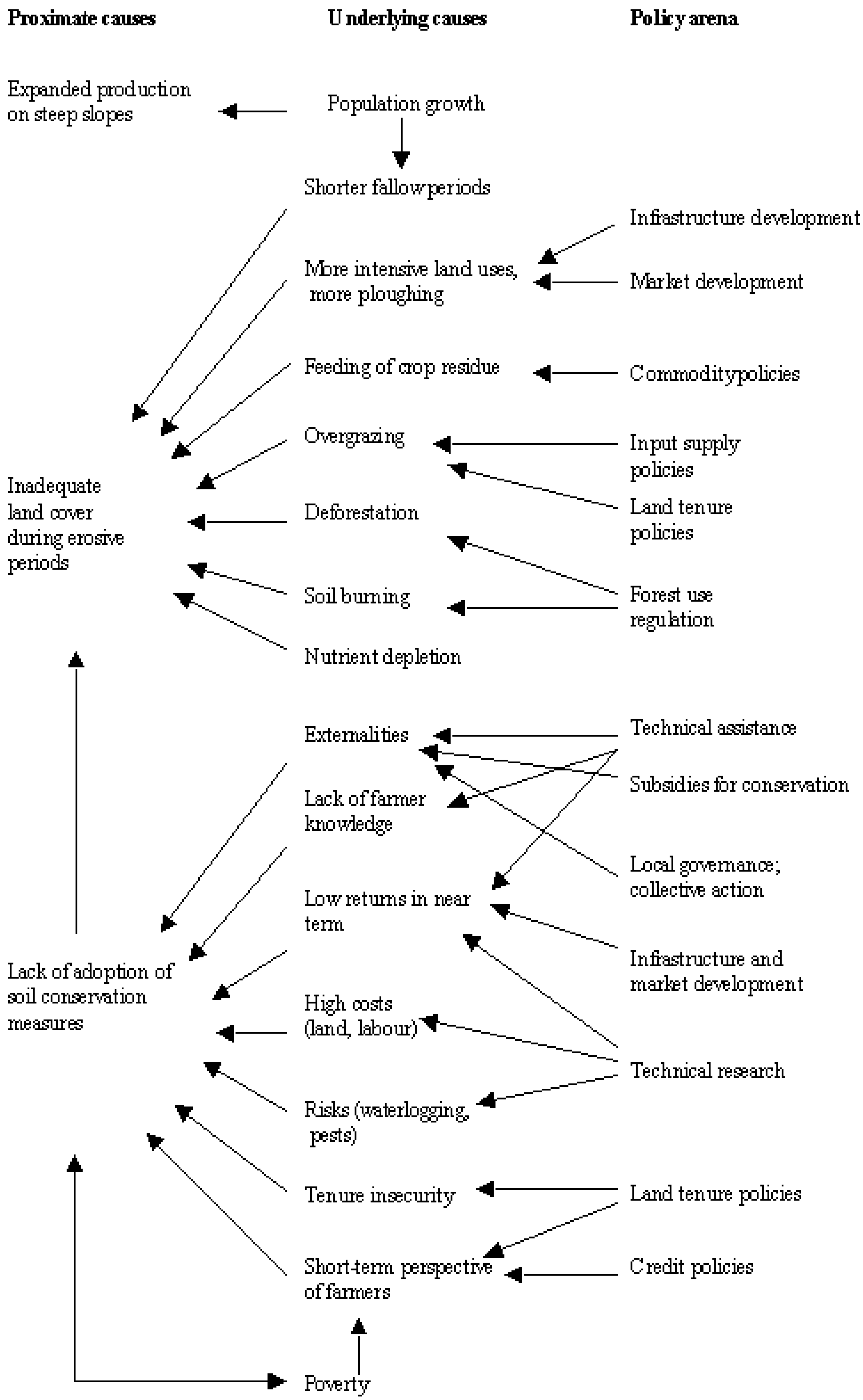
Land degradation can be triggered by various processes that lower the potential productivity of land leading to long-term (sometimes irreversible) deterioration. These processes are numerous but for the purpose of this study, the primary focus is on processes of soil erosion and biological, chemical (nutrient depletion) and physical degradation as forms of land degradation. These processes are interrelated and could occur due to natural causes but they are invariably accelerated by human intervention in the natural environment (Barber 1984; Agray-Menash 1985). Human intervention increases with population growth and pressure. For example, based on his study in the Gauche catchment area (234 ha) in West Hararghe zone, Thomas (1991) reported that of all the visible erosion incidents, 81% were caused by human induced factors while the rest were by natural factors. The most common human-induced factors that cause accelerated erosion include deforestation, inappropriate agricultural practices such as over cultivation and overgrazing, and inappropriate institutional and policy applications, e.g. land tenure, input supply and forest regulation policies. Poorly designed and constructed roads, defective conservation measures, cattle tracks and footpaths are also some of the human induced factors causing visible degradation.

Extreme diversity in natural resources and ecological conditions within the region causes the processes of land degradation to vary significantly. Fertile soils and abundant rainfall attracted early farmers to these highlands. As soil degradation in the northern highlands of Ethiopia advanced, people moved southwards, particularly to the Oromiya highlands. This situation is still putting pressure on the highlands of the region. Increased demand for trees/forests for construction and fuel, and expansion of farmlands to steep and marginal areas have also contributed to degradation. The present extent of soil degradation which is over a very large area of the Hararghe highlands, North and East Shewa, and Wellega, Arsi and other zones is evidence of the unabated spread of soil degradation in the Oromiya region.

In this section, we will discuss the extent of various forms of degradation and their proximate, mainly natural, causes. First, the different forms of degradation and natural causes are discussed in the following order: soil and water erosion, biological degradation, chemical degradation (nutrient depletion), and physical degradation. It should be noted that the various forms of degradation are to some extent inter-linked, so there may be some repetition in the discussion. The impacts of these various forms of degradation are discussed in Section 5 while Section 6 discusses some of the underlying causes including socio-economic, institutional and policy-related causes.

4.1 Soil erosion as a form of land degradation

The major physical agent in environmental degradation in the settled highlands of the Oromiya region is soil erosion. Topography, rainfall, wind, lack of vegetation cover, soil properties, and land use and management practices are the immediate causes of soil erosion (Barber 1984). There are also underlying or distant causes, such as population pressure, poverty, high cost and inaccessibility of inputs, insecure land tenure, lack of appropriate production and conservation technologies and many of these are further influenced by various government policies or lack of them (Figure 3). In this section, the nature and extent of soil erosion and the proximate causes will be discussed.



Source: Fitsum et al. (1999).

Figure 3. *Causes of soil erosion.*

4.1.1 Topography affecting erosion

Oromiya region's topography consists of high altitudes and rugged landscapes, as described earlier. The rugged topography and steep slopes affect soil erosion rate through its morphological characteristics. Two of these, namely gradient and slope length, are essential components in quantitative relationships for estimating soil loss (Wischmeier and Smith 1978). On sloping lands, more than one-half of the soil particles that are dislodged by raindrops during rainfall are carried downhill. Erosion increases dramatically because the increased angle facilitates water flow and soil movement. It is not surprising, therefore, that areas like the Charchar highlands in Hararghe, MartiJaju areas in Arsi, central Shewa etc. suffer some of the region's highest erosion rates.

Data for assessment of the effect of slope gradient and length on soil erosion is limited. However, it is generally accepted that an increase in slope and slope length will increase erosion because they lead to an increase in overland flow volume and velocity. Runoff on low slopes flows slowly and quickly forms a water layer deep enough to act as surface mulch. Increasing slope length enhances soil loss as more runoff can accumulate on long slopes. Thomas (1991) identified that slope shape together with ground/field attributes exercise a strong influence on the nature and extent of visible erosion damage.

On steep slopes, soils are generally shallower and their nutrient and water storage capacities are limited. Thus, soils in these areas, when exposed to soil eroding agents, face greater degradation consequences compared to soils in flat areas. Since most of the terrain of the highlands of the region is undulating and hilly, most agricultural land is situated on sloping ground. Increasing population has resulted in an increasing demand for cultivable land which has increasingly moved on to steeper slopes previously covered (through cutting and burning) by forests.

A survey in three Peasant Associations in West Hararghe showed that due to population pressure farmers were forced to cultivate lands over 50% slope even though there was a directive from the *woreda* not to cultivate lands over 35% slope (Adugna et al. 1996). The Soil Conservation Research Project (SCRP) has shown that an increase in population as a result of the resettlement programme in Illubabor has forced the community to clear forests on steep slopes for maize cultivation. As a result erosion and leaching due to heavy rainfall decreased soil fertility (Hagmann 1991). In the Ginchi watershed in West Shewa, analysis of aerial photographs shows that in 1950 only 34% of the watershed was under cultivation, mainly in the lower and middle part of the undulating landscape, 60% was under pasture and woodland, covering the medium and higher slopes, and 6% was roads, pathways and water bodies. In 1990, the situation has completely changed. Crops are now grown on over 60% of the land area extending up to 35% slope while pasture and woodland has been reduced to half its previous size. Furthermore, the length of gullies increased 14 times between 1950 and 1990 and they have become wider and deeper because of severe erosion (Saleem 1995). Similar situations exist throughout the region.

4.1.2 Rainfall and wind affecting erosion

The major components of climate that affect soil erosion are rainfall and wind. Erosive processes are set in motion by the energy transmitted from either rainfall or wind or a combination of these forces. Although the effects of erosion are not easily observed on a daily basis, water and wind are both capable of quickly damaging the soil. Sheet and rill erosion are by far the most widespread kinds of accelerated erosion and impact agricultural production more than other kinds of erosion. Soil erosion by rainfall and wind consists of two principal sequential events: the detachment of soil particles from the soil mass and the transportation of the detached particles (Young and Wiersma 1973). Raindrops hit exposed soil launching soil particles into the air. When rainfall is intense and rapid runoff occurs, gullies ranging from 1 to 100 m deep may form and large volumes of water and soil may be swept away (Pimentel et al. 1998). The power of rainfall to produce erosion is related to rainfall amount, intensity and distribution. Rainfall intensity is more important than rainfall amount in causing erosion. Rainfall with an intensity equal to or exceeding 7.6 cm/h in 5 minutes, 3.6 cm/h in 15 min, 2.5

cm/h in 30 min, or 2.0 cm/h in 60 min is classified as excessive (Krauer 1988). When erosion increases, less water enters the soil matrix and is available for the crop. In the tropics, erosion may reduce infiltration by up to 93% and thus, increases runoff (Lal 1976, cited in Pimentel et al. 1998).

The average amount of rainfall in the Oromiya region decreases from west to east. The highest is in Gore (2212 mm), followed by Arjo and Hurumu each receiving 2140 and 2025 mm, respectively. The lowest amount of rainfall occurs in the eastern border area, where the average yearly amount is 200 mm (Berhanu et al. 1998a). In most of the highlands of the region, the largest proportion of rainfall occurs during the main rainy season (June–August). The rainfall erosivity is also highest during this period. For example, out of 1082 mm of rainfall recorded in 1988 at Hunde Lafto (West Hararghe) station, 64% occurred during July–September. Out of the calculated 642 J/mh erosivity index, 78% was imparted during the same period. At Dizi Research Station (Illubabor), out of 1654 mm of rainfall, 86% was registered during June–September which accounted for 89% of the 1227 J/mh erosivity index. Furthermore, rainstorms of 1.2 cm/h lasting 20 minutes were recorded in Dizi, and 14.1 cm/h intensity rainfall in six minutes was recorded in September 1984 at the SCRP station based in Suke, Hararghe. Although of short duration, these rainfall events of high intensity produced about 50% of the total soil loss from test plots at the research sites (Krauer 1988; Hagmann 1991).[2]

2. These results from the Dizi research station by SCRP in 1988/90 indicated that among the various erosivity indices, the rainfall erosivity factor used in the Universal Soil Loss Equation (USLE) was the most appropriate rainfall erosivity index for the Ethiopian environment (Solomon 1994). The reason could be that it combines the effect of rainfall amount, maximum intensity and duration of all significant rains.

The agricultural practices in most highland areas of the region leave the soil bare and loose at the onset of the rains to facilitate planting and weeding. Therefore soil loss could be high at this time even during low erosive rainfall. For most of the highlands of Genale Dawa Basin, the estimated soil loss rate is 0–50 t/ha per year. However, in some parts of Sidamo and Bale highlands, high soil loss rates of 51–200 t/ha per year (predominantly 51–100 t/ha per year) have been reported (FAO 1986).

The estimate of average annual soil losses for all types of land cover in the highlands of Ethiopia lies between 10 and 35 t/ha and average values for croplands vary between 20 and 100 t/ha. These values of erosion rates are much higher than the rate of soil formation and conversion of parent material into soil. The rates of soil formation in Ethiopia, as estimated by Hurni (1983), vary between 2 and 22 t/ha per year. A comparison of erosion rates by country or region within a country is often misleading because average erosion rates obscure the high degree of variability within each area or watershed. For example, in Ethiopia an average of 42 t/ha per year is estimated to be lost each year from agricultural land (Hurni 1988b, 1993), but in the Illubabor area, soil loss on slopes under cultivation is estimated to be a minimum of 100 t/ha per year, with modal values between 150 to 200 t/ha per year for different locations (Hagmann 1991). These rates might be higher compared to the highlands of Hararghe and East Shewa, where there is less intensive rainfall and where erosion has already removed most fertile topsoil.

Wind erosion is determined by soil erodibility, surface soil roughness, wind velocity, wetness of soil, vegetation cover and management practices (with regard to windbreaks). Usually, when wind speed reaches 25 mph, the wind detaches soil particles from unprotected soil (Pimentel et al. 1998). Wind erosion is accelerated when soil is dry, weakly aggregated or less cohesive and bare. Due to the decrease in vegetation cover, an increase in tillage methods that leave the surface smooth, frequent trekking of large number of livestock for water and grass and poorly constructed roads, wind erosion is becoming a serious problem in the region.

Although the severity is not as serious as water erosion, it is posing a threat in Rift Valley areas and associated lowlands with light texture soils. In some parts of these lowlands deforestation either for cultivation or settlement is in progress.

4.1.3 Soil properties affecting erosion

The major soil classes found in the highlands of Oromiya are Vertisols, Nitosols, Luvisols, Acrisols, Cambisols and Phaeozems. Each of these has properties that affect soil degradation differently (OESPO 1999). Soils vary in their resistance to erosion partly based on texture and amount of organic matter. The resistance also depends on soil condition and depth. Soils high in silt and low in clay and sand are highly erodible (Nill et al. 1996). The high erodibility of silty soils is explained by their weak structural stability. They rapidly form surface seals upon the impact of rain drops. Erosion is less on clayey soils due to better aggregation and on sandy soils due to the non-sealing surface.

Some soils like Inceptisols which cover the Charchar highlands (Hararghe) are fragile in nature and sensitive to both geological and man made activities. The reddish brown to red clay soils of tropical and subtropical areas, known as Alfisols or Nitosols are widespread in the region where intensive cultivation is practised. They are common in the coffee, tea, oil crops and fruit-growing areas of Hararghe, Borana, Illubabor, Jimma, Wellega and Bale zones. Andosols found in coffee growing areas are generally young volcanic soils and have high water absorbing capacity, which create high water pressure in pore spaces. River bank erosion and road excavation aggravate the situation.

Nitosols have high moisture storage capacity, a stable soil structure and hence are less susceptible to erosion than many other soils. Vertisols are characterised by their extensive cracking from the surface to depths of 50 cm or more with the advance of the dry season (El Wakeel and Abiye 1996). Vertisols have developed in the central highlands and basins in the western Oromiya region where rainfall reaches 2000 mm (OESPO 1999) and soil erosion takes place even on slightly sloping plains (Driessen and Dudal 1991). Field observations have shown that these areas very often suffer from rill and gully erosion that cut deep gullies into the soil and aggravate the rate of land degradation.

If soil depth is inadequate, the water holding capacity and rooting anchorage of the soil may decrease below the critical levels. As soil depth decreases, croplands revert to weedy grasslands and ultimately degrade to bare rock. The sloping areas in the highlands of Hararghe, Arsi, Shewa and Wellega are some of the areas which have lost most of their fertile topsoil and have become susceptible to land degradation.

Organic matter in the soil improves soil structure, root penetration, water-holding capacity and infiltration. With increasing organic matter, erodibility decreases (Wischmeier and Smith 1978). The increasing reliance of the rural population on animal dung and crop residue for fuel has reduced the amount of organic matter which should have been added into soils as organic fertiliser. Consequently soil structure has deteriorated and soils have become fragile and prone to erosion.

Soil conditions, e.g. antecedent moisture content, vegetation cover, slope and tillage system generally influence soil erodibility and land degradation. On moist soils, rainfall starts and causes higher runoff volumes than on dry soils. For this reason rains occurring at the onset of the rainy season generally cause less runoff and soil loss than rains at the end of the rainy season. However, better vegetative cover at the end of the rainy season also helps to reduce runoff and erosion from occasional heavy rains.

Sodium has a pronounced dispersion influence on soil structure. Soils in the Rift Valley area have a high sodium content and are easily dispersed and susceptible to wind and water erosion. Deposition of sediment (silt and sand) caused by runoff on the surface plains within the channels in the drainage system and on the lower slopes of colluvium or alluvium plains is generally observed. The soils in these areas are dominantly coarser in texture, easily detachable but difficult to transport.

4.1.4 Vegetation and land cover affecting erosion

Throughout the world, the lowest erosion rates, ranging from 0.004 to 0.5 t/ha per year, are found in undisturbed forests (Pimentel et al. 1998). However, once forest land is converted to agriculture, erosion rates increase because of vegetation removal, over-grazing, and tilling. Vegetation cover reduces erosion. Living and dead plant biomass reduces soil erosion by intercepting and dissipating raindrops and wind energy. Above-ground foliage slows the velocity of water running over the soil decreasing the volume of water and soil lost in surface runoff. Plant roots physically bind particles, thus stabilising the soil and increasing its resistance to erosion. Plant roots also enhance water conservation by creating pores in the soil surface that enable water to enter easily into the soil matrix. The uptake of water by plant roots also depletes the soil water content and thereby further increases infiltration rates.

It has been estimated that closed forests covered about 40% of the western, southern and central parts of the country (what is now Oromiya region) about a century ago. However some argue based on chronicles of the many travellers to Ethiopia in the last 500 years that forest cover was not really that high, particularly in the north of the country which has been densely populated for a long time. This inconsistency has resulted in several different estimates about the current volume of forest cover in the region. For instance, the estimates (in the mid 1990s) vary from 7.2% to 8.2%, while that of wood and bush lands vary from 32% to about 60% (Berhanu et al. 1998a). However, continued extensive deforestation in places like the Rift Valley since the 1990s could have reduced the forest area further.

The Oromiya regional state has identified 43 high natural forests as regional forest priority areas covering a total area of nearly 3 million hectare (Table 6). Forests found in the Bale, Borana, Arsi, Shewa and Hararghe areas are dominated by *Juniperous, Podocarpus,* and *Juniperous-Podocarpus* mixed forests. There are also mixtures of *pegeum africanum, ekebergia ruppeliana, schefflera abyssinica,* and *apodyties dimidiata* spp. On the other hand, those found in Wellega, Jimma and Illubabor areas are dominantly mixed broad leaves, consisting of *aningeria adolfi friederici, edebergia, albizia, bosqueca, fagaropsis, pegeum, syzygium, croton, celtis, polyscias* and *schefflera* spp. These areas are homes to coffee arabica, which accounts for about 66% of the country's foreign exchange earnings. The coffee-growing area increased from 345 thousand hectare in 1993–94 to 435 thousand hectare in 1998–99. This expansion has been taking place by removing forest cover including wild coffee plants, thereby posing a threat to biodiversity in coffee. In some areas such as east and west Hararghe, coffee and other crop-growing areas are being converted to chat plantations because of its quicker cash generation potential and because of the high incidence of coffee berry disease. Between 1993–94 and 1998–99, the area growing chat increased from 68 to 78 thousand hectare. It is becoming an important source of cash income for farmers and foreign currency for the country. It is claimed that growing chat contributes to reducing erosion as fields are prepared and trees are planted so moisture is retained and runoff is reduced.

Table 6. *Regional forest priority areas (identified so far) in the Oromiya region.*

Name of zone	Number of forest priority areas	Total area covered (ha)
East Wellega	5	264,937

Illubabor	6	937,000
Jimma	4	343,000
West Shewa	4	162,000
East Shewa	3	9,629
North Shewa	1	Unknown
Arsi	2	69,725
Borana	5	404,348
Bale	6	573,444
West Hararghe	2	40,340
East Hararghe	5	112,937
Total	43	2,917,360
Source: Berhanu et al. (1998a).		

The wood and bush lands of Oromiya region are restricted to agro-pastoral and pastoral areas of Jimma, Illubabor, Wellega, Borana, Shewa, Bale, Hararghe and Arsi zones. They are found in a variety of forms depending on the altitude, topography, ground water level and associated vegetation types. The wood and bush lands are found on slopes, along rivers, on mountain tops and on plains and generally include various species of acacia, boswellia, commiphora, balanites, euphorbia, combretum, croton, oxythantera, *protea, erica arborea, hypericum*, poor stands of *juniperous procera* and *hagenia* (EMA 1988 cited in Berhanu et al. 1998a).

There are also man-made forests in the region including industrial and peri-urban plantations. Most of the industrial plantations are found in and around the natural forests in Arsi, Jimma, Wellega, Illubabor, Shewa and Borana zones. The main planted species include eucalyptus, cypresses, juniperous and pinus making up 53.2%, 30.8%, 5.4% and 2.3%, respectively. The remaining 8.3% is covered by other minor species (Berhanu et al. 1998a).

The mixed broad-leafed forests in the region provide almost all the lumber marketed in the whole of Ethiopia. The exploitation rate of forest resources is so high that in the last decade many of the natural forests have shrunken in size while others have degraded in terms of quality or have been converted to other land use types. Between 1989 and 1998, plantation forest areas declined by 93% in the Jalo-Muktar forest in east Hararghe and 32% in the Gara Gada forest in West Wellega (Table 7). The density of Syzygium guincense has declined drastically in West Wellega and *Cordia africanum* and *Anenjeria adolfi-friedrici,* the species very good for timber, have become endangered in the western zones of the region because of uncontrolled logging (Devendra et al. 1998).

Table 7. *Changes in forest resources in the Oromiya region, (1989 and 1998).*

No	Name of the forest	Location	Area (ha) 1989		Area (ha) 1998	
			Natural forest	Plantation forest	Natural forest	Plantation forest
1	Komto-Wacha-Tsige	East Wellega	9077	1891.1	500	1901.69
2	Konchi	East Wellega	63,000	20	2600	196.57
3	Cato-Sangi-Dagab	East Wellega	44,860	651.84	2080	1014.18
4	Jorgo-Wato	West Wellega	20,000	1338.8	1836	1234
5	Gara gada	West Wellega	137,398	1022	9600	692.5
6	Sibo-Toli-Qobo	Ilu Aba Bora	100,000	413	64,160	513
7	Babiya-Fola	Jimma	74,500	164	33,238	628.5
8	Belexe-Gera	Jimma	174,000	-	112,700	1103.5

9	Abalti-Gibe	Jimma	21,200	247	10,000	530
10	Jibat	West Shewa	12,1000	na	48,000	na
11	Cilimo-Gaji	West Shewa	22,000	na	12,000	800
12	Gedo	West Shewa	10,000	na	5000	na
13	Dire-Garbicha	East Shewa	9629	na	8603	1649
14	Arba-Gugu	Arsi	47,725	1920	34,173	3918
15	Cilalo-Galama	Arsi	22,000	3607	12,000	3867
16	Arero-Yabelo	Borana	40,000	na	8000	350
17	Bore	Borana	219,100	na	33,000	1515
18	Magada	Borana	21,000	na	15,000	1692
19	Nagele-Dawa	Borana	17,780	na	na	na
20	Anfarara-Wadara	Borana	106,568	na	7000	3700
21	Kubayu	Bale	78,444	50	73,950	300
22	Alushe-Batu	Bale	40,000	1700	28,000	1000
23	Mana-Angetu	Bale	190,000	na	120,000	200
24	Harana-Kokosa	Bale	182,000	na	132,851	135
25	Goro-Bale	Bale	100,000	na	60,000	40
26	Dindin	West Hararghe	19,000	2072.5	5700	600
27	Jalo-Muktar	West Hararghe	21,340	1459	920	95
28	Jarso-Gursum	East Hararghe	52,318	1200	0	0
29	Gara-Mul'ata	East Hararghe	7000	200	3000	304
30	Dhangago-Hawale	East Hararghe	8431	300	0	0
Grand Total			1,979,370	5231.5	431,421	6374
na: not applicable Source: Dhaba (1999).						

In recent times, felling of trees for fuel, wood and charcoal without replacement has become a serious problem contributing to the loss of vegetation and hence to increased soil erosion. The increase in the human population has reduced land holding per capita and created pressure on limited land for agricultural production. Those who cannot produce enough cut forests and trees for fuel, wood and charcoal to earn a living. For example, 22% and 33% of households in Melkedera Peasant Association (PA) in Ambo *woreda* depend occasionally and regularly, respectively, on nearby forests for their livelihood (Mirgissa 1994). Also, the removal or destruction of vegetation cover through overgrazing and bush burning etc. leads to land degradation as such practices leave soils bare and exposed to erosion and other degradation processes.

Recent estimates show that 3.1% of the natural forests is lost annually due to shifting cultivation, commercial agriculture, fuel wood collection, urbanisation, forest fires, poor utilisation and logging (Berhanu et al. 1998a). A study in Bura Adele, Berisa and Daneba Peasant Associations of Adaba Dodola district (Bale zone) shows that the annual rate of deforestation was 1.6, 9.4 and 5.6%, respectively, during the period 1993–97 (Abdurahiman 1998). Another study on the Belete and Gera forests of Jimma zone shows that the annual rate of deforestation was 9.5 and 4.7%, respectively, during 1996–98 (MoA 1998).

In rural areas in the region, woody biomass provides 70% of the energy while crop residues, animal dung, charcoal, kerosene and electricity account for 19.5%, 10% and 0.5%, respectively. In the small and medium urban centres, charcoal, kerosene and electricity provide 6.7% and 22% of energy, respectively; the remainder is provided by woody biomass and dung cakes imported from rural areas. Under 9% of the population in the region have access to electricity (Berhanu et al. 1998b). The relative importance of fuel sources varies widely across the region depending on the availability of alternative sources but in general the importance of woody biomass has been declining while that of dung and crop residues has been increasing. It is estimated that an equivalent of about 15,000 ha of forest is being lost annually in the region due to fuel needs alone (Haile-Yesus 1996). In Ada *woreda* in East Shewa, for example, lack of fuel wood induced farmers to use dung as the main source of energy instead of fertiliser. In 1983, an average household in the area used 10 kg of wood and 41 kg of dung cakes as fuel (Gryseels and Anderson 1983). With an increasing population, the situation has most likely worsened in this and similar areas.

Among other factors that contribute significantly to deforestation are property rights. Private ownership protected forests to some extent during the imperial reign (Adugna et al. 1996). The ownership right was passed to the Peasant Association during the Derg regime for management as a community resource. These forests were not only poorly managed but they were sometimes exposed to accidental fire and even reportedly set on fire deliberately which then allowed free grazing rights and free cutting of fuel wood after burning. Such practices have a negative effect on proper management of forest resources and ultimately the land is easily degraded (Asefa 1994).

Overgrazing in some parts of the region has changed grassland from a high cover perennial species to a low cover annual species, and from more palatable to less palatable species. Expansion of farmlands has not only led to forest or bush clearing and burning, but also restricted the area for overgrazing. Due to the shortage of grazing lands in many areas of the highlands, croplands are usually used for uncontrolled grazing immediately after crop harvesting. Livestock roam, feeding on weeds and grasses and creating stresses on agricultural lands. Although this practice is not entirely new or recent, the intensity and the duration of such common access grazing has apparently increased in recent times due to a feed shortage for an increasing livestock population. This kind of livestock grazing and the resulting traffic causes soil crusting and reduced infiltration which makes the vulnerable to erosion.

Cropping need not necessarily cause erosion, even on steep slopes. Perennial crops, for example, can protect the soil in the same way that the natural vegetation does. Areas in the Sidamo highlands (Uraga, Bensa, Bule etc.) show little evidence of erosion as there is good vegetation cover and perennial field crops such as enset, *chat,* coffee and fruit trees are grown. In western Oromiya region, more and more forests are cleared to open new farmlands because of rapid population growth and new settlements. Owing to the high rate of rainfall and sloping terrain, these areas are now under the threat of severe land degradation. However, because of its relatively better vegetative cover, people often underestimate the problem and hence less effort is made to control land degradation there.

In coffee growing areas, where Nitosols predominate and in other Rift Valley areas (especially around Zuway lake), vegetation loss due to termite infestation which leads to erosion has become a problem. Termites build galleries and mounds and damage buildings, crops, coffee, eucalyptus trees, pasture grasses, tree regeneration, the wood quality and the life span of large trees plus they leave the area bare. Areas devoid of their vegetation are vulnerable to soil erosion and degradation. Overgrazing and the decrease in soil fertility aggravate termite infestation and damage. For example, in West Wellega several districts have been suffering from the infestation of termites for the last twenty years but the problem has worsened in recent years (Devendra et al. 1998; EARO 2000). Manasibu, Nadjo, Jarso and Bojji districts are the worst hit. In Manasibu alone, about 66 thousand hectares of land have been taken out of production and more than 33,367 farmers have abandoned their lands due to termite damage. The problem in the above-mentioned districts is exacerbated by land degradation due to soil erosion and poor crop and livestock husbandry (ICRA 1998). The recent spread and intensification of termite damage are largely the result of changes in the balances within the agro-ecosystems following human interference, poor land use and mismanagement of natural resources. The termites have existed for a long time but the ecological changes that occurred as a result of expanding human and livestock population has promoted a change in termite survival strategy inflicting heavy damage on agricultural land.

4.1.5 Land use and management affecting erosion

Croplands and pastures are susceptible to erosion but croplands are more vulnerable because the soil is repeatedly tilled and left without a protective cover of vegetation. The socio-economic situation in rural areas often leads people to use their environment inappropriately which induces land degradation. In any area the type of land use affects the level of soil protective cover and consequently the rate of erosion and erodibility. Deforestation and the removal from the fields of dung and crop residues for fuel and feed causes a steady reduction in the organic matter content of highland soils, rendering them less productive and more easily erodible.

Fallowing has been traditionally used as a soil management and fertility restoration strategy as vegetative regrowth during fallowing helps these processes. Where there has been persistent population pressure on arable land, the length of the fallowing period has shortened over time leading to continuous cropping. For example, in Dizi catchment in Metu area, 30% of available land was under cultivation in 1957, which increased to 41% in 1982. In 1957, one year of cropping was followed by two years of fallow, while in 1982, cropping was done every other year (Solomon 1994). A survey in Agucho village in West Hararghe showed that cultivated land per capita decreased from 0.29 ha in 1983 to 0.12 ha in 1988 (Thomas 1991). Another survey in three Peasant Associations in Chiro *woreda* in West Hararghe showed that in 1995 average farm size in the lower midlands, midlands and highlands was 0.70, 0.50 and 0.40 ha, respectively, and land per capita was 0.11, 0.07 and 0.07 ha, respectively. Moreover land was more fragmented in the highlands compared to the lower midlands and midlands. A survey in Tiyo *woreda* revealed that 98% farmers wanted 2.5 ha more land to earn a good living (Gavian and Amare 1996). About 31% of the households in five PAs around Chooman dam did not have any land to cultivate (Asefa 1994). In all these cases of increased pressure on land, increased continuous cropping and a shortened or the absence of fallowing for soil management would be normally expected. When land is used more intensively without better quality inputs such as manure and fertiliser, fertility loss and erosion might be exacerbated.

Tillage operations are sometimes carried out along slopes. Furrows formed along slopes cannot slow down runoff compared to those made along contours. Production of teff, the main cereal crop in the region, requires fine land preparation to allow the small teff seeds to germinate. However, fine tillaging also makes the soil vulnerable to erosion during the early part of the main rainy season. For example, in Metu *woreda*, two test plots with teff and maize at the same slope (18%) exhibited runoff rates of 437 mm and 112 mm, respectively. On the other hand, a plot under coffee forest at a 51% slope in the same *woreda* showed only 36 mm of runoff. Over 81% of soil erosion in Chiro *woreda* has been attributed to inappropriate practices such as steep slope cultivation, runoff from surrounding fields, cattle tracks and footpaths and defective soil conservation measures (Thomas 1991). Some farmers ignore erosion because it is difficult to measure the extent of erosion visually in one storm or even in one season. The government also ignores erosion because of its insidious nature; that is, there are no major crises because the soil is gradually lost year after year.

Management of animals and their feed sources is also a major contributor to soil erosion in parts of the region. Main feed sources are savannah grasslands, bush lands, temperate pastures, fallowed farmlands, crop residues and by-products, and the aftermath of grazing cropland. In the perennial zone in the highlands, tree foliage is also a major source while in other areas it is a minor source. However, taking all these sources together, there is an estimated 24% deficit in feed supply for the current stock. Consequently there is overuse of some grazing resources leading to soil erosion, compaction and other forms of degradation (Berhanu et al. 1998b). For example, in Mekro PA in Tiyo *woreda*, 32% of PA-allocated private pastureland, 33% of rented pastureland and 52% of common/shared pastureland were rated by the community as 'poor' in terms of the quality defined by density of pasture cover, soil condition and species dominance in pasture. Since 91% of the total pasturelands are common pastureland, the overall quality of land and pasture in the community is likely to deteriorate rapidly, given present trends (Getachew 1997).

Mass movement of soil can be caused by human activity and land use change. In Oromiya region, mass movement of both solifluction (earth flow) and landslides occur in steep areas where the natural balance is upset due to the removal of root binding forces through clearing of forests and bush for cultivation on steep lands. When soils are saturated with water during periods of exceptionally heavy rain, mass movement will occur. Places like Omo Nada (Jimma), Dadar highlands (East Hararghe) and other steep areas in Oromiya are vulnerable to landslides.

4.2 Biological degradation of soil

Biological degradation refers to the process that leads to a decline in the humus content of soil through mineralisation (Solomon 1994). Decomposition of organic matter is a function of microbial activity. The majority of organic matter is concentrated near the soil surface in the form of decaying leaves and stems so erosion of topsoil results in a rapid decrease in soil organic matter levels and therefore causes a loss of food for soil micro organisms. Once the organic matter layer is depleted, soil productivity and crop yields decline because of the degraded soil structure and depletion of nutrients.

The stability of soil aggregates is dependent on microbial biomass. Thus, elimination of soil micro organisms (by erosion, burning etc.) causes physical damage to the soil ecosystem. These physical effects may in turn lead to increased erosion, organic matter depletion, and further reduction in microbial activity. All factors that favour the production and decomposition of organic matter will minimise the risk of biological degradation.

A decline in organic matter has a far-reaching effect on both chemical and physical properties of soils. It affects soil physical properties through its influence on soil structure and aggregate stability which therefore influences soil erosion. The availability of nitrogen and phosphorous is dependent on the organic matter content of the soil.

Because of the concentration of organic matter on the surface and its low density, it is one of the first to be removed by erosion and is the hardest to replace. Solomon (1994) reported that based on his study in Metu area Illubabor zone soil organic matter content dropped from 20% to 7% in less than three years of continuous cultivation due to mineralisation. In the warm humid areas the rate of mineralisation is faster than in the drier areas. However, in the western part of the region particularly in Ilubabor, Jima and parts of Wellega the turnover of biomass is better and thus the organic matter content of the cultivated soil may stabilise at 3–4%.

The rate of mineralisation is high in the absence of natural cover when topsoil is exposed to unusually extreme temperatures and humidity. Getachew (1991) showed that organic matter content increased as the length of the fallow period increased, and decreased as the cultivation period became longer. However, due to increases in pressure on cultivated land, land holdings have continuously shrunk leading to short and/or no fallow period which can lead to nutrient depletion and soil structure deterioration.

Removal of grain and crop residues from the fields, without replacement of nutrients such as manure and fertiliser, tends to deplete the soil of nutrients, as the natural replenishment cannot compensate for the nutrients removed. In large parts of Oromiya highlands fuel wood deficits were and still are mainly made up by substituting dung, grass, and straw as sources of fuel. Stalks of maize and sorghum in Hararghe are used as an energy source. This is also evident in the northern and central parts of the region. Besides home consumption, preparing and selling dung cakes has become a source of household income especially for women in rural areas. The use of dung and crop residues as household fuel rather than to maintain soil fertility and structure is likely to contribute to land degradation.

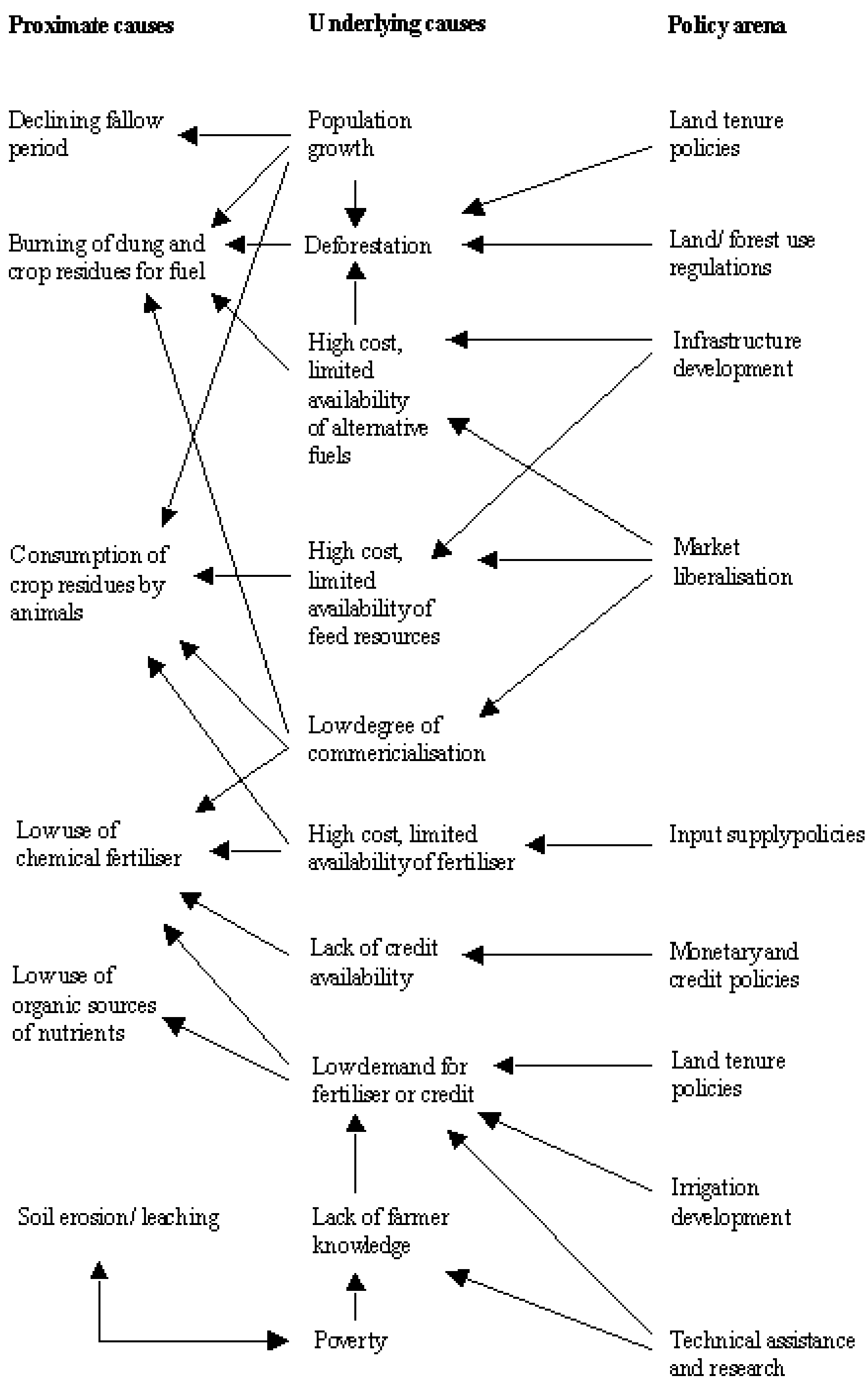
An equivalent of about 6 million G cal/year of animal dung is used for fuel in the region (Berhanu et al. 1998b). This is equivalent to about 1.5 million tonnes of dung or 14.9 thousand tonnes of nitrogenous fertiliser or about 29 thousand tonnes of urea which is the amount of urea distributed in the region in 1997. If applied at the rate of 50 kg/ha (equivalent to about 100 kg urea/ha), this amount could cover 286 thousand hectares of land. Use of dung for fuel means denying the soil of its effective conditioner and fertiliser. This practice is most pronounced in areas where forest cover has more or less disappeared and where acute fuel shortage is being felt like in East Shewa, North Shewa, West Shewa, Arsi and Bale.

In order to compensate for the lost soil nutrients, farmers in areas around 2500 m elevation (in northern Oromiya) practice *guie* (soil burning) as a traditional fertilisation practice. It increases the levels of available P and K in the soil and improves the structure of the surface horizon allowing better water movement in the plough layer at temperatures low enough to prevent drastic change in particle size and organic matter. It is widely known that yields of barley and wheat increase because of soil burning in the first few years. Nevertheless, yields continuously reduce after a few years and the land has to be fallowed thereafter. Roorda (1984) mentioned that the loss of organic matter content and dehydration of lattice clays, which lead to changes in clay mineralogy, are some of the disadvantages of soil burning. The effect of such indigenous knowledge is temporal but the farmers are doing it in the absence of a better option, for *guie* is also very labour intensive.

In western Oromiya (Wellega, Illubabor and west Shewa) animals are kept in 'dallaas', a fence-like temporary structure constructed on farmlands where animals are kraaled for systematic collection of manure to increase soil fertility. Asefa (1994), based on his socio-economic study in the Fincha'a watershed area in East Wellega, showed that 98% of the farmers interviewed use a traditional fertilisation method called *ciicata baasuu,* whereby a movable wooden barn is prepared to kraal animals and this is moved from place to place within or between plots. In other parts of Oromiya highlands, farmers generally produce blends of compost manure to increase efficiency of nutrient release for crop production.

4.3 Chemical degradation (nutrient depletion) of soil

Generally nutrients are lost through erosion in runoff and in the eroded sediment. Finer soil fractions are the most vulnerable to erosion. Nutrients, being abundant in these finer soil fractions, are also lost to erosion. Further nutrient losses occur through chemical degradation, i.e. deterioration of properties of the soil, that occur as a result of acidification and salination or sodification. The latter is common in arid and semi-arid areas where rainfall is inadequate to leach excess salts down through the profile but is not a concern in this study. The acidification process may be accelerated through burning and clearing of vegetation, continued use of acid containing fertilisers and excessive irrigation (Thomas 1997). There may be other underlying causes of chemical degradation (Figure 4). In general, soil erosion has received the most attention in Ethiopia as this is seen as the principal form of soil degradation and nutrient loss. Therefore little is known about other nutrient losses processes. For example, Pol (1992) based on a study in southern Mali, reported that loss of nitrogen by erosion accounted for 17% of total nitrogen export and the remainder is lost through other mechanisms. The relationship between soil erosion and nutrient depletion is not widely understood with respect to the Ethiopian situation. It was estimated that the highlands of Ethiopia lost about 41 kg of Nitrogen/ha from agricultural lands between 1982 and 1984 and that the projected loss would reach 47 kg Nitrogen/ha by the year 2000 (Stoorvogel et al. 1993). Other studies have reported nitrogen deficits of over 100 kg/ha per year for the Ethiopian highlands (e.g. Steinfeld et al. 1998). However, how much of these losses and deficits are due to soil erosion and how much is due to chemical degradation is unclear. In this section, some of the direct or immediate causes of chemical degradation are discussed.



Source: Fitsum et al. (1999).

Figure 4. *Causes of nutrient depletion.*

Leaching, a process of translocation of nutrients beyond the reach of crops, occurs in areas of heavy rainfall where there are lengthy periods of rain. The Soil Conservation Research Project has indicated that the highlands of Metu area (Illubabor) experienced chemical degradation due to leaching. Although no quantitative evidence is available to substantiate this, there is reason to suspect chemical degradation in areas like these. The nature of the soils, which varies from moderate to strong acidic, is an indication of leaching with more cation absorption sites being occupied by aluminium ions. This also implies potential aluminium toxicity and a decline in available nutrients. Actual aluminium toxicity, however, is not present (Hagmann 1991).

Kefeni (1992) found that the loss of nutrients from eroded soil in a 100 ha catchment area in Anjeni in the Amhara region was about 210 kg N, 680 kg P and 160 kg organic matter per hectare per year. Tadesse (1992) found that out of 1000 soil samples collected and analysed from Wellega and Assosa, 68% were classified as strongly acidic having a pH range of 4.5–5.5. At Nejo, liming of acidic soil improved yield significantly. Soils having a low pH can fix nutrients such as P, Mo and Ca thus not making them available to plants while they release Mn and Al into the soil solutions leading to toxicity in crops and animal feeds.

Nutrient depletion can be reduced, if not reversed, if adequate additional nutrients are applied to crops to replace potential losses through leaching, uptake by plants and other processes. The problems related to reduced organic manure application were highlighted earlier. Inorganic fertiliser application has been increasing slowly and Oromiya region is the largest consumer in Ethiopia utilising over 50% of the imported urea and di-ammonium phosphate. This is in a setting where the recommendations have neither been location specific nor periodically assessed for fine tuning (OESPO 1999). Fertiliser use is still not widespread and those farmers who apply inorganic fertilisers continuously to their soils to replace depleted nutrients cannot sustain high crop yields everywhere, perhaps because soil erosion exacerbates nutrient losses that are not fully compensated by current application rates.

The length of the fallow period in the cropping cycle also influences the chemical properties of soils. Continuous cultivation leads to deterioration of the essential nutrients. Getachew (1991) showed a sharp decrease in total nitrogen content of Lixisols in Dizi catchment (Illubabor zone) in the first 3 to 5 years of continuous cultivation. This is obviously connected to a decline in organic matter under the same practice.

4.4 Physical degradation of soil

Physical degradation may occur as a result of sealing, compaction, reduction in aeration and reduced permeability etc. Lack of organic matter and a high percentage of very fine sands and silt in soils are some of the factors contributing to surface sealing.

Crop production requires finely prepared seedbed with the *maresha* which affect soil structure, leave the soil devoid of vegetation exposing the latter to kinetic energy exerted from rain drops. In such cases the clods dislodge and seal soil pore spaces. A decrease in soil pore spaces reduces infiltration and increases overland flow volume and velocity, leading to soil crusting especially when it is dry.

The situation is worse when it comes to sowing fine seeds like teff (*Eragrostis tef*) which demand fine seedbeds and cattle trampling to compact the soils for better germination and weed control. A teff-seedbed preparation at Jima (where the rainfall is over 1500 mm per year) resulted in a soil loss of about 37 t/ha per year on a 9% slope (unpublished data), while the same type of soil at Holetta (rainfall above 1000 mm per year) had a soil loss of 16 t/ha year on a 6 % slope (Asrat 1992). The former is 4.5 times higher while the latter is 2 times higher than a tolerable level of soil erosion of a given field.

Overstocking and overgrazing including grazing of leftover residues on cropland after harvesting cause soil compaction due to heavy and continuous trampling by livestock. Watering points and cattle routes are particularly vulnerable to soil compaction, which leads to excessive runoff and reduced water infiltration. Revegetation in these areas is therefore impeded. Unimpeded water flowing down slopes causes rills and gullies. The bulk density of grazing land in Illubabor area was measured to be 1.34 g/cc. This is a high figure compared to 0.83, 0.79 and 1.12 g/cc for a coffee forest, ungrazed grass fallow, and crop land, respectively (Solomon 1994).

5 Bio-physical impacts of land degradation

As discussed earlier, the assessment of the extent of land degradation and its causes in Ethiopia in general remain largely theoretical and qualitative with inadequate efforts to quantify it. In fact the measurement of land degradation is an imprecise and value-laden activity and there are competing perceptions of what degradation is. For example, a forest conservator may view the scraping away of natural forests in mining areas (Laga Dambi in Borana and Youbdo in East Wellega) as degradation, while the mining authority may view the tree as a barrier to mining operations and consider its removal necessary.

Some of the more direct and intermediate impacts of various forms of degradation were mentioned in earlier sections. The immediate impact of degradation is on soil productivity leading to impacts on people's welfare. Soil degradation through erosion, nutrient loss and other processes results in undesirable physico-chemical soil properties and thereby considerably depresses crop yields. The most important factors reducing soil productivity by soil degradation are reduced soil depth (reduced root depth) and soil water storage capacity, and loss of nutrients. The reduction in soil depth can depress crop yields by reducing the amount of water that the soil can hold. Thin soils are unable to retain as much water as thick soils, and therefore exhibit lower crop yields. The effect of soil depth on crop yield is particularly pronounced during periods of drought.

Based on the findings of the Soil Conservation Research Project sites in different parts of Ethiopia, it is estimated that about 1500 million t of soil was lost from the highlands of Ethiopia every year, about 50% of the rural population were affected to some degree, and 1–2% of the country's agricultural production was lost (Hurni 1998). Adugna et al. (1996) reported a 72% yield reduction of barley in west Hararghe as a result of soil erosion over a 15-year period. Annual productivity losses on croplands in the Ethiopia highlands due to erosion are estimated to be from 0.12–2% (Kappel 1996). Since Oromiya region constitutes a greater proportion of the Ethiopian highlands, these figures would be applicable. The incidence of crop failure is repeatedly reported in areas like Hararghe, Wellega, Arsi, Bale, East Shewa and North Shewa, which have been suffering from high rates of soil erosion. It has been found that agricultural soils around the lakes in the Rift Valley are being affected by salt and aggravated with an increasing moisture deficit, leading to reduced crop productivity (Fisseha 1998).

A study indicated that on red and volcanic soils, negative impacts on crop yield commence when soil depths are reduced to 80–95 cm and that crop failures occur when soil depths are reduced to 30–45 cm (Hurni 1985). An analysis of the projected impact of soil erosion on agricultural production in Ethiopia for the period 1985–95 indicated that the annual financial costs of grain and livestock production foregone due to top soil erosion and nutrient breaches would amount to about 3.5% of the 1985 annual GDP (Sutcliffe 1997).

Reduced grazing resources and quality and productivity of grasslands and the loss of nutritious and palatable plant and grass species due to deforestation have all contributed to reduced livestock productivity. Feed shortages are a major reason for many small-holders to not keep livestock any more. Many smallholders cannot afford to maintain draught oxen for land preparation and so they rent or borrow them. However, such means of acquisition usually takes place at less than optimal ploughing times (as owners generally prefer to prepare their land before opting to sell draught power). Consequently, it is claimed that less than optimal crop productivity is achieved by farms without oxen (Cabal 2000). In Ginchi watershed in west Shewa, feed shortages compel farmers to reduce herd size and cows are usually given up, as oxen ownership for crop production remains a priority. The result is, among other things, reduced consumption of milk and milk products in the community. Similar situations may prevail in other communities.

Land degradation not only impacts crop and livestock productivity but also water resources on which welfare of human life depends. Many activities, both good and bad, have been practised in the watersheds of lakes, reservoirs, rivers and streams due to an increasing human population. As a result of extensive deforestation, overgrazing and poor crop and soil management practices in the watersheds over long periods, large sediment loads have accumulated in river channels, lakes and reservoirs. A study conducted with the help of remote-sensing techniques and direct observation to assess degradation of vegetation and gully erosion showed that on average 10% of the soil moved by water in the highlands actually ends up in rivers and thus represents a permanent loss (Wright 1984). Siltation along river valleys has led to the disappearance of once perennial streams. Although reliable hydrological data is not available to evaluate the situation, continuous reduction of the depth and volume of water in the lakes due to siltation is observed. For example, Lange Lake in East Hararghe has dried up and Lake Haro Maya in the same zone, is almost filled up with silt. About 85% of the farmers' associations in Fincha'a watershed have reportedly experienced recent famines due to a shortage of land to cultivate and they claim that siltation-induced overflow of the Chomman Lake was the cause of land shortage (Bezuayehu Tefera, personal communication).

The sediments ending up in rivers and lakes carry excess nutrients from soils, sewage, livestock and human waste, fertilisers, industrial waste, mining etc. The release and migration of nutrients and other chemicals like pesticides is an economic loss and a threat to the quality of water and life in the region. No precise estimates of these effects are yet available.

The high incidence of flooding in the downstream areas of Awash River could be due to the effect of land degradation in the upstream catchment area. Increased runoff and reduced infiltration due to land degradation contributes to the flooding problem. Streams change their course when silted up by soil erosion or from river bed erosion. Deposition of such loads along riverbanks especially during heavy floods might have led to changes in river courses and resulted in the degradation of water resources.

Increases in overland flows due to deforestation, overgrazing, excessive cultivation etc. on steep slopes reduce ground water recharge. This could be the reason why many perennial springs in the highlands of Oromiya have dried up and the existence of others is precarious. Therefore, livestock herds are forced to concentrate at a few watering points thus leading to trampling of the soil surface and formation of rills and gullies.

6 Institutional and policy factors influencing land management and land degradation

The nature and evolution of local rules and norms (institutional development) and the organisations established to make decisions about or to enforce such rules and norms (organisational development) set the context and constraints within which land management decisions are made.[3] Specific government policies or lack of them may influence the nature and evolution of institutions and organisation, and in turn impact land management and degradation. In this section, some of the institutions, organisations and policy aspects that have evolved in Ethiopia (particularly in the Oromiya region) will be discussed along with their implications for land management and degradation.

3. 'Institutions' here are defined as 'complexes of norms and behaviours that persist over time by serving collectively valued purposes', and are distinct from 'organisations', which are defined as 'structures of recognised and accepted roles' (Uphoff 1986 cited in Fitsum et al. 1999).

6.1 General government policies and programmes on agriculture

Government policies and programmes help to shape the direction of economic development of any country. Before embarking on the specific policies of development related to Oromiya region it is worthwhile to consider the national development policies adopted in the past as well as more recently in Ethiopia.

A national policy for development was established for the first time immediately after the Italian war when five-year economic development planning in three successive phases was introduced. The first five-year plan (FFYP) covered the period 1957–61 during which the policy emphasis was on the development of infrastructure and industry. The main instruments of policy included fiscal reforms, development of agricultural extension and establishment of manufacturing industries. The agricultural policy had two main objectives: to create the basis for a more dynamic long-term development of agriculture; and to take measures that would achieve a sizeable increase in agricultural production particularly of marketable crops and raw materials for industry (IGE 1957). At this stage the emphasis was more on development of commercial agriculture, so peasant agriculture received less attention. However, this plan could not be fully implemented so the result especially for agricultural development was far below expectations.

Based on the shortcomings and the experiences gained from the FFYP, the second five-year plan (SFYP) (1962–67) stressed extending cultivable areas, improvement of livestock husbandry, establishing modern large-scale agricultural undertakings and producing raw materials for processing industries. Commercialisation of agriculture was the major instrument for agricultural development. Hence, investment priorities were given to modern commercial farming and many marketing and producer co-operatives were also developed. In some places, small peasant farmers were evicted to make room for large-scale commercial farms (IGE 1962). Many institutions including the Ministry of Agriculture were established to meet the target of the plan. However, like the FFYP, this phase also faced many problems. The level of investment for agricultural development was much lower than expected and peasant agriculture was totally neglected in terms of investment allocation. Consequently, growth in productivity lagged behind population growth and the plan did not pay specific attention to natural resource management.

The Third Five Year Plan (TFYP) (1968–73) had two major policy goals: To continue to establish large-scale commercial farms to meet the growing demand for food and raw materials; and to allocate resources strategically for selected geographical areas to improve the welfare of smallholders. Many commercial farms were established and peasant eviction was continued especially in parts of Awash valley. Consequently, substantial vegetation, and hence, the ecosystems were destabilised. To achieve the desired objectives in relation to peasant agriculture, comprehensive package projects e.g. Chilalo Agricultural Development Unit, Wolaita Agricultural Development Unit and a few other similar projects were launched as instruments of rural development. The programme used model farmers to promote proven technologies. Infrastructural services (road, water etc.) were also included in the project. However, the projects were later found to be too expensive in terms of finances and manpower and could not be replicated in other parts of the country. To alleviate some of the shortcomings faced in the comprehensive package project, the minimum package project I (MPPI) was launched in 1971 under the Extension Project Implementing Department (EPID). The package comprised of provision of inputs on credit and cash, and extension advice to model farmers for demonstration of proven technologies. Since the majority of the smallholders did not own land and those that did operated the land under a different form of tenancy (see below), they did not benefit much from the project. It was found to widen income inequity as large-scale farmers benefited more than the poor farmers. Consequently, the project was phased out after the initiation of a socialist transformation of agricultural development and the reform of 1974.

Beginning in 1974, the Ethiopian economic policy was guided by a socialist ideology of public ownership of productive resources. Hence all resources including land and industrial enterprises were nationalised and turned into state property. National development plans, delineated into perspective plans of short, medium and long term national development, were drafted and implemented (ONCCP 1985). Some of the annual plans were enforced in the form of campaigns and mobilisation of scarce resources of the country. Private investment was limited and nearly absent. One of the major outcomes of the reform process especially in agriculture was the establishment of large state farms and collective farms. Little attention was given to private smallholders. The objective of establishing large state farms was to extract surplus and provide food to the urban populations and raw materials to industries as well as to promote socialist ideology. To meet these objectives institutionally, an authority or agency to deal with state farms was established which was later elevated to a ministry level. Although state farms in general occupied less than 5% of the total cultivated land in Ethiopia, they consumed almost two-thirds of the public funds allocated for agricultural development and yet a majority of the farms were operating at a loss (Gezahegn 1991).

In 1991, the transitional government declared collectivisation and villagisation as undesirable and liberalised agricultural markets. The overriding objective of the government was to attain fast, broad-based economic development. Consequently, an economic reform programme, similar to the Structural Adjustment Programme, under the auspices of the International Monetary Fund (IMF) and the World Bank was implemented. The development policy adopted since 1992 focused on introducing market-oriented economic development. The policy area covered rationalisation of the role of the state in the economy, encouraging private participation in the economy, improving mobilisation of the external economy and involving the public in economic management and devaluation of the currency. Based on the adopted macroeconomic policies, the development path was envisaged to be through a strategy of Agricultural Development Led Industrialisation. The major goal of the strategy was to bring about sustainable economic growth, regional equity, and structural transformation. As a focus of this strategy, the agricultural sector was expected to play a crucial role by providing exportable products, food, industrial raw materials, and labour, and enhance the process of industrialisation thereby creating forward and backward linkage effects. In order to achieve this objective, the government took successive policy reforms.

In spite of these policy changes, the overall structure of the economy changed very little with agriculture remaining the dominant sector with over 51% contribution to the GDP (Table 8). The share of industry in the GDP remained stagnant over the seven-year period after 1992 averaging 10.6%. The share of service sector GDP increased to 24% from an average of 20% over the seven years before 1992. The real GDP has grown at the average rate of 4.4% for the seven years after 1992. The structure of foreign trade did not show any significant change in the past few decades. Coffee is still dominating the export sector accounting for 50–60% of total exports. However, export as a percent of the GDP increased from an average of 8.7% in the last seven years of the command economy to 12% between 1990/91 and 1997/98 (Befekadu and Berhanu 2000). Gross fixed capital formation as a percent of GDP showed a significant increase after the reform, averaging 15% over the past seven years. Overall, inflation has been reasonably controlled after the reform, partly because of the improved performance of the agricultural sector and tight monetary policy.

Table 8. *Growth rate of GDP (%) and share (%) of various sectors in Ethiopia, 1991–98.*

Year	GDP growth rate	Agriculture		Industry		Distributive services		Other services		Per capita real GDP growth rate
		GDP share	Growth rate	GDP share	Growth rate	GDP share	Growth rate	GDP share	Growth rate	
1991/92	–3.7	56.5	–2.7	9	–7.0	12.1	–2.5	22.4	–5.2	–6.7
1992/93	12	53.5	6.1	10.4	28.5	13.2	22.2	23	14.2	9.0
1993/94	1.7	50	–3.7	10.9	7	13.8	6.2	24.7	9.2	–1.5
1994/95	5.4	49.7	3.4	11.2	8.1	13.9	6.4	25.2	7.7	2.3
1995/96	10.6	51.5	14.7	10.6	5.4	13.7	9	24	5.9	7.5
1996/97	5.2	50.7	3.4	10.8	6.8	14	7.7	24.5	6.7	2.1
1997/98	–0.5	45.7	–10.3	11.6	6.3	14.8	5.3	27.9	13.3	–3.5
Mean	4.4	51.2	1.6	10.6	7.9	13.6	7.8	24.5	7.4	1.3
Source: Ministry of Economic Development and Cooperation, National Income Accounts, unpublished data.										

Data on macroeconomic performance of the Oromiya region is not available. However, being the largest region in Ethiopia, it may be reasonably assumed that the economy in the region performed as well as the national economy. There is some evidence to suggest that as a result of policy changes, food production increased appreciably in the region (Table 9). Part of this increase is the result of increased fertiliser distribution (Table 10) as well as improved seed distribution, for which accurate figures could not be collected.

Table 9. *Total cultivated land and food grain production in the Oromiya region, 1995–2000.*

Year	Total cultivated area (x 10^6 ha)	Food grain production (x 10^6 t)	Yield (t/ha)
1995	4.38	4.82	1.1
1996	4.6	5.72	1.23
1997	4.68	5.73	0.79

1998	4.73	4.99	1.06
1999	4.89	5.42	1.11
2000	5.02	6.26	1.25
Note: In 1997, yield and production fell sharply due to bad weather in the middle of the planting season. Source: Oromiya Agricultural Development Bureau, unpublished data.			

Table 10. *Distribution of fertilisers in the Oromiya region, 1993–2000.*

Year	Urea (x 10^3 t)	DAP (x 10^3 t)
1993	6.5	34.1
1994	6.94	53.9
1995	14.93	88.9
1996	22.69	100.9
1997	28.6	109.3
1998	90.5	90.5
1999	397.97	96.3
2000	395.6	82.6
Source: Oromiya Agricultural Development Bureau, unpublished data.		

The second round adjustment programme was initiated between 1998 and 2000 which focused on deepening the reform process while strengthening the market-oriented economic policy. The strategy focused on rural-centred development programmes through increasing productivity of agriculture; conserving and rehabilitating natural resources; encouraging private sector participation; and expanding economic and social infrastructure. The government also adopted a food security strategy through improving agriculture by promoting a new extension programme and removal of substantial taxation from agriculture (Mulat 1999). While the strategy addresses nearly every sub-sector of agriculture in terms of investment, it failed to emphasise investment in natural resource development.

In order to effectively discharge the role of the transitional government, power was devolved and regional governments were established by proclamation No. 7/1992. The main activities of the regional governments include, among others, formulating and executing economic and social development policies and strategies, administering land and natural resources on the basis of the federal laws, determining laws, determining taxes and collecting revenues from regional sources. The main development tasks of regional governments are approval and allocation of budgets to the zonal administration. The regional governments through their different bureaus are responsible for undertaking development projects in the region.

The devolution of substantial responsibility to the regions for economic development was a major step in the process of democratisation of development and ensuring that programmes addressed the needs of the beneficiaries. Accountability for the programmes now lies with the regional councils rather than the central government. The outcome of this policy is that the technical and economic planning staff in each region are the ones ultimately deciding what programmes should be implemented, formulated in a participatory way.

The development strategy within Oromiya region was derived from the above broad national development policy. The development strategy has been developed considering the resource base of the region, which is the largest national regional state in terms of the size of its population and agricultural resources. Like the rest of Ethiopia, the majority of farmers are smallholders and are rural based.

6.2 Land tenure

Land tenure is one of the most important institutional factors affecting farmers' decisions with regard to land use and management. Such issues as tenure security, entitlement, modality of ownership or management of land, size and fragmentation of landholding, the right or ability to mortgage and transfer land by sale, lease, or bequeath etc. are therefore pertinent with regard to their impact especially on the land degradation processes in the region.

6.2.1 Land tenure during feudal era

In the past, the Oromos had their own customary tenure systems that evolved but they were introduced to different land tenure systems during the 20th century. Prior to their incorporation into the Shewan kingdom in the 19th century, as a result of Minilik's conquests, land among many Oromo communities in Shewa was a clan or lineage resource. Individuals had the right to use this resource but could not claim ownership. However, due to continuous wars, subjugation by conquerors and changes in governments following the adoption of new political doctrines, tenure systems have changed over time (Mirgissa 1994).

During the feudal period lasting until 1974 when the *Derg* came to power, the most common tenure systems in Ethiopia were the 'kinship and village', the 'private ownership', the 'nomadic' and the 'government ownership'. The kinship and village tenure system was common in the northern parts of the country while it was non-existent in Oromiya except in some areas bordering the Amhara region (Berhanu et al. 1998a).

Three general types of tenure were found in the kinship and village tenure category: *rist, gult* and village. *Rist* was the right to claim a share of land based on kinship to an ancestor held in common with other *rist* holders, where the land was subject to tribute and taxation. Briefly, the land in *rist* areas was divided into a multiplicity of geographical units originally held by a founding father. Those who could establish kinship through either parent might enter a claim to a share of the land from elders controlling the allocation of land held by what was in effect a decent corporation. Generally, the *rist* holder had the right to lease all or part of his land. Since the extended family principle extended, with few exceptions, to maternal and paternal relatives, it was common to find peasants owning land in different kinship areas. These were frequently physically separated by many kilometres—a factor increasing the tendency to lease land to others in order to reap the economic benefits (Cohen and Weintraub 1975).

Individuals holding a given parcel of land were required to pay tribute or tax to the state. However, in practice, the crown granted tribute rights over particular lands to imperial favourites, unsalaried local government officials, religious institutions, local gentry and others. These grants by the crown were called *gult*—a right to tax, which by virtue of the assignment by the crown became tribute. The *gult* right tended to be temporary; it could be withdrawn by the king and had to be reaffirmed from time to time by royal order. A recipient's loyalty and rank determined the size of *gult* land and in certain areas, the grant took on inheritable characteristics by being granted to members of the royal family or high nobility. Such land became revocable only in cases of treason or grave misconduct and was known as *riste gult*. Regardless of the size of a *gult*, from a small parish to tens of thousands of hectares, the holder or his representatives could displace the *ristegna* (i.e. the peasant cultivating the *gult* land) only if he failed to pay tribute. However, there were few controls on the amount of tribute he could extract. In general, the higher the *gult* holders status, the larger the *gult* and the fewer the controls on his administration and tribute collection (Cohen and Weintraub 1975).

The private ownership type of tenure system, where areas of land were held in freehold[4] by individuals, was dominant in central and southern Ethiopia (Shewa, Arsi, Sidamo, Wellega, Kefa, Illubabor, Gamo Gofa, Bale, Hararghe and Wollo), most of which forms the present day Oromiya region. Prior to the great territorial expansion of the late 19th century, most peasants worked land not held under private tenure. The private type of tenure system expanded more during the reign of Emperor Menilik II, during which share-cropping relationships were common (Berhanu et al.

1998a).

4. The use of the term freehold is justified by the fact that occupants' rights of permanent possession were nearly absolute. Still, it is important to note that in general, Ethiopians viewed land in terms of rights of the holder rather than possession of physical territory (Cohen and Weintraub 1975).

The private tenures were created when the crown confiscated land conquered by its armies and granted vast blocks to a wide range of people and institutions. Grants were made to soldiers and civil servants who came to administer the new areas, peasants moving south because of land pressure in the north, church officials and a host of central and provincial elites close to the crown. Local tribe, village and clan chiefs that did not resist the conquest were also given the title of *balabat* and one third of the conquered land was kept aside for them (locally termed *siso gult*) so that they would help in administrative needs and stifle opposition from the locals. Thereafter, most highland peasants worked privately-held land as either small-scale landholders or tenants (Cohen and Weintraub 1975).

The types of contracts and mode of payments between tenants and landowners varied from place to place and even from individual to individual within the same place. For instance, over 90% of the tenants in Arussi province (which corresponds to the same areas as present day Arsi zone) were share-croppers and 50% of the share-croppers paid one-quarter to one-half of their crop as rent. About 20% of the share-croppers were provided with oxen by the landlord. Only 7% of the tenants in Arussi paid rent in cash while in Illubabor province, 66% paid in cash and 25% paid as crop share (IGE 1967 and 1969a).

The church also held *gult* rights over some land, a tenure known as *semon gult*. The conquered people who lived on this land became either tenants or tribute payers. Those who farmed land granted as *gebbar* or *semon*, or land held by the government, became tenants. Those who worked land granted as *siso gult* or *rist gult* took on the appearance of tenants but were really tribute payers. This distinction became crucial with the tax reforms of 1966, which turned many tribute payers into private owners of *gebbar* tenure. Many of those who held *gebbar* tenure were absentee owners (Cohen and Weintraub 1975).

The government ownership type of land tenure was applicable to those lands which were neither communal nor private. These lands were registered under government holding and included forested areas, free grazing land and abandoned land, i.e. land for which taxes were not paid by the owners (Berhanu et al. 1998a). The basic types of government tenure were the palace land, *gebretel* land, *maderia* land and *mengist* land, the features of which are described below.

Palace tenures were named for the purpose they served, and included h*udad, weregenu* and *madbet* among others. Such land was carefully selected for fertility and used for agricultural production or the grazing of livestock intended for palace consumption. Imperial representatives known as *mislenie* oversaw this land and the tenants who worked it. Some of it was known to be used by high local government officials as a source of their household provisions. Since the details of palace land were a closely kept secret, it was almost impossible to discover its scope, but there were numerous holdings of large tracts of land, particularly in Shoa, Arussi and Hararghe provinces.

Gebretel was land taken over by the government on failure of the owner to pay land taxes. The government leased it to tenants or granted it, although the delinquent taxpayer had the option to reclaim it by paying double the tax due, unless the land had already been granted to a third party. This led to corrupt practices wherein powerful local or national elites became lessees and in the contract agreed to pay tax obligations on the land. Then, they intentionally failed to pay tax obligations; when the land was taken as Gebretel tenure by the government, the lessee had the land granted to him and used his political influence and wealth to block court action by the original lessor and owner.

Maderia was land granted to government employees in place of salary or as a pension. *Maderia* landholders did not pay land tax but paid any other tax based on the land-holding, and had the right to lease their land and keep the rental. Despite the private nature of the tenure, the land essentially belonged to the government, which retained the power to transfer it to others in case the holder terminated his contract, was convicted of a crime, or otherwise violated the conditions of his grant. The holder of this tenure could not transfer his right of possession by sale, gift or inheritance. This type of tenure had actually been evolving into *gabbar* tenure under the impact of some legislation which allowed a *maderia* holder to have up to 40 hectares of land converted to *gebbar* on payment of a registration fee in the *woreda* treasury. The balance of the non-convertible land returned to the government as *mengist* land. The *mengist* tenure in general constituted the bulk of government land in Ethiopia. This type of tenure included all land, the titles of which were registered or claimed in the name of the government. They were either vacant or leased to tenants for farming or grazing. It was from this type of tenure that many grants were made.

The pastoralist type of land tenure included the lowlands of Hararghe, Bale, Awash Valley and the lowlands bordering Sudan. The nomads who lived in these areas had well-established grazing and water use rules and regulations. Out of the lack of capacity, the feudalists had no strong control of these areas (Berhanu et al. 1998a).

Table 11 shows the incidence of different tenure types in three provinces in present day Oromiya region in the mid-1960s. In general, land tenure systems prevailing in the region during the feudal era have been characterised by specific agrarian problems with regard to such issues as utilisation, continuity and security of cultivation, rent, tribute, tax exploitation etc. For instance, owing to the ever present possibility that another kin could claim one's share of the family lands, occupants in the kinship or village tenures were often reluctant to improve their fields, which might thereby stimulate claims by others (Cohen and Weintraub 1975). There are also indications that the same was true under the private ownership type of tenure in the southern and eastern parts of Ethiopia. These tenure arrangements also gave rise to many disputes and court cases. A survey conducted in Illubabor and Bale provinces showed that inheritance was the source of disputes on agricultural land in 85% and 47% of total dispute cases, respectively. Likewise, in Kuni *woreda* court (Harar province), landlord-tenant relations and ownership issues constituted respectively 79% and 7% of total disputed cases (IGE 1969a, b and c).

Table 11. *Distribution (%) of land by tenure system and extent of absentee ownership in private tenure areas in three provinces, 1960s.*

Tenure system	Arussi	Bale	Illubabor
Gebbar	41.2	47.8	49.3
Semon	23.5	2.4	5.3
Maderia	2.6	0.1	6.4
Siso	11.7	-	15.6
Riste-Gult	3.5	-	1
Mengist	17.1	22.9	22.2
Gebretel	0.3	26.8	-
Urban	0.1	-	0.2
Total	100	100	100
Absentee owners (%)	28	15	42
Land owned by absentee owners (%)	27	12	42
Source: IGE (1967, 1969a, b).			

Because of the different origins and forms of land tenure prevailing during the feudal period, tenancy was far more common and onerous in the south than in the north of the region. Generally, the land rented to tenants rarely exceeded 10 ha and the average tenant cultivated 2–5 ha. Moreover, 10–42% of southern landlords were absentees, controlling 12–48% of the cultivated land and 27–67% of the total land (Cohen and Weintraub 1975). During the feudal period the emperor confiscated and granted land as he chose, sometimes every year or many times per year. These interferences led to disincentive in investment in land improvement (Pankhurst 1969).

Population pressure combined with the tendency of Ethiopian land tenure systems to promote fragmentation of plots resulted in a general diminution of operating units (Table 12). Fragmentation increased costs as more time was required for travelling from plot to plot, and advantage of economies of scale could not be derived. Also, small-holdings reduced access to credit, which was needed to improve land and obtain agro-technology (Cohen and Weintraub 1975). Small landholding and fragmentation may undermine farmers' interest in undertaking some types of land improvements, regardless of tenure security or private management. For example, farmers may find the costs of hauling manure or other organic materials to distant and small plots not worth the considerable effort required (Fitsum et al. 1999).

Table 12. *Average size of holding and distribution of farms by number of plots per holding in four provinces, 1960s.*

Province	Average cultivated area (ha)	Percent (%) farms by number of plots								
		1	2	3	4	5	6	7	8	Total
Arussi	1.64	26	20	23	15	8	4	2	2	100
Shoa	1.58	32	23	17	12	6	4	3	3	100
Gojjam	0.93	26	27	24	12	6	3	1	1	100
Tigre	1.02	16	25	20	16	7	6	4	6	100
Source: Cohen and Weintraub (1975).										

6.2.2 Post-feudal land tenure

After coming to power, the Derg regime undertook the agrarian reform programme in 1974, proclaimed all rural farmlands as belonging to the 'people' but was to be controlled by the government. This was largely a response to the popular discontent about the highly exploitative tenure systems prevailing in Ethiopia and large-scale eviction of tenants and smallholders following the policy of establishing large commercial farms during the third Five Year Plan (1968–73, see above). Proclamation No 31 of March 1975 abolished land lordism, tenancies, other obligations and all claims to land through paternal or maternal lines and allowed claims only on the basis of residence. The only formal way of obtaining access to land was through the PAs, the lowest administrative unit. In order for newly formed households to obtain crop or pasturelands, the PAs periodically redistributed existing lands between households based on family size, availability of land, and land quality. Land transactions between individuals, such as selling, share-cropping, and renting were outlawed. The government also established co-operatives and they were the favoured institutions for resource allocation compared to private farmers. Through villagisation and co-operative policies of the government, private forestry and hillside closure, including communal grazing resources were taken over by the state (Dessalegn 1994).

The implementation of the 1974 land policies combined with other policies caused widespread destruction of natural resources of the country and production almost stagnated in the face of a growing population. A quota system was imposed to extract marketed surplus from the peasants through the co-operatives. Consequently, in the face of political and economic pressure, the government decided to revise its policy in March 1990 and promote what was called mixed economic policy. Membership of producer co-operatives was made voluntary, use rights in land were guaranteed, tenancy and hiring of labour was permitted and grain quota was abolished. As a result many of the producer co-operatives were dissolved.

After the transitional government came to power in 1991, state ownership of land and other natural resources was retained and usufruct in land by users was granted. This was conceived primarily as a preventive measure against possible massive peasant displacement and was a safety-net instrument for the majority poor peasants. The 1994, and later the 1997, proclamations delegated power to the regional states to administer land and other natural resources and further provided the responsibilities and mechanisms of administrations of land (GPDRE 1997a). However, the responses to the proclamations regarding allocation and land redistribution and compensation from regional states were different. While the Amhara and Tigray National states have issued some form of rules and regulations regarding the distribution of land, neither allocation nor land redistribution has been undertaken in Oromiya regional state since 1991. Thus, the problem of landlessness is very serious in some parts of Oromiya region. It is estimated that close to 50% of the population is landless in some localities (Berhanu et al. 1998a), and land is becoming one of the scarcest resources in the Oromiya region. There is no allocation principle to form economic size (i.e. there are no lower and upper limits of land holdings though in previous allocations, family size basically determined the limit). Distribution of different qualities of land to individual households ensured some degree of equity and perhaps has helped farmers to distribute risks but it also led to serious fragmentation and loss of vast areas of land in the form of farm boundaries.

After the Derg implemented land reform, smallholder farmers have been acquiring crop and pasturelands in two basic ways. If they are members of the PA, they receive an official allotment of crop and pasture fields based on family size and, in some cases, herd size. If they are not PA members (i.e. formed new families after adulthood and marriage, have qualified for PA membership but could not get it so did not get land allocation due to the moratorium on land distributions) or if they are PA members who want more land due to an increased family size, then they can get land or extra land, as appropriate, only by making informal contracts with PA-member households. The major types of such informal contracts for croplands include renting, share-cropping, gifts and borrowing (Gavian and Amare 1996). Although such practices were illegal, from the point of view of a strict interpretation of the land law, they nevertheless emerged in varying degrees and forms due to land shortage and lack of official redistribution of land.

Renting and share-cropping are fairly business-like with a clearly set duration and fee. Rented fields are associated with a cash sum paid in advance by the tenant to the land-holder. The renter-tenant pays for all inputs and reaps all the benefits (or losses) of his cropping activities whereas, share-cropped fields involve a commitment by both partners to share output with or without sharing the cost of the inputs. The cost of renting and size of output to be shared from share-cropped lands varies from place to place and even within the same area depending on the quality, location and other features of land. Gift fields are given free of charge for an indefinite period or until the PA reallocates land. Borrowed fields are also given free of charge but for a defined period of time. Both gift and borrowed fields are almost always given by relatives, usually parents, who give part of their holdings to their newly married sons (Gavian and Amare 1996).

In present day Ethiopia and hence in Oromiya region, no farmer has a permanent, legally defensible claim to land and thus even the officially PA-allocated fields are somewhat insecure in the long run. For instance, in Tiyo *woreda*, 82% of the PA house-holds interviewed had experienced land distribution, with about 3.5 redistributions per household while 17% of all PA members had experienced five or more redistributions since their first allocation in the mid-1970s. Those who accessed land privately from other farmers through renting, leasing or borrowing experienced even less security. The use farmers make of land and the outcome depends on the individual's or the family's entitlement and rights, which have a direct influence on farmers' decisions on investment. For instance, most farmers in Tiyo *woreda* felt that they are able to exercise several usufruct rights and make such investments as building wells, stone bunds or permanent fences of metal or stone on PA-allocated fields (Table 13). Farmers who rented, leased or borrowed fields from other farmers, however, feel significantly more restricted in all activities, except the right to choose the crop they planted. Structural changes, fallowing and subcontracting out the land were usually not possible for these farmers (Gavian and Amare 1996). This, therefore, exemplifies the fact that tenure security has an impact on the type and level of investment to be made on land, and hence, the degree of land degradation. More specifically, the higher the security of tenure, the better the level of investment, and hence, the higher the endeavour to maintain or at best improve the condition of land. Getachew (1997), on the contrary, reported that in the same study area the mode of access to pasture fields (PA-allocated or contracted) had no effect on the field improvement measures taken by farmers, which calls for further investigation on the issue.

Table 13. *Nature of contracts for croplands in a community in the Oromiya region.*

Nature of contract	PA-allocated	Contracted
No. of years farmer has used this field	8	2
Duration of current contract (% fields)	100	100
One year	0	59
Two years	0	5
Three or more years	0	1
Indefinitely*	100	35
% fields for which user holds the following right(s):		
Plant whatever crop he/she wants	100	99
Fallow for 1 year	96	48
Fallow for more than 1 year	95	30
Plant trees	92	37
Install a well or pump	77	37
Build stone bunds	79	54
Build fence from natural materials	93	59
Build fence from stone/metal	79	38
Share out	98	48
Rent out	97	43
Lend out	96	43
Bequeath	99	42
Number of fields	166	151

* Indefinitely means until next redistribution of land, if any.
Source: Gavian and Amare (1996).

Moreover, some regulations regarding the conservation and utilisation of land and other natural resources are not clearly defined. Issues such as land administration, measurement, registration, and planning are not clearly demarcated, and hence, create a problem in implementation by different involved agencies. This creates serious problems in soil conservation and land improvement measures such as drainage, gully rehabilitation and controlled grazing (considered mainly as collective activities). Many of the community plantations were destroyed and many soil bunds previously established for conservation purposes were ploughed out. Trees were cut down to build new houses by dismantling the structures built under the villagisation programme and hillside farming was expanded without due consideration of the environment (Sutcliffe 1995). This effect is especially observed in parts of Wello, northern Shewa, southern Ethiopia and some parts of Hararghe and Bale. In the absence of appropriate land policy, population pressure, particularly in the highlands of Oromiya, induced farmers to cultivate land that should not be cultivated because of the fragile nature of their ecology or steepness of their slope. Such practices have accelerated active erosion resulting in massive degradation.

People may behave differently on common properties as opposed to private properties. At times, the communal tenure system may undermine the incentives to manage land in a sustainable manner for various reasons including the problem of free riding, breakdown of social norms, short time horizons and problems associated with carrying capacity (Olson 1965, cited in Fitsum et al. 1999). This would mean that common properties could be prone to misuse and damage. For instance, in Melkedera PA, communal grazing areas were reportedly poorly managed. As herd owners paid little attention to maintaining the grass cover, community management of resources was very weak and neither traditional nor governmental institutions appeared to have either the will or ability to induce proper management of these resources. On the other hand, farmers practised conservation measures and tree planning on privately held homesteads and croplands (Mirgissa 1994).

The consequences of land policy under the Derg and later on productivity are not yet fully assessed. Critics of this reform process mention drawbacks in terms of constraints on agricultural productivity, natural resource management, and household well-being (e.g. Gavian and Amare 1996). After examining agricultural output between 1961 and 1988, Mengisteab (1992) was, however, sceptical that the land reform resulted in any significant improvement in land use. On similar issue, Tesfaye et al. (1999), after analysing the informal land markets in Ethiopia, have indicated that households transacting land in the informal markets improved their net income and farm equity positions. Haile (1999) concluded that agricultural output would not have been higher if land distribution were not undertaken; but the margin of improvement due to land distribution was minimal.

Using data from a survey in the highlands of Oromiya, Gavian and Ehui (1999) found that total factor productivity on informally contracted plots (rented, share-cropped, borrowed) were 10–16% less than on PA-allocated plots but input intensity was higher on informally contracted plots. They thought that the lower productivity of informally contracted plots could be due to the inferior quality of inputs or lack of skills in applying them rather than a lack of incentive to allocate inputs. Therefore land tenure was perhaps not a constraint to productivity in the given context. Using the same data set, Ahmed et al. (2001) found by using a frontier production function that share-cropped and borrowed land were less technically efficient than owner-cultivated or fixed rental land due to restrictions imposed on them by landowners and the interactions of land market with other imperfect and absent input markets. On the other hand, comparing 'Marshallian' theory (unenforceable labour effort), 'New School' perspective (costlessly enforceable effort) and 'transactions cost theory' (land leasing being influenced by transaction costs of enforcing labour effort, risk pooling motives and availability of non-tradable productive inputs), Pender and Fafchamps (2001) did not find empirical support for the 'Marshallian' prediction of inefficient share-cropping, since factor intensity and output value were not significantly different on tenants' own versus share-cropped fields. They found that factor intensity differed between tenants and landlords, contradicting the 'New School' perspective but consistent with the transactions cost theory. Thus, the debate on land tenure and productivity remains unresolved and needs further investigation.

6.3 Agricultural research and extension policy

No formal agricultural research system existed in Ethiopia until 1952, except a few attempts made by Italians in Eritrea on cotton research and production. The earliest attempt in Ethiopia was in 1953 when the College of Agriculture established at Alemaya took over the national responsibility of research, training and extension. The idea emanated from the land grant college system of USA, where agricultural training, research and extension are fully integrated into one institution. The College at Alemaya established the Debre Zeit Agricultural Research Centre (DZARC) in 1955 as a satellite station to conduct research on crops addressing various agro-ecological conditions of the country. The college conducted adaptive and basic research on biological (improved varieties, breeds etc.) and agronomic practices, livestock production and to a limited extent, mechanical technologies like farm tools and implements and socio-economics. The college was successful in generating improved technologies in field crops of maize, wheat, pulses, and horticultural crops. Little research was conducted on natural resource development and chemical technologies like pesticides and herbicides.

A major structural change was undertaken in 1963 by transferring the extension wing of the college to the Ministry of Agriculture (MOA). Later in 1966, the Institute of Agricultural Research (IAR) was established by law to co-ordinate research programmes and conduct research at a national level. During 1966 to the late 1970s, IAR opened research centres in various parts of the country and streamlined research priorities for the major crops. It widened its scope to conduct research on oil seeds, pulses and cash crops including coffee and spices. The national mandate of the commodity crops research programmes was also transferred from Alemaya to IAR. The college was elevated to the university level in 1987 and mandated to conduct and co-ordinate research on pulses, durum wheat and teff through the DZARC. The IAR on the other hand was mandated to co-ordinate and lead research in many other crop and livestock areas including veterinary research, which could not be covered by the university. Limited research activities in agro-forestry existed at IAR focusing mainly on the screening of multipurpose trees. The Fish Breeding and Research Centre established in 1974, under the Fisheries Resources Development Department (FRDD) of MOA, undertook limited research and extension activities. Nevertheless, it has been unable to develop useful innovations mainly due to lack of resources.

In view of the numerous institutions conducting agricultural research to generate innovations, duplication of effort and inefficient use of the available scarce resources were common. The research endeavour in the various pubic institutions was virtually uncoordinated, and therefore, remained at large fragmented. Scarce resources were thinly spread without significant outputs. Inconsistencies and lack of long-term research programmes resulted in some cases in the pursuit of ill-defined and conflicting objectives. The absence of a clear national research policy to guide the system of governance, co-ordination, follow up, and monitoring at a regional and national level created conflict of interests and stress among the various national institutes (Goshu 1995). Consequently, most of the research programmes lacked scientific depth and continuity. Most of the research projects terminated before completion because of high turnover of qualified senior staff. This gap remained for many years to be a major drawback of the Ethiopian National Agricultural Research System (NARS). To overcome the drawback and to co-ordinate and effectively guide the research programmes in the country, the Ethiopian Agricultural Research Organization (EARO) was established by law (Proclamation No. 79) in 1997 as an autonomous organisation. EARO is expected to co-ordinate and lead the NARS as an apex body and eventually help to avoid duplication of efforts. It also aims to design mechanisms for sustainable research–extension–farmer linkages on how best existing research centres would serve on the basis of agro-ecological zonation.

In line with administrative and political decentralisation, regional research centres were also established based on agro-ecological zonation. Accordingly, the Agricultural Research Service of the Oromiya region is structured under the Oromiya Agricultural Development Bureau. There are eight regional research centres belonging to the Oromiya regional government. Most of the federal research centres are also located in the region. At this stage, there is no clear definition of the responsibilities, legal mandates and authorities of the regional and federal research institutions. Particularly, the responsibilities of the federal research centres with respect to research of interest to the region, is not well defined. Moreover, the responsibility of EARO over the regional research system is not clearly defined. The mandates of some of the regional research centres are confusing. Bako and Adamitullu regional centres, for instance, are being run under split responsibility of catering for national and regional programmes.

Historically more emphasis has been given to crop science and crop research as the 'commodity' approach has been followed in the execution of research programmes. In the 1980s, recognising the trend in the outside world, IAR and Alemaya University adopted a farming system research (FSR) approach at a pilot scale to undertake participatory research for designing and disseminating appropriate technology. However, FSR was not institutionalised as an approach so it still remains a sideline approach applied in specific donor-funded projects. However, where it has been applied, biological scientists have been able to better appreciate the need for using a multidisciplinary approach as well as incorporating farmer knowledge and perception in designing new technology. Important components such as forestry, irrigation and drainage aspects have received inadequate attention. There has been no natural resource research programme per se either in IAR/EARO or in the regional centres. Soil conservation has been looked upon as a separate issue and addressed through a special project (see below) under the MOA, though recently it has been incorporated into the regional research programmes.

Agricultural research expenditure in Ethiopia remains low (Table 14). The agricultural research intensity ratio, as measured by the proportion of the GDP spent in agricultural research for sub-saharan countries in 1981–85 was 0.5%, while during the same period that of Ethiopia remained 0.3% (Goshu 1995).

Table 14. *Agricultural research expenditure in Ethiopia (1985; million US$).*

Year	Government institutions	Academic institutions	Total
1961–65	2.888	0.658	2.946
1971–75	9.771	1.826	11.6
1981–85	19.832	2.291	22.12
1986	27.89	2.456	30.35
1987	44.033	3.098	47.13
1988	47.307	3.747	51.05
1989	41.72	4.035	45.76
1990	42.423	4.268	46.69
1991	33.058	4.747	37.81
Source: ISNAR (1993).			

A total of 340 agricultural technologies were generated by the NARS until 1994 in various fields. The highest number of technologies was generated for field crops (wheat, maize etc.) followed by horticultural crops and livestock reflecting research emphasis given to these commodities (Goshu 1995). Among the research programmes, 62.5% focused on crop production, 18% on livestock production, 7.5 on natural resources, 4% on forestry development and 7.9% on socio-economics and other issues (Table 15).

Table 15. *Number of programme/projects implemented by national agricultural research services (NARS) in different research areas.*

Research area	IAR	AUA	AAU	Total NARS	Percent (%) of total
Crop	200.4	6.8	-	230	62.5
Livestock	43.5	3.2	4.1	64.8	17.6
Forestry	-	-	-	15.2	4.1
Fisheries				1.2	0.3
Natural resources	27.1	-	-	27.5	7.6
Socio-economics and others	17	9.1	3	29.1	7.9
Total	288	19.1	7.1	367.8	100
IAR = Institute of Agricultural Research, AUA = Alemaya University of Agriculture, AAU = Addis Ababa University Source: ISNAR (1993).					

Very few of the technologies generated have reached the farmers who are the final beneficiaries. Part of the reason lies in the history of poor extension and technology transfer mechanisms. The MOA was established in 1908 with the major responsibility of guiding the overall agricultural development of the country. However, there was no formal extension programme until the establishment of the College of Agriculture at Alemaya in 1953 under the MOA with training, research and extension as its functions. The college used demonstration plots and trained farmers and school children in new technologies introduced from abroad. The technologies included new crop varieties, vegetables, exotic breeds of chicken and improved animal health practices. In 1963, the responsibility of co-ordinating the national extension service was transferred to MOA and therefore the college lost the direct research and extension linkages. At that time there were only 132 extension agents located all over the country.

Under the auspices of the MOA, the transfer of technologies continued through agricultural clubs in schools and demonstration plots. Soil conservation and afforestation were included and encouraged as part of this programme. Soon, however, inadequacy of new and proven technologies applicable in diverse situations hampered technology transfer to the wider community. With the launching of the TFYP (1968–73) and with peasant agriculture receiving more attention, comprehensive package pilot projects were launched as instruments of rural development. The programme used model farmers to promote proven technologies. Infrastructural services (road, water etc.) were also included in the project. However, the projects were found to be too expensive in terms of finance and manpower and could not be duplicated in other parts of the country.

To alleviate some of the shortcomings faced in the comprehensive package project, the minimum package project I (MPPI) was launched in 1971 under the extension project implementing department (EPID). Its characteristics and shortcomings were mentioned earlier. Minimum package project II (MPPII) was launched in 1980 by making Peasant Associations the major agent of extension service and distribution of inputs and credit. MPPII concentrated only on crop production through provisions of improved seed variety, simple farm implements, crop protection and post harvest management and credit. Development Agents (DAs) and trained model farmers demonstrated new technologies to members of the Peasant Associations. The MPPII was extended to 440 out of a total of 580 districts in the country (the majority of which are in the Oromiya region).

Towards the end of 1985 the MOA launched a new agricultural development programme with World Bank support known as Peasant Agricultural Development Project (PADEP) that used the Training and Visit extension system. PADEP divided the region into 8 zones based on agro-ecology. In the beginning, priority was given to high potential areas with surplus production through intensive extension coverage by employing more DAs and giving them monthly training. Technical staff of the extension department of the MOA and resource persons from research centres and agricultural colleges and universities were involved in the training of subject matter specialists. The training in principle emphasised current and timely application of agricultural technologies, mainly crop related, by farmers in a given season. Pre-season and quarterly training was also provided to extension agents at various training centres. After 1987, there were further reorganisations of the MOA as the zonal offices of agriculture were abolished and their role was taken over by the new regional offices of agriculture. The DAs trained contact farmers every fortnight on current and timely agricultural practices and technologies. Contact farmers in turn passed the extension advice to the rest of the farmers of the communities. In addition, batches of farmers were also trained in training centres for a period of three to six weeks. This programme, however, confronted a number of technical and financial problems. It was not cost-effective since it demanded massive human and financial resources. It was also found to be weak in addressing major problems of the farmers.

After 1991, new strategies were worked out for agricultural development as follows: introducing improved techniques of production; promoting improved seed varieties, fertiliser, pesticide and farm implements; developing irrigation techniques and schemes; undertaking an integrated and conservation-based approach to rural development; and creating a supportive policy environment mainly through security of land tenure and land use. The degree of implementation and success of this strategy vary across regions, although these strategies were worked out at the macro level. In order to implement them, MOA remained the single most important public organisation for the provision of agricultural extension service, while research (technology generation) was mostly in the hands of IAR/EARO and the academic sector. Many NGOs also participated in providing extension services. One of the most outstanding NGOs, Sasakawa Global 2000, has been active in terms of extension activity since 1993 to raise agricultural production through transfer of technology, as it is committed to undertake similar work in other countries in Africa. The project is basically an educational extension project. Its main objective is to assist small farmers in increasing agricultural production through dissemination of proven technologies in collaboration with the MOA and to strengthen the capacity of extension service of the MOA. The project uses a technology transfer model that fosters linkages between research, extension, input distribution and credit through the extension service of MOA. Today, this approach has been fully integrated into the nation wide extension programme.

The extension and input delivery system functioning in Oromiya region was derived from the national extension approaches and programmes. The principle promotes a participatory approach in which multiplicity of issues of rural life could begin to be tackled by involving all the natural resources that a community uses and all the people involved in their use. Based on the participatory approaches of extension, the federal government has decided to employ a unified system of extension throughout the country and the general principles and the methodology to be used are determined at the federal level. The execution of extension work is more the responsibility of the regional agriculture bureaux, which exercise considerable autonomy from the federal ministry. The national extension strategy is known as the Participatory Demonstration and Training–Extension System (PADETS). Building on the successful experience of the SG 2000 programme, PADETS uses a one-half hectare demonstration plot to promote a standard technical package. Empowerment, mobilisation and participation of a community are part of the declared objectives of PADETS. This approach is currently being incorporated in a project funded by the Food and Agriculture Organization of the United Nations (FAO) and The Netherlands to develop client-oriented extension (FAO 1997). Although, the programme emphasises a resource conservation strategy in its approach, in reality it is less responsive to resource management issues and mainly focuses on crop production technologies giving very little attention to agroforestry and livestock components.

6.4 Agricultural credit and fertiliser distribution

The most important inputs being distributed through the extension system are fertiliser and improved seeds. Oromiya region alone accounts for 56% of the annual fertiliser consumption in Ethiopia (NFIA 1998). Close to 90% of all fertiliser is supplied through in-kind credit. Many projects have provided credit lines in support of fertiliser use. The Development Bank of Ethiopia used to be the intermediary between the government and the disbursing projects. At the local level, co-operatives used to take responsibility for identification of borrowers and disbursement and collection of loans. With reduced emphasis on co-operatives, which provided group guarantee, and given the large accumulated arrears with co-operatives, credit delivery to small farmers became difficult. In the past four years, responsibility for small farmers credit has been extended directly to commercial banks other than the Development Bank of Ethiopia. Beginning in the 1995/96 cropping season, arrangements were made between the banks and regional governments whereby the banks provide the requested input loan to the regional administrations that are responsible for the administration of the loan especially with regard to distribution and recovery. The most important fertiliser suppliers in Oromiya region are Agricultural Input Supply Enterprise (AISE), Ethiopian Amalgamated (EAL), Dinsho Trading Co., and Fertiline. Of these four suppliers, AISE and Dinsho each has been operating in 12 zones, while EAL and Fertiline have been operating in five and two zones, respectively. This fertiliser distribution network starts from main stores and is then channelled through *woreda* sales centres and service co-operatives. The largest portion of agricultural input credit has been apparently extended to Arsi and east Showa zones, where intensive cereal production is dominant.

The volume of credit disbursed from 1994 to 1998 ranges from Ethiopian Birr (EB) 138.3 to 226 million, with the lowest being in 1994. A large portion of this was distributed in kind in the form of fertilisers and seeds. As shown in Table 10 above, from 1993 to 2000, the distribution of DAP fertiliser increased then decreased while that of urea increased very rapidly. In estimating fertiliser demand and supply, no clear approach is followed. Only a rough estimate by DAs and *woreda* offices about farmers' demands is extrapolated to assess zonal aggregate demand, and on that basis requests to higher offices are made. A similar approach is followed for improved seeds. Available credit for natural resource management technologies is limited. Moreover, timely availability of inputs, a shortage of rural based microfinance institutions and a lack of co-ordination between the existing institutions are among the shortcomings for efficient delivery of inputs and credit.

6.5 Agricultural conservation policies and programmes

Since the mid 1970s, Ethiopia has been experiencing an increasing food deficit. Land degradation, particularly soil erosion by water, is cited as a major factor in exacerbating both the long-term decline and seasonal reduction in crop production (FAO 1986). Although the Oromiya region is endowed with an abundance of natural resources,

including diversity in terms of species of plants, animals and micro-organisms, there has not been adequate attention given to their conservation and sustainable use. Alike other regional states of Ethiopia, the absence of appropriate policies, strategies, laws and regulations to promote conservation, management and sustainable use of natural resources consistent with other development policies has remained a hindrance in implementing sound measures that ensure efficiency in natural resource management and use. In addition, some policies and strategies lacked continuity and participation of stakeholders.

Prior to the 1970s, attempts at conservation in the highlands were localised and insignificant. Serious concerns on the consequences of land degradation developed after experiencing major food deficits and famine in 1974, 1984/85 and 1987/88 (Berhanu et al. 1998b), and the attention of both the government and external development organisations were drawn to resource degradation. In the mid 1970s, the establishment of PAs provided the mechanism to implement the World Food Programme co-ordinated food for work (FFW) programme, which provided the initial motivation for mobilisation of the rural labour force for conservation and development work (Constable 1985). The land conservation activities introduced through FFW included mainly physical measures such as level and graded bunds, level and graded *fanya juu*[5] and reforestation. Between 1975 and 1985, some 600 thousand km of bunds were constructed on cultivated land, some 500 thousand km of hillside terraces were constructed and 5 million tree seedlings were planted (Hurni 1988a). Other measures promoted were grass strips, alley cropping and crop rotation-all with the objective of reducing runoff and improving infiltration.

5. This is a type of terrace adapted from Kenya. In Swahili, *fanya* means throw while *juu* means up. Thus it means 'throwing up the slope' as opposed to throwing down the slope in the conventional soil bund construction. With *fanya juu,* less land is taken up by the structure and benching is faster than the conventional soil bund, but *fanya juu* requires more labour (Lakew et al. 2000).

Since soil conservation research was not institutionalised in the research system, a special Soil Conservation Research Project (SCRP) was initiated in 1981 under the MOA in collaboration with the University of Berne, Switzerland primarily to provide basic data for proper implementation of the various soil conservation efforts as well as train local staff in this field. Between 1981 and 1987, seven research units were established in different agro-ecological zones of Ethiopia. Two of them are located within the Oromiya region (one in Dizi, Illubabor and another in Hunde Lafto, west Hararghe). The projects monitored and assessed soil erosion processes and extent, some of which have been mentioned earlier. The project sites in the Oromiya region also tested the efficacy of a number of conservation measures. The results from one test site are summarised in Table 16.

Table 16. *Annual runoff, soil loss and grain yields under selected conservation methods on experimental plots in Hunde Lafto, West Hararghe zone, average of 1988 and 1989.*

Treatment	Runoff (mm)	Soil loss (t/ha)	Grain yield (t/ha)
Control (existing)	28.4	12.5	3.59
Level bund	3.8	0.01	3.86
Level *fanya juu*	2.8	0	3.79
Graded bund	31.3	5.6	2.79
Graded *fanya juu*	31	4.3	2.19
Level grass strip	8.6	3.5	3.57
Note: 1988 data on runoff, rainfall and soil loss are for August to December			

period; grain yield is for 1989 only as no data was available for 1988.
Source: Thomas (1991).

It appears that on average, runoff rates with level *fanya juu*, level bund and level grass strips were respectively 10%, 13% and 30% that of the control plot and soil losses in these three plots were respectively 0%, 0% and 28% of the control plot. On the other hand, the plots with the graded bund and graded *fanya juu* had about 10% higher runoff than the control plot but soil losses on these plots were respectively 45% and 34% that of the control plot. The highest annual soil loss (15.15 t/ha) measured on the control plot in 1989 is much higher than the estimated soil formation rate of 6–10 t/ha per year in the Hararghe Highlands—the study area (Hurni 1983). The treatments with graded *fanya juu* and graded bunds gave about 40% and 25% lower yield, respectively, compared to the other treatments including the control. However, since the yields are for one year only, definite conclusions on the relative performance cannot be made.

Although the SCRP has generated a huge amount of data on the soil degradation process and tested some interventions on experimental plots, failure to incorporate socio-economic aspects, discontinuation of funds in recent years, shortage of qualified local manpower and lack of conducive organisational setup have led to a serious decline in the research effort in soil and water conservation (Bekele and Holden 1997). In the Oromiya region, the project has been almost non-functional since 1999. Also few of the tested conservation techniques have been widely disseminated and adopted. Most of the technologies developed and applied in the past focused primarily on soil conservation rather than improving soil fertility, which may impact yield improvement directly and sooner. Technologies that could improve yield as well as conserve soil might have a higher possibility of adoption. An increasing proportion of food aid to Ethiopia has been allocated to FFW which was devised and implemented by MOA mainly in food deficit degraded parts of Wello, northern Shewa, Hararghe and southern Ethiopia as an incentive mechanism to encourage adoption of soil-water conservation measures. On the other hand the PAs organised voluntary labour for conservation activities primarily in the food non-deficit areas and this accounts for 40% of the conservation works under the FFW programme (Constable 1985). The cutting of trees by peasants was also banned. Yet these measures are said to have covered only 1% of the highlands and at this rate it would take up to 70 years to cover all the highlands.

Out of about 12 million hetare of Vertisols in Ethiopia, only about 30% are used because these productive soils suffer from poor internal drainage and result in water-logging during the rainy season. The cultivated Vertisols are ploughed before the main rains and sown towards the end of the rainy season to avoid water logging. Therefore the fields are exposed to soil erosion and crops grow on residual moisture giving low yields. In order to better use Vertisols by improving drainage, The Joint Vertisols Project (JVP)[6] developed a broadbed maker (BBM), a type of equipment made by joining two local ploughs called mareshas, which is operated by a pair of oxen to create two furrows on two sides of a 1.5 meter bed. During heavy rains, the furrows allow excess water from the bed to drain to a sub-field or main drain at the end of the plot. A suitable agronomic package (crop varieties, planting dates, and fertiliser regime) to complement the BBM has been developed. Better drainage allows early sowing, longer growing periods and higher yields as well as less erosion due to vegetative cover during the main rainy season. With the improved package, wheat yields of 2–3 t/ha were obtained compared to 0.7–1.0 t/ha under the late planted traditional system (Mohamed Saleem 1995).

6. A research consortium composed of the Ethiopian Agricultural Research Organization, Alemaya University of Agriculture, Ministry of Agriculture, International Livestock Research Institute and the International Crops Research Institute for Semi-arid Tropics. The JVP functioned from about 1987 to 2000 with partial funding initially from Swiss Development Cooperation, and later from the Government of The Netherlands.

After on-station trials, the BBM package was tested on-farm. The Sasakawa-Global 2000 along with the MOA undertook a pilot demonstration programme in 1993 throughout the highlands of Oromiya and Amhara regions. Later it was taken up by the MOA for diffusion along with other production technologies. Although the exact number of BBMs distributed so far is not known, it is generally believed that several thousand have been distributed and adopted (Jabbar et al. 1998; Gezahegn 1999).

Many NGOs started or expanded their activities in Ethiopia in response to the 1984/85 famine. At present, there are many international and national NGOs operating in different parts of the country, but only a few are directly or indirectly involved with activities related to soil conservation and management. Among the few involved in conservation activities are CARE Ethiopia (CARE), the Canadian Physician Aid and Relief (CPAR), FARM Africa, Christian Relief Service (CRS) and Agri-Service Ethiopia (ASE) (Table 17). CARE has been carrying out soil conservation activities in parts of eastern Hararghe including around Diredawa and eastern Shewa. CARE uses both FFW and other approaches in its project interventions. CRS implements different types of integrated natural resource management through its work with government counter-parts. Land Use Planning projects funded by GTZ also undertake a limited number of conservation activities including construction of check dams, bunds, hillside terraces, grass planting in gullies and soil bunds.

Table 17. *Agriculture and resource management activities in Oromiya region by some major NGOs*.

Name of NGO	Location of activities	Types of activities
CARE-Ethiopia	Eastern Hararghe (Garamuleta, Bedeno), East Shewa (Adama and Boset)	Soil conservation and fertility through FFW
Christian Relief Service (CRS)	Mainly in Tigray but also in limited areas of Shewa	Environmental stabilisation (construction of check dams, bunds, hillside terraces, grass planting in gullies and on soil bunds), establishment of nurseries, production of tree seedlings on private lands, food production, water resource development and institutional development
Canadian Physician for Aid and Relief (CPAR)	North-West Shewa-Selale and Jarso areas	Natural resource management (agroforestry, stone bunds, terraces construction, agricultural extension, food security etc.)
FARM-Africa	Southern Ethiopia, and limited works in Eastern Hararghe parts of Oromiya region	Forage for livestock, improve soil fertility, physical and biological measures of soil erosion control (mainly grass strips and multipurpose tree species)
Norwegian Church AID/Ethiopia (NCA)	Mada-Romso in Borana, Dello Mena	Fodder production, treatment of degraded areas using physical and biological measures
Agri-Service Ethiopia	Southern parts of Oromiya region (Bale), Hararghe	Soil improvement through forestry, soil and water conservation measures, forage improvement, seed production etc.

Some of the conservation measures were evaluated for their economic viability. Argay-Mensah (1985) found that an economic rate of return of about 12% over 50 years can be generated by the bunding technique taking into account on-site agricultural productivity. The non-quantified benefits of conservation in terms of reducing the severity and frequency of drought and flooding and improving the availability of water and fuel wood are even indicated to be more important than quantified benefits. Sutcliffe (1995) has evaluated, using cost–benefit analysis, the alternative forms of conservation measures. He clearly indicated that grass strips and bunds are economically feasible and the most preferred structures by the farmers because of shorter pay back periods and higher benefit–cost ratios. Berhanu (2001) found in the east Hararghe area that intensive conservation practices, e.g. bunds and terraces, were profitable and had the potential to reduce the risk of crop failure, particularly if combined with some modification to include fodder trees and legumes for livestock production.

Nevertheless, the massive interventions in building physical structures for conservation were not sustained and many structures have completely disappeared. While most of the community plantations have been misappropriated, closed areas have been encroached and state plantations have seriously degenerated. Simpler conservation options such as grass strips and *fanya juu* also have not been widely adopted. In general, most of the conservation measures did not live up to expectations. Erosion prevention was seen as an end in itself and its effects on agricultural production were overlooked. Large-scale conservation measures considered farmers as part of the problem as organising and motivating them was not easy lack of motivation by farmers and failure to consider conservation as part of the overall development programme and lack of a comprehensive policy framework on conservation of natural resources (Kebede Tato 1994). Berhanu (2001) further mentioned the following reasons for low adoption and non-sustainability of adopted techniques: local knowledge and practices were not incorporated in the design of practices and end users were not involved in the design and dissemination of the techniques; lack of land, labour and access to credit of potential users; some measures were not suitable as they harboured pests and weeds; measures were not sufficiently attractive in terms of productivity improvement.

Given the haphazard manner in which environmental and conservation issues have been handled in the past, the government decided to establish the Environmental Protection Authority in 1995. Subsequently, a comprehensive cross-sectoral policy on the environment was issued (GPDRE 1997b). In this policy, environmental sustainability is recognised in the constitution and in the national economic policy as a key prerequisite for success in achieving economic sustainability. The overall objective of this policy is to improve and enhance the quality of life of all Ethiopians and promote sustainable social and economic development through rational use of natural resources and the environment as a whole. Following the draft policy, the detailed conservation strategy of Ethiopia was prepared in five volumes (GPDRE 1997c), where the 5th volume provides a listing of projects in various areas (some are funded and being implemented and others are only proposed) with estimated costs. The actual outcome of this policy is yet to be ascertained.

6.6 Infrastructure development

Development of the transportation infrastructure is an important precondition to enhance economic development of a region. This infrastructure determines access to markets for inputs and outputs and prices received and paid, which in turn influence patterns of land use and management, technology adoption and income. It also determines access to social services such as education and health and contributes to the overall quality of life. The Oromiya region has a relatively well-established transport network (road, rail, air) compared to other regions in Ethiopia. Roads provide most of the communication links and are particularly of economic significance to the development of agriculture. There are 4394 km of all-weather roads (2102 km of asphalt surface and 2292 km of secondary gravel road) and 4354 km of rural roads that include dry-weather (seasonal) roads. The density of all-weather roads is 25 km/1000 km^2. The total all-weather roads per 1000 population is about 0.44 km where asphalt roads constitute 0.11 km, secondary gravel roads are about 0.11 km and gravel surface is about 0.22 km. Comparable density figures are 12.9 km/1000 km^2 in Tigray region and 35 km/1000 km^2 in Amhara region. However, density per 1000 population in Amhara region is 0.37 km (Fitsum et al. 1999; Lakew et al. 2000). Overall, these ratios are much lower than the African average of 50 km/100km^2 and 0.61 km/1000 population (Berhanu et al. 1998a).

Many parts of the rural areas have still remained underdeveloped and disconnected from major market centres. The major road network is mainly confined to highland sections with a high population density and comparatively higher level of urbanisation with manufacturing and business activities compared to rural areas. As a result, the main axis of the road network including the railway system passes through Addis Ababa, Metahara, through Diredawa to Djibouti. Borana and Bale zones are among the least developed (9–12 km/1000 km^2) in Oromiya region in terms of road density. Of the 180 *woredas* in Oromiya region, 146 are classified as highland (>1500 masl) and the remaining 44 as lowland (<1500 masl). Based on available secondary data, the average road density for the 146 highland *woredas* is 80 m per km^2; 74 *woredas* are classified as having low road access (below the regional average) and 72 have high road access (above the regional average). For example, some villagers in the east Wellega zone have to travel 25 km to get to the nearest all-weather road and the nearest wholesale market may be even further away (Asefa

1994).

The telecommunication infrastructure plays an important role in modern life, both as a means of daily communication and as a source of market information. However, this infrastructure is poorly developed in the country and in the region. The number of public telephones are concentrated in major towns like Addis Ababa, Jimma and Nazreth which account for nearly 70% of the infrastructure. In Uganda, mobile phones are spreading rapidly and are perhaps playing some role in market information dissemination (John Pender, personal communication). However in Ethiopia, mobile phones are accessible to a limited number people in the capital and it may take a while before it will become a major means of communication in the whole country. There are 243 postal offices in the region concentrated in Jimma, West Shewa and West Wellega zones.

Education is vital for improving life and welfare in many ways. It is also important for agricultural development as education influences modern technology adoption. The number of primary schools in the region has increased from 3203 in 1992/93 to 4294 in 1996/97 with an average annual growth rate of 5.3%. Yet primary school participation rate is still low and was only 31% in 1997–43% for males and 19% for females. Senior secondary schools have increased by 4.8% over the past three years. The same trend holds for other social services such as public health and clinics. In 1996, there was one hospital per 781 thousand people, one health centre per 310 thousand people, and one hospital bed per 9 thousand people. Clean water was accessible to only 14% of the population and only to 6.4% of the rural population. Most of the social services are concentrated in major urban areas and with respect to both quantity and quality, there are substantial zonal variations (Berhanu et al. 1998a).

6.7 Farmers' organisations, perceptions and participation

Like any other society, people in the Oromiya region have developed various local institutions and organisations serving a variety of purposes such as associations for burial, credit, social activities, dispute settlement and resource allocation and management. For example, indigenous institutions and local leadership in many communities have traditionally determined how common grazing and forest resources were to be accessed, used and maintained, and how violations would be dealt with. Although conservation did not feature prominently in the activities of these local institutions, there are examples where conservation did receive attention. One example below will illustrate the point.

An Oromo institution called Gada system incorporates land management decisions in its functioning. The Oromos have strong and influential traditional values and customs for natural resources conservation and protection. These cultural values and customs are built into the Gada system, which is a unique, quite comprehensive, and complex institution that exhibits a very rich Oromo tradition. It embraces all aspects of life including religion, politics, justice, administration, economics and a wide range of socio-cultural issues among which regulation of population growth is one (Berhanu et al. 1998a).

Gumi-Gayu, for instance, is one of the most important living experiences of the Oromo *gada* system in the pastoral areas. It has passed a number of proclamations and regulations on its assembly in 1988, which have full legal force to be observed by the members of the society. These include: the need to keep water sources in good condition; owners of wells and ponds must not accept money from users; the need for everyone to try to stop unnecessary cultivation of land; trees with value for forage and shade must not be disturbed (Coppock 1994).

Generally people are aware of the problems of land degradation and possible solutions, although at times they may not realise the long-term consequences of degradation because of their near-sightedness. For example, a survey in east Hararghe on the causes of soil erosion through time revealed the following answers: 43% mentioned floods were caused by heavy rain, 35% mentioned the absence of adequate conservation practices, 25% mentioned deforestation and the loss of vegetative cover, 20% mentioned the expansion of cultivation to unsuitable land, 12% mentioned soil fertility decline, 11% mentioned intensive cultivation with less fallow, 8% mentioned poverty and food insecurity, and 6% mentioned lack of money and labour for conservation. With respect to possible solutions: 75% mentioned the availability of yield increasing inputs e.g. fertiliser and manure, 35–40% mentioned the use of high yielding crops and high value crops, 35% mentioned that labour and cash should be available for conservation activities, and 10% mentioned that conservation structures could be made during the dry season before rains came (Berhanu 2001). These answers point to both farm and policy level constraints and opportunities in the use of conservation measures.

In many places people have developed indigenous methods of soil conservation in response to local problems and they have also developed many production technologies to make the best use of available resources for increasing production. However, traditional knowledge and institutional mechanisms and values did not receive proper attention in designing research and development agendas in terms of understanding and using them as appropriate tools and vehicles for development. For example, traditional institutions like credit and burial associations could perhaps be used to mobilise people for production and conservation related activities. Instead external interventions and influences have tended to destabilise the traditional institutions (Berhanu 2001). For example, most of the micro-finance projects currently being tried in the region and the country have basic principles (e.g. group borrowing, group security etc.) that may be commonly found in the local traditional credit institutions.

Rural peasant organisations established during the Derg era were aimed at extracting surplus food and promoting socialist ideology. Although, there were various stages and degrees of development of these co-operatives, they were often politically loaded rather than being economic units. After 1992, the government of Ethiopia issued various directives to establish co-operatives with different objectives from previous times. Based on the national directives and in accordance with regional state of Oromiya's Proclamation No. 15/1997, a total of 1615 co-operatives have been established in the Oromiya region. Nevertheless, almost all are marketing co-operatives operating in the sphere of coffee and other food processing processes. Production, improvement, natural resources conservation and management are not normally included as functions of these co-operatives.

7 Responses to land degradation and pathways of development: Some hypotheses

In the conceptual framework we argued that land degradation or conservation is an outcome of many proximate and underlying causes. The current status of land resources and its use patterns are the result of many highly inter-linked factors including natural, socio-economic, policy and those related to agricultural practices. Technologies and institutions evolve partly through people's responses to emerging problems and opportunities (indigenous technologies and institutions) and partly through the introduction of technologies and institutions generated by formal research and development efforts. People's choices of production and conservation technologies are primarily influenced by profitability or comparative advantage, which is a function of many factors. Among others, three main factors thought to determine comparative advantage are agro-ecology or agricultural potential, population pressure and market access. Moreover, resource degradation is both a cause and an effect of poverty. Where poverty is endemic, technologies that address the problem of poverty through improved productivity and have resource conservation potential are more likely to be adopted than those that address conservation alone.

Agro-ecology defines the boundary of biological production processes and options within which choices are to be made. However, human interventions through science and policy may moderate these options in the long run, e.g. investment in irrigation and pest and disease control measures may increase the choices available. Population pressure affects land and labour use intensity. Increased population pressure changes the land-to-labour ratio and increases opportunity cost of land relative to labour, leading to changes in land use intensity through reduced fallow and more frequent cropping per time period. This may also lead to degradation in resources, but at some point people may find it economic to invest in productivity improving and conservation technologies. By inducing more intensive use of land, population pressure increases productivity through better land and crop management, manure and fertiliser application, better caring and feeding of animals as well as improvement of land (Templeton and Scherr 1997). Improved market access may enhance these processes by providing opportunities to produce marketable products, particularly high value perishable commodities, promoting the use of better productive purchased inputs at less cost, and increasing access to information and technical assistance.

Agricultural potential, population density and market access may interact with each other in complex ways and evolution of production systems and intensification may depend more on the interaction among the three factors. For example, population density is generally higher in high potential areas or high market access areas as they provide better opportunities for earning a better living. Unless care is taken to maintain and improve the quality of the land resource base, increased population pressure may lead to land degradation, reducing the potential compared to the past. Market access tends to be better in high population density areas as well as in high potential areas as per capita costs of building transport facilities are lower and returns are higher (Lakew et al. 2000). Because of these interactions, within an ecozone, a higher degree of intensification may be observed as one moves from low population with low market access situations to high population with high market access situations. However, the process may not follow a simple linear path. In some situations, improved market access may induce intensification in low population density, while in another situation, population pressure may induce intensification in low market access areas.

It has been mentioned earlier that the highlands of the Oromiya region are divided into three agro-ecological zones or domains of agricultural potential: high and low potential cereal zones and the perennial zone. Population density and market access (measured by density and quality of road) vary widely within and between the domains of agricultural production. Three domains of agricultural potential and high and low levels of population density and market access gives 12 domains in the region.[7] Using *woreda* level data on population density and market access and superimposing this on the agricultural potential, each of the *woredas* in the region was classified as belonging to one of the 12 domains (Figure 5). Theoretically, each of these domains would be expected to follow specific paths in terms of choice of production systems, production and conservation technology use and input intensity. These choices would be expected to be determined by initial resource conditions, and household and community responses to changes in markets, prices and local and higher level institutions and policies.

7. Average population and all weather road densities were calculated for the highland *woredas*. Then *woredas* with above average populations were considered high density and those below the average were considered low density.

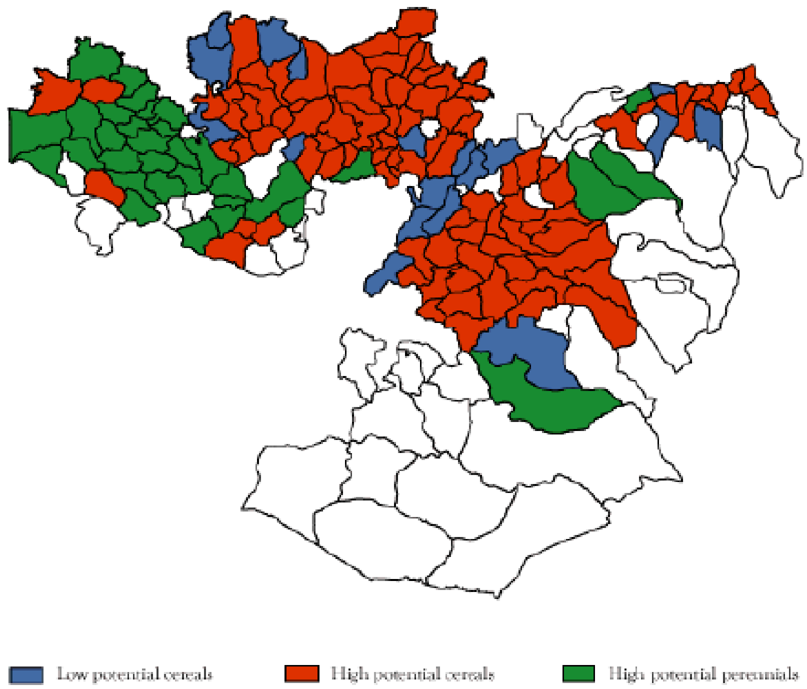


Figure 5. Woredas *in Oromia highlands classified according to agricultural potential, population density and market access.*

Some of the possible production enterprises, technologies used and input intensity levels that might emerge in the 12 domains, both as natural responses by people and through external interventions, are summarised in Table 18. For example, in high potential cereal areas with high population density and good market access, farmers would be expected to adopt high input cereal production for the market. The efforts of the government and NGOs in the region through infrastructure development, provision of inputs, extension, credit and other services would be expected to be focused in this domain to produce marketable food to achieve the region's food self-sufficiency as well as to produce surplus to export to deficit areas. Because of good market access, farmers would also be expected to adopt improved technologies to produce high value products such as dairy products and fruits and vegetables, in some cases as specialised activities. Population growth may initially lead to intensive land use without better quality inputs such as fertilisers, with deforestation and general degradation of land, but with improved market opportunities people may find it profitable to invest in land improvement measures of various kinds. Because of scarcity of land, tree planting and agro-forestry may be practised more intensively in limited homestead areas. Although land still remains a public property with farmers having usufruct rights, population pressure may induce people to move informally towards more private control of land instead of communal control, particularly in common grazing and forest land management. Plus they might develop informal local rules and norms to protect rights and exclude others from access. Such developments also might contribute to investment in land improvement for productivity enhancement and conservation. One example could be integrated soil nutrient management through the combined use of chemical fertilisers and manure. This domain might also benefit from access to health and education services more than other domains, so literacy rate and education level could be high in this domain and could be a reason for many household members to migrate to urban centres for employment opportunities and/or higher education. Population pressure might also induce some to migrate to other less populated areas for settlement.

Table 18. *Possible production and technology options and strategies for sustainable land management in the highlands of Oromiya region.*

		Agro-ecological zone

Population density	Road density			
		Low potential cereal	High potential cereal	Perennial
High	High	Low input cereals	High input cereals, pulses and oilseeds	High input coffee, tea, *chat*, enset
		Stronger crop–livestock integration	Fruits and vegetables	High input cereal
		Small ruminants and small scale poultry	Intensive dairy	Limited dairy and fattening
		Fruits and orchards	Intensive woodlot/agroforestry	Fruits and vegetables
		Root crops	Move towards private control of land, especially grazing land	Non-farm employment
		Woodlots	Soil and water conservation	Bee keeping
		Off farm employment	Soil fertility management	Agroforestry
		Soil and water conservation	Resettlement/migration	
		Soil fertility management		
	Low	Low input cereals	High input cereals, pulses and oilseeds	Low input coffee, tea, *enset*
		Stronger crop–livestock integration	Fruits and vegetables	Low input cereals
		Fruits and orchards	Limited woodlot/agroforestry	Limited livestock intensification
		Root crops	Soil and water conservation	Bee keeping
		Woodlots	Soil fertility management	Agroforestry
		Soil and water conservation Resettlement/migration		
Low	High	Low input cereals	High input cereals	Medium to low input coffee, tea, *chat*
		Livestock fattening	Fruits and vegetables	Fruits, vegetables
		Woodlots/agroforestry	Limited dairy and fattening	Dairy and fattening
		Bee keeping	Pulses and oilseeds	Woodlots/agroforestry
		Off farm employment	Limited woodlot/agroforestry	Bee keeping
		Soil fertility management	Soil and water conservation	
			Soil fertility management	
	Low	Low input cereals	High input cereals	Low input coffee, tea
		Pulses	Pulses and oilseeds	Low input cereals
		Limited livestock	Bee keeping	Livestock fattening
		Woodlots	Woodlots/agro-forestry	Woodlots/agroforestry
		Bee keeping	Soil and water conservation	Bee keeping
		Soil and water conservation	Soil fertility management	
		Soil fertility management		

NB: By high input, it is meant here that high amounts of either manure, chemical fertilisers, high yielding seeds, irrigation, labour, capital input or a combination of them will be used per unit of land as appropriate. Low input implies the opposite.

In low potential areas with high population density and high market access, subsistence food production would be a major goal. High market access may provide opportunities and incentive to invest in productivity increasing inputs, as input costs are likely to be reasonably low, leading to improved food supply for local consumption as well as sale. Root crops such as sweet potatoes and cassava are likely to be adopted as fertility levels decline. Crop–livestock integration might be strong and production enterprises might be more diversified to minimise risk. Land degradation may still be on a downward spiral though some efforts in combating the process might be in place provided extension and development agencies are promoting such technologies. Emergence of informal private control on property, particularly in grazing and forest areas, may take place though not at the same rate as in the high potential cereal areas. There may be a tendency for people to migrate to look for alternative employment opportunities.

In a low potential cereal zone with low population and market access, people would be expected to be highly subsistence oriented, as input costs to produce surplus would be high and product prices low due to limited local demand and inaccessibility to distant markets. n this case root crops may increase in importance to produce cereals due to fertility problems. Livestock may be raised on extensive grazing for cash income. Degradation of land may be an on-going process but labour scarcity may be a limitation to embark on conservation investment. Common resource management may still be a dominant phenomenon though local rules and norms might emerge to tackle relative scarcity where applicable.

In a perennial zone with high population and market access, intensive production of perennial crops for market may be the major enterprise but subject to availability of suitable land. High input cereal for subsistence and market may also be pursued. Livestock may be an important component of the farm system, particularly in enset growing areas as manure is essential for enset. Land degradation, particularly erosion, may be low to moderate in the perennial crop growing areas because of better vegetative cover but cereal growing areas may suffer from more degradation due to intensive use without adequate productive inputs. Therefore, investment in conservation may be required in cereal growing parts of the landscape. In other perennial zones with low population and market access, extensive low input production systems would be expected to prevail with more emphasis towards subsistence food production and perennial crops for the market.

These are some of the examples of what might be expected to emerge in the various domains and why. Other examples for various domains in Table 18 are self-explanatory. Since the present is the result of the past, the future has to be built on the basis of both the past and the present. It is therefore necessary to investigate if the expected land use, production and conservation practices mentioned above (and many others not mentioned above) are in place, i.e. have been emerging through natural or induced farmer response. If the production systems and associated practices have evolved or did not evolve as expected in various domains, it will be necessary to identify factors that have facilitated or provided incentives or constrained the process. Such factors could be biophysical conditions, household or community characteristics and conducive infrastructures, institutions and polices. Within the framework of this project, the recent evolution of land use, production and conservation practices and their relationships to various factors will be studied through detailed sample surveys among communities and households in representative *woredas* in the 12 domains. Once these relationships are established, it will be possible to develop suitable strategies for future development pathways for each of these domains.

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