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Land degradation and its impact in the highlands of Ethiopia: Case study in Kutaber wereda, South wollo, Ethiopia

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In Ethiopia, more than 85% of the populations are dependent on the agricultural economy. However, the productivity of that economy is being seriously eroded by unsustainable land management practices especially, the highland part of the country was highly exposed to erosion risk due to population booming, overgrazing and deforestation. This study aimed to characterize the nature and extent of land degradation and its impact on the highlands of Ethiopia specifically Kutaber woreda. Three kebeles were purposefully selected from the Kutaber woreda. From these kebeles, 150 households were randomly selected and interviewed. All data that generated from the respondents of the selected kebeles (Haroye, Barkana and Beshilo) were analyzed by using simple descriptive statistics such both qualitative and quantitative techniques. The study result showed that the average farm size of the sample households was 2.00 hectares. There was positive and statistically significant relation between family size and farmland holding significance level of 5% at and correlation coefficient of 0.280. Based on the finding of this study, it was estimated that about 250 million tons of soil was lost from the the wereda every year.

Key words: Extent, impact, land degradation, population booming, productivity

INTRODUCTION

Background

Ethiopia is located in the horn of Africa with an area of 1,127,127 Km^2, of which 7,444 Km^2 is water (CIA, 2006). About 45% of country is dominated a high plateau with chain of mountains ranges that divided by East Africa rift valley. Ethiopia has population of about 73.9 million in 2007 growing by 2.6 annually (PCC, 2008). Ethiopia is one of the largest most populated countries in Africa. The country can also be regarded as the home of important biodiversity due to its range in physiographic features with altitudes ranging from 116 meters below sea level in the Dallol to 4,620 meters above sea level on Ras Dajen. Ethiopia's economy is primary based on agriculture

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which accounts for 50% of the Gross Domestic Product (MOARD &WB, 2007). Around 83.9% of Ethiopia's population lives in rural area (PCC,2008) and depends for their wellbeing .In Ethiopia, although 60% of the total land area is estimated to be potentially suitable for agricultural production less than 15% is currently under cultivation. In spite of its vast agricultural potential, Ethiopia has been suffering in a vicious down ward cycle of land recourses degradation and poverty.

Ethiopia has a livestock population of about 31 million heads of cattle, 21.7 million of sheep, 16.7 million of goats, 7.02 million of equines, 1 million camels and 56 million poultry. This makes the country ranks first in Africa in livestock population.

Geographical regions with elevation greater than 1500meters above sea level is known as high lands where almost 90% of nation's population resides, perhaps to take advantage of its relatively disease free environment. High lands temperature varies between 16 and 30^0c.The high lands experiences over 2000mm rain fall and relatively fertile soils. This high land watersheds contribute from 60 to 80% of the water flow in the Nile River yet represents less than 10% of the land area in the Nile basin. Population growth is more sever especially in the high lands which are home to 85-95% of farm households.

Most of the agricultural potential is located in the Ethiopian high land which consist 35-40% of the land mass. The highlands are home to 90% of the population, comprising 90% of cultivated land, and 20% of the countries livestock population. Much of the country's food crop production including 75% livestock production currently takes place in the highlands and 25% in low land. A crop such as barely, teff, wheat, and beans and also cattle, sheep and goat constitutes the livestock in the high lands (Senait, 2002).

Land degradation in the Ethiopian highlands has been a concern for many years. Soil erosion, nutrient depletion and deforestation are common, but little has been done to determine their impact on productivity. Loss of arable land due to soil erosion is a widespread phenomenon in the highlands, which account for about 45% of Ethiopia's total land area and about 66% of the total land area of Amhara Region. On steep hillsides, soil losses of and exceeding 200 t/ha per year have been recorded (Kappel, 1996). The potential threat of land degradation to the country's fragile economy and food security has been emphasized by several publications (Wright, 1986; Hurni, 1998; MNREP 1994: Kappel, 1996). The threat is credible as about 90% of the population of the Amhara Region lives in the highlands and 90% of the regularly cropped land is found there.

Similarly more than 85% of the population in Kutaber wereda lives in the highland parts and share common features in topographic like other countries of Ethiopia.

Statement of the problem

Ethiopia is one of the countries in Sub-Saharan Africa that is well-endowed in terms of its natural resources including biodiversity and particularly its agricultural biodiversity. Its location in the tropics combined with wide altitudinal variations allow the country to enjoy both temperate and tropical climate and grows over wide range of crops. This gives a wealth of biophysical resources including rich biodiversity, relatively fertile soils and good fresh water resources potential. However it has been affected by multifaceted environmental problems including land degradation and declining of biodiversity (Sisay & Tesfaye, 2003).

Ethiopia is facing rapid deforestation and land degradation of land resource. Population increase have resulted in extensive forest clearing for agriculture use, over grazing and exploitation of existing forests for fuel wood, fodder and construction materials. Forest areas have been reduced from 40% a century ago to an estimated to less than 3% to day. The current rate of deforestation is estimated to 160,000 to 200,000 per year and fertile top soil is lost at an estimated rate of 1 billion cubic meter per year (FAO, 1981, UNEP, 1983) resulting in massive environmental degradation and consisting a serious threat to sustainable agriculture and forestry. All physical and economic evidence shows that loss of land resource productivity is an important problem in Kutaber wereda and that with continued population growth the problem will probably be even more important in the future.

Objectives

The overall objective of this study was to characterize the nature & extent of land degradation in the Ethiopian highlands. Specifically the study addressed the following:

- To examine the nature of land degradation
- To identify factors of land degradation
- To assess the impacts of land degradation on productivity
- To recommend possible solution of degraded land rehabilitation

MATERIALS AND METHODS

Description of the Study Area

Kutaber is one of the 21 Woredas of South Wollo Zone. It is located in South Wollo Zone of the Amhara Regional State at a distance of 401 Km from Addis Ababa. The Woreda capital is Kutaber, located on the main highway about 20 Km north of Dessie, the Zonal capital. The topography of the Woreda consists of 26.4% mountainous, 48% undulating, 13.3% plain and 12.3%

valley. The Woreda is characterized by altitude ranging from 1400-2900 meter above sea level.
The agro-ecology of the Woreda comprises Dega (temperate-highland), Woina Dega (mid-temperate- mid-highland) and Kolla (hot - lowland).

Climate

The Woreda has two cropping seasons, Belg (little crop season) and Meher (main crop season). The Belg season is from March to May. The Maher season is from June to August. The rain during the Belg season is non-consistent and inadequate. The Meher rain is almost uniform in amount and distribution. The Belg season is now widely used for land preparation and planting of sorghum and maize. The mean annual rainfall is about 650 –800 mm. But, variation does exist in amount and distribution among the three agro ecologies. Shortage of rainfall is more severe in Kolla than in other areas.

Agriculture

The main source of income in the wordea is agriculture. The farming system of the Wereda is dominantly sedentary mixed farming consisting both crop and livestock production. Due to population pressure, land holding has increasingly become smaller than ever before with current holding size of 0.25 hectare per household cropland and 0.001 hectare grazing land.

Figure 1: Barkana kebele sampled site

Figure 2: Haroye kebele sampled site

Data Sources

The data used in the study was primary and secondary sources. Group discussion with key informants and personal interview with randomly selected 150 households' generated primary data. The key informants were elderly people, peasant association leaders, development agents, and extension workers. The general situation concerning land degradation in the district were assessed based on information from the key informants using checklist prepared for the purpose. Structured interviews were made with the randomly selected family heads and their wives in case heads were males. Wives were included in the interview to obtain more reliable data on consumption pattern and expenditure of the household. Types of data collected using structured questionnaire include: household composition, religion, assets, livestock type and number, land use types, inputs and crops products, income, consumption, expenditure, farmland parcellization, labor. Enumerators were selected based on the experience they had in interviewing and the ability of speaking local language. Moreover, their knowledge of farming was also considered, as all of them were residents of the district. They were given intensive training as to how to undertake the whole process of interviewing in addition to close supervision was made.

METHODOLOGY

Selection of the Study Area

According to Yang (1965) the area in which a farming business survey is to be made depends on the particular purpose of the study (Solomon, 1996). In this study too, highland areas of three model kebeles namely Haroye, Barkana, and Beshilo were purposefully selected from the Kutaber woreda.

Sample Design

A two stage sampling technique was applied to select the sample households. At the first stage, five PAs were selected randomly among 15 Peasant Associations (PAs) found in the district. In the second stage, 150 household heads were selected randomly and proportionately from sample PAs based on the list obtained from PAs.

Methods of Data Collection

Questionnaire survey

Questionnaires were prepared and distributed to the selected agricultural experts to collect sufficient information

about the extent and nature of land degradation in the selected kebeles.

Observational study

A direct visit of the study site was carried out by visualizing the area and photos were taken.

Data Analysis

All data that generated from the respondents of the selected kebeles (Haroye, Barkana and Beshilo) were analyzed by using simple descriptive statistics such as both qualitative and quantitative techniques. Quantitative methods include percentages, graphical maps, and tabular form. Qualitative techniques were cause and effect relationships and also the data that collected from direct physical observation or visualization was analyzed by describing the phenomena using personal judgment and supported by photographs.

RESULTS AND DISCUSSION

Farm Landholding Pattern

Table 1: Average land holding pattern in the woreda

Area in hectare (ha)	Percentage (%)
0-0.5 ha	31.5
0.5-1.0 ha	33.5
1-1.50 ha	24.2
1.50-2.00 ha	8.1
>2.00 ha	2.7
Total	**100**

Source: household survey

As indicated in the table above, 31.5% of respondent households own 0.0-0.5 hectares of land. Only 2.7% of the households own more than two hectares of land.

Crop Production

The livelihood of the rural population is heavily dependent on crop and livestock production. The major food crops are teff, wheat and barley. Haricot bean, chickpea, sorghum and nug are the dominant crop grown in kolla zones while barley and wheat are grown in Dega areas. Sweet potato and onion are the major cash crops grown in the area.

Different wealth groups have varied means of livelihood. The better offs mainly depend on crop and livestock farming. The low income groups including female-headed households usually depend on sale of fuel wood, labour and relief support. Goats and Sheep are the major livestock reared in the area and are one of the major sources of income of the households. Productivity of both crop and livestock especially in Kolla area is poor due to erratic rainfall, poor soil fertility, feed shortage and other related problems.

Table 2: Major types of crops grown in the two cropping seasons of the woreda

Cropping season	Highland	Middle	Lowland
Belg season crops	Barley	Lentil	Lentil
	Lentil	Maize	Sorhum
	Potato	Pea	Maize
	Onion/garlic	-	-
Meher/main season crops	Wheat	Teff	Teff
	Barley	Barley	Nug
	Oats	Wheat	Chickpea
	Potato	Bean	Haricot bean

Source: household survey

The two crop production seasons, Belg with little rains and limited production and Meher heavy rain and main production season, have varied production levels depending on the elevation of the land. The high land and mid-top land is suitable for most of the crops throughout the year. The low lands provide crop production only during the main cropping season.

The lowland and mid altitude perennial crops/are mainly fruits - orange, ‘Zeitun ’or banana, papaya, coffee, sugarcane and vegetables such as tomato, carrot and cabbage. In the highland, Chat and eucalyptus trees are major sources of income.

Agricultural Extension Service

There is an agricultural extension service which provides technical assistance with regard to introducing modern technology and to withstand various animal and crop diseases. It was found that out of 150 interviewed households, 83.7% of the respondents confirm that they get agricultural advisory services from the Agricultural Extension Program.

Farmland Size

One of the criteria used in land redistribution among the farm households during land reform of 1975 was family size. During that time, equity was a pillar motive. According to Dessalegn (1994), this criterion aggravated population growth, which caused subdivision and diminution of farmland.

According to the group discussion made, newly married households and other landless people have no chance of obtaining land because of the prohibition of land distribution and redistribution and shortage of farmland

since 1991. These farmers usually share land with their parents and relatives during marriage and obtain land use access through land transaction systems (sharecropping and renting).

Based on the sample survey made farm size holding status of sample households of the study area in 2001 was analyzed. The study result shows that the average farm size of the sample households was 2.00 hectares. There was considerable variation in land holding among the sample households with coefficient of variation of 50.7%.

Average farmland holding was also calculated for different age groups. The highest average farmland holding 2.5 hectares was owned by households of age group of 56-66 years, followed by age group of 45-55 years with average holdings of 2.02 hectares, the last age group above 77 years owned average farm holding of 1.42 hectares (Table 3). The younger farmers and the older farmers have lesser land holding than the middle aged.

Table 3: Average land holding by age group of household heads

Age group (years)	Average land holding (hectare)
23-33	1.86
34-44	1.90
45-55	2.02
56-66	2.5
67-77	1. 77
Above 77	1.42

Source: Sampled Survey

There was positive and statistically significant relation between family size and farmland holding (significance level of 5% at and correlation coefficient of 0.280). Therefore, farm size increases as farm family size increases. Neither family size nor farmland holding size is significantly correlated with age of household head. The farmland holding analyzed above was not totally used in crop production. It includes cultivated and fallow lands. However, the income obtained from crop farming depends on area of land covered with crops. The study result shows that average land holding covered with crops during the study year by the sample households was 1.70 hectares. There was considerable variation among households in size of operated land holdings as shown with coefficient of variation of 54%.

Factors of land degradation in the study areas

The proportion of land area covered by forest in the Woreda is about 9 %, which is more than the national average. The community has better traditional experience in the conservation of forest lands. Environment is one of the national developmental concerns and is being given due attention at all levels. Target setting for safe water and the concern for the forest protection is a good opportunity that drives to achieving MDG 7. The amount of fuel wood consumption among the surveyed households ranged from 5 kg (for those who depend entirely on cattle dung) to 5,000 kg per year, which is the largest number of households consumption for domestic purpose. The average consumption was 2502.5 kg of fuel wood. Based on fuel consumption norms obtained from detailed household surveys, it is estimated that, fuel wood required in the domestic sector (for cooking and heating) of the District was 9560.3 kg of solid wood/year.
Land degradation in the study site was triggered by complex processes of natural, socioeconomic and institutional factors. So, the main causes can be categorized as natural and human induced.

Natural Causes

High intensity of rainfall, type of soil, topography is the major natural causes of land degradation in the study area. In addition some aspects of the environmental degradation are caused by natural factors such as drought and landslide.

Human induced causes

The manmade land degradation includes production on steep slopes and fragile soils with inadequate investment in soil conservation or vegetation cover, declining use of fallow, limited recycling of dung and crop residues to the soil, limited application of external source of plant nutrient, deforestation and overgrazing. The cause also includes proximate causes such as population pressure, poverty, high costs of and limited access to agricultural inputs and credits, low profitability of agricultural production, farmers' lack of information about alternative technology. Moreover, in order to survive in subsistence economy, farmers are forced to mine soil and to cut down trees leading to land degradation (Hurni.H.1998).

Socioeconomic and institutional factors are the underlying causes that affect land degradation through their impacts on farmers' decisions with respect to land use and land management practices. For example absence of a comprehensive land use and administration policy, proclamations, laws, regulations and master land use plans developed in a participatory at federal, regional, and community level are the major factors that have contribute to the unchecked land degradation in the country.

Dung Fuel

Dung represents the second largest source of domestic energy in the study area. It ranges from zero kg to 2580 kg/household/year. Mekonnen (2009) who put the national average at 9.3%. The use of dung as fuel among the surveyed households was an average of 1290 kg/year.

A variation was observed in the annual dung consumption among income groups. This can be attributed to differences in number of cattle, availability of fuel wood and availability of dung itself in communal fields. Where the average number of cattle owned by households is high, the use of dung is also high. However, the differences between the three economic groups were significantly varied. The demand for animal dung in the District was increase from rich to poor households. The average dung fuel consumption of different wealth groups were 577kg, 856.4kg and 950 kg for rich, medium and poor households.

Table 4: Annual dung (in kg) use in Kutaber District (n=150).

Dung use (kg)	Rich		Medium		Poor	
	Frequency	% of Households	Frequency	% of Households	Frequency	% of Households
<1095	8	72.7	8	57.1	8	38.1
1096-1460	2	18.2	4	28.2	7	33.3
1461-3285	1	9.1	2	14.6	6	28.6
Total	11	100	14	100	21	100

Source: household survey

Farmers are well aware of the value of dung as a soil conditioner; however, their principal reason for using dung as fuel source is the existing short supply of fuel wood (84% of respondents). Other reasons included the difficulty of spreading dung over fields (8.1%) and no other alternative sources (7.9%). As fuel wood gets scarcer, households forced to choice more animal dung as a fuel. In rural areas, animal dung is used as compost but due to the above reason the farmers didn't use it. This in turn leads to decreasing of soil fertility.

Impact of land degradation in the study area

The net soil loss from erosion, as reviewed by Kappel (1996), is estimated to range from 20 to 100 t/ha per year, with an annual productivity loss on cropland of 0.1% to 2% of total production for the country. Commenting on the wide variation of the estimates, Kappel (1996) argued that the economic implications of soil erosion in Ethiopia are neither as catastrophic as commonly believed nor negligible. With the same fashion production decreased by 0.5- 2% in the wereda due to nutrient depletion.

Land degradation has caused economic and environmental impacts. These impacts can also have a significant adverse effect on the population and can harm national, regional and global development**.**

The immediate impact of land degradation is on soil productivity leading to impacts on people's welfare. Soil degradation through erosion, nutrient loss results in undesirable physio-chemical soil properties and there by considerably depresses crop yield. The most important factors reducing soil productivity by soil degradation are reduced soil depth and soil water storage capacity and losses of nutrient.

Based on the finding of this study, it is estimated that about 250 million of soil was lost from the the wereda every year. About 50% of the rural population was affected to some degree and 1-2% of the county's agricultural production was lost (Hurni, 1998).

Annual productivity losses on crop lands in the wereda due to erosion is estimated to be 0.12-2% (Kappal,1996).Reduced grazing land resources , quality and the loss of nutritious and palatable plants and grass due to deforestation have all contributed reduced livestock productivity.

Land degradation has also an effect on climate change by reducing carbon sequestration and increasing accumulation of greenhouse gases in the atmosphere through deforestation and soil erosion. It also can cause loss of bio diversity, ecosystem services which are difficult to measure as they are not normally given monetary value or bought or sold and thus are poorly reflected in estimate of losses. Large areas of the wereda covered by the forest were cleared for fire wood and charcoal production and thin in turn facilitate land degradation.

CONCLUSION

Land degradation is a complex phenomenon influenced by natural, social and economic factors. It generally refers to the loss of the land's biological and or economic productivity. Land degradation remains an important global priority issue for the 21st century requiring renewed attention by individuals, communities, and governments because of its adverse impact on agricultural productivity and the environment, and its effect on food security and quality of life. The land degradation process appears particularly severe in developing countries, which has significant implications for climate change mitigation and adaptation. This is because the loss of biomass and soil organic matter releases carbon into the atmosphere and affects the quality of soil and its ability to hold water and nutrients.

The study wereda is affected by deforestation and degraded soils, which have eroded the resource base and aggravated the repeated food shortages caused by drought. Based on estimates of the severity & extent of erosion this study concluded that land degradation particularly in the form of soil degradation and erosion, nutrients depletion and deforestation are sever particularly Barkana and Haroye Kebele.

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