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Farmers' Perception on Indicators, Causes and Consequences of Soil Erosion in Soro District, Southern Ethiopia

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Abstract

In Ethiopia, soil erosion is a major contributor to the prevailing food insecurity. As a result, the soil becomes unable to support intensive food production to satisfy the rapidly growing demands of people. The main objective of this study is to evaluate the farmers' perception on indicators, causes and consequences of soil erosion in Soro District, Southern Ethiopia. The data for this study was collected via interviews with key informants, questionnaire dissemination and field observation. Sample households were selected from the available list randomly. The criterion to select sample households was wealth status of farmers that includes landholding and length of food secured months. Farmers perceive indicators of the existence of erosion and soil fertility loss differently. For many farmers, gully development and stoniness of soil were main indicators to soil erosion. Others recognize by observing soil colour. The steepness of farmland and ceaseless cultivation without the period of fallowing are perceived as two major causes of soil erosion. Apart from these, other causes also have been identified. Severity of soil erosion is categorised as severe, moderate, and minor respectively. When the land becomes rock outcropped, perceptibly there would be shortage of cultivable and grazing land. Severe soil erosion results on loss of fertile topsoil, low productivity, and loss of farmland.

Key words: *Soil Erosion, Indicators, Causes and Consequences, Soro District, Ethiopia*

Introduction

Ethiopia is one of the most densely populated countries in Africa with over 90 per cent of its people deriving their income from agriculture and natural resource (Bekele and Holden, 1998). In the world, about 80 per cent of agricultural land is suffering from moderate to severe soil erosion, and 10 per cent suffers slight to moderate erosion (Pimentel et al., 1995). Ethiopia is not an exceptional; it is facing severe and continuous soil erosion. It is one of the third world countries affected by soil erosion severely and is one of the most environmentally troubled countries in sub-Saharan Africa (Fitsum et al., 2002). Soil erosion is found as a root cause of land degradation and the most dangerous ecological process in the country (Ludi, 2004). The same study states that in Ethiopia the impact of soil erosion was recognized after the famine that occurred in the country in the year 1973. However, in Ethiopia, land degradation, low and declining agricultural productivity and poverty are severe and interrelated insecurities that totally appear to feed off each other, as well still going on. Studies uncover that in Ethiopia, erosion

averages 42 metric tons per hectare per year on currently cultivated lands and 70 metric tonnes per hectare per year on formerly cultivated degraded lands (Hurni, 1988). About 45 per cent of the total annual soil loss in the country occurs from cultivated fields, which accounts for only 15.3 per cent of the total area (EPA, 2003). Vast areas of the highlands of Ethiopia could be classified as suffering from severe to moderate soil degradation (Bekele and Holden, 1998). The latest land degradation estimates indicate that out of the 52 million hectares of land making up the highlands of Ethiopia, 26.9 per cent are severely degraded, 25 per cent are moderately degraded and 3.9 per cent have nearly lost the minimum soil cover needed to produce crops (DCI, 1997). Astonishingly, Ethiopia loses annually 1.5 billion metric tons of topsoil from highlands by erosion (Girma, 2001). According to Brown and Wolf (1984), the loss of topsoil affects the ability of land to grow food crop in some ways. It reduces the inherent productivity of land, both through the loss of nutrients and degradation of the physical structure. As to this study the apparent increase in soil erosion over the past generation is not the result of a decline in the skills of farmers but rather the result of the pressures on farmers to produce more. Farming system mostly used in highlands of Ethiopia like cultivation of teff and wheat which require fine tilled seed bed and single cropping of fields encouraged soil erosion (Belay, 1992; Woldeamlak, 2003).

Hadiya zone is one of the thirteen zones of the Southern Nations, Nationalities, and People's Region (SNNPR) of Ethiopia. A large part of the zone's land is exposed to severe soil erosion, land fragmentation, deforestation and land pressure. As a result, the soil is not capable to satisfy the rapidly growing demands of the people. The Soro district has been exploited and degraded continuously. Thus, majority of rural inhabitants are suffering from food insecurity, due to that the soil is incapable to support cultivation caused by soil erosion and its related problems. In the area, erosion problems and measures to tackle were rarely investigated.

Objective

The main objective of this study is to evaluate farmers' perception on indicators, causes and extent of soil erosion in Soro District, Southern Ethiopia.

Study Area

Hadiya zone is located in South-central part of Ethiopia and topographically contains mountains, hills and plains. Soro is one of 10 districts in Hadiya zone which is located at 7°30'-7° 43' N Latitude and 37°35'-38° 05' E Longitude (Figure1), in the Southern-tip of the zone. With highest proportion of area coverage of 57,141 hectares; 35 per cent is flat and 65 per cent is moderately sloping and steeping lands. Altitude ranges from 840m to 2850m above mean sea level. The mean annual rainfall is about 1260mm with average temperature of 19°C.

The wide diversity in climate, topography and vegetation cover in the area has given rise to marked variations in soils, even within relatively small area, yet not detailed soil surveys have been carried out in the district.

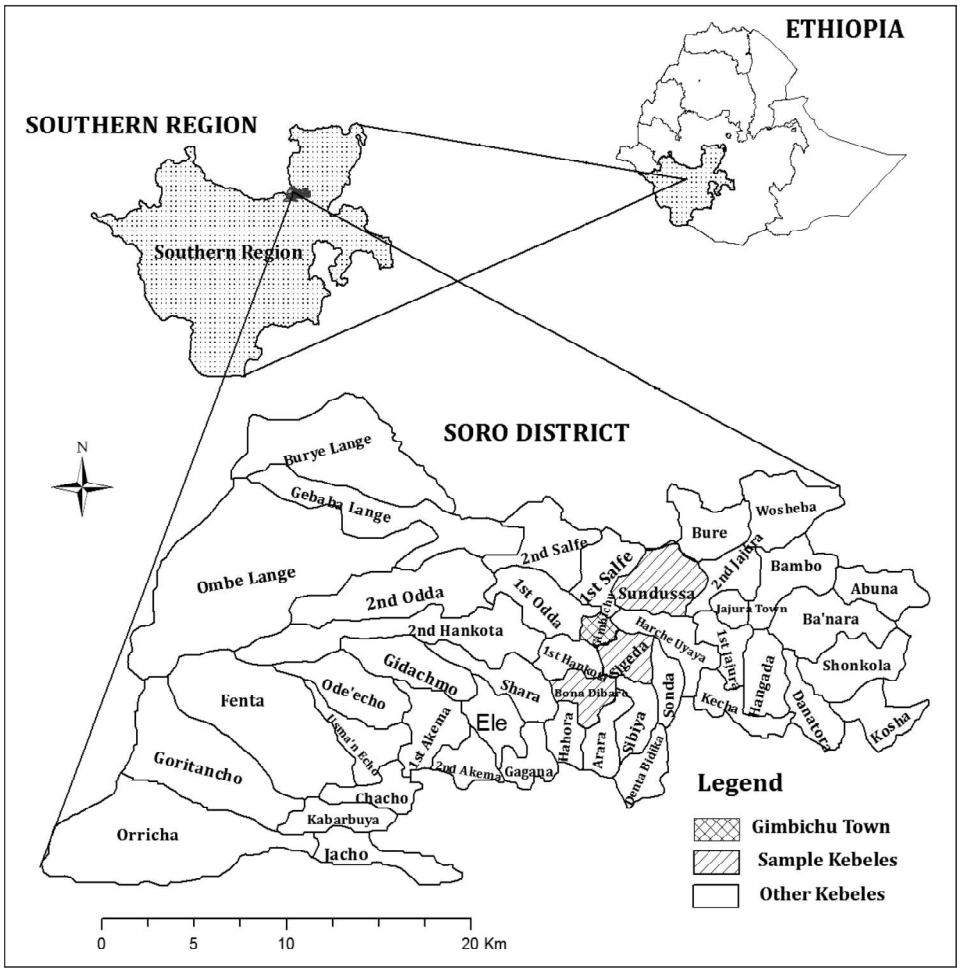

Fig.1: Location Map of the Study Area (Soro District, Southern Ethiopia)

As farmers' classification, the dominant soil types are red-brown to red clayey soils on undulating land to steeping lands including the rolling plateau. The soils of this area are highly susceptible to erosion with gradually declining productivity. Farming is exclusively rain-fed and is dependent on weather conditions. This area has an old history of land use with high erosion damages, especially with increasing slopes. As the remnants of tree species (scattered here and there) depict the area has once been covered by dense forest. The landholding of farmers in the study area is very small, as in most of the highlands of the country. Landholding among households varies significantly where the household per capita landholding being 0.10 ha. Minimum and maximum size of landholding were 0.12 ha and 5.70 ha, the average being 0.85 ha. The per capita landholding of the study area is by far less than what was reported even for the year 2015 by International Union for Conservation of Nature (IUCN, 1990).

The population of Soro District was 217452 by the 2009/10, of which male accounts 109181 and females were 108271 (CSA, 2009). The four largest ethnic groups

reported in Soro were the Hadiya (89.57 per cent), the Kembata (1.67 per cent), the Timbaro (1.49 per cent), and the Amhara (1.23 per cent); and all other ethnic groups made up 6.04 per cent of the population.

Materials and Methodology

The research design was mainly descriptive method. Data for this study was captured from two sources: primary and secondary sources. Although farmers were main source of data, additional data was collected from field observation, focus group discussion, interviews with other informants. Zonal and district agricultural experts, Kebele administrators, soil and water conservation supervisors and Development Agents (DAs) provided primary information. In addition, secondary sources of information also have been used for this study.

Soro district is divided into 46 kebeles (peasant associations). Two-stage sampling technique was employed to select sample farmers. In the first stage, three (3) peasant associations (kebeles) were selected as study samples. Selection was made through the use of topography/slope, adjacency/neighbourhood, erosion severity (rough estimation made by district agricultural office) and implementation of soil conservation practices as criteria. In the second stage, sample households from three kebeles were selected from the available list randomly. The criterion to select sample households was wealth status of farmers that includes landholding measured in hectare (Table 1) and length of food secured months measured in month (1,2,3, and 4 are labelled as food security level as less than 3 months, from 3 months to 5 months, 5 months to 8 months, and above 8 months, respectively).

Table 1: Distribution of Study Samples by Kebele and Landholdings in hectare

Kebeles	Land size (in Hectares)	Number of Farmers	Sample Size	%
Sigeda	<0.5	169	10	
	0.5 ha-1.0	151	9	
	1.0 ha-1.5	89	4	
	1.5 ha-2.0	24	2	
	>2.0	10	1	
	Total	443	26	5.9
Bonadibaro	<0.5	183	11	
	0.5 ha-1.0	162	9	
	1.0 ha-1.5	96	4	
	1.5 ha-2.0	39	2	
	>2.0	31	2	
	Total	511	28	5.5

Sundusa	<0.5	230	11	
	0.5 ha-1.0	171	9	
	1.0 ha-1.5	119	5	
	1.5 ha-2.0	49	3	
	>2.0	31	2	
	Total	600	30	5.0
Total		1554	84	5.5

In order to collect relevant data, critical field observation, structured interviews, and focus group discussion were employed as instruments/tools of data gathering. Field observation was started while writing the proposal and continued onto the whole process of data collection to make sure the validity of acquired information. Largely used instrument for data collection was structured interview with carefully constructed questions. Based on information acquired from informal discussion with farmers and field observation, and from literatures reading; structured questionnaire was developed for randomly selected 84 household heads. Focus group discussion was conducted in all three kebeles with 27 selected farmers. Two ways of communication was conducted between farmers and interviewers in order to make the process of data collection more effective. In this way, farmers could also ask questions on problems of soil erosion.

Both qualitative and quantitative methods were used in order to analyse collected data. The findings of the study were presented in tables, figures and charts. Some structured household survey data were analysed using percentages, multiple response (frequency and cross tabulation), and descriptive statistics (frequency and cross tabulation) using the Statistical Package for Social Sciences (SPSS) for Windows 17.0.

Results and Discussions

Basic Demographic and Socio-economic Characteristics of Sample respondents

Of sample respondents, 83 per cent households were male headed, but the remaining 17 per cent households were female headed. Out of the sample household heads, 48.8 per cent were illiterate (cannot read and write), 28.6 per cent can read and write (attended elementary or junior school), 14.3 per cent attended secondary school (9-10) and the remaining 8.3 per cent completed grade 12. The minimum and maximum sizes of households were 2 and 25 respectively, the average being 8.2 members. This is the same to the average of the district, but by far greater than 5.7 that have been reported for Hadiya Zone by Central Agricultural Census Commission (CACC) in 2003.

Indicators, Causes, Extent and Consequences of Soil Erosion

Indicators of existence of soil erosion:

Directly to create link to indicators of soil erosion, farmers were managed to explain their farmland problems, which considered

as related issue. They tried to mention insufficient cultivable land, declining soil fertility, and severity of soil erosion as major problems they currently face.

Majority of the farmers (97.6 per cent) have insufficient cultivable land to support their households. Farmers perceive rapid population growth, land degradation by severe soil erosion, and expansion of town to nearby farmland as root causes to the scarcity of arable land. Thus, about 30.0 per cent of farmers confirmed that rapid population growth brought high demand for farmland and that in turn resulted on fragmentation of existing land into household members. 28.0 per cent of the farmers stated that land degradation (loss of fertile soil due to erosion) was the main cause for the scarcity of cultivable land, yet 6.0 per cent of them lost their land due to the expansion of town and main roads. For example, the expansion of the Gimbichu town converted much of the agricultural land to urban land.

Discussion on indicators of existence of soil erosion should be corresponded with the identification of soil fertility, soil colour, and soil moisture. Farmers were assessed for their identification of soil type, colour, and fertility level by using their experience. Majority of farmers have good acquaintances of identification of soil fertility and classify soils based on their fertility, consistence, colour and moisture using local language, such as; '*harsha* or *sham bucha*' (very dark and fertile soil), '*lambe'anch bucha*' (heavy gray and moderately fertile soil), '*qottala* or *goggal bucha*' (light gray and infertile soil), '*borbora* or *kashar bucha*' (very infertile and red soil) and '*dora*' (sticky grayish to reddish clay soil that is mainly used for pottery and ceramics). About 54.8 per cent and 40.5 per cent of the farmers described the colour of their soil as grayish and reddish, respectively. Only 4.8% of farmers' land was described as dark to grayish in colour (i.e. relatively fertile soil). All farmers affirmed that the soil colour changes are the consequence of severe soil erosion.

Moreover, almost all farmers have confirmed that soil fertility was declining from year to year. They approved that the two major indicators of soil fertility decline are yield decline and need of high fertilizer and management. Besides, other indicators as changes in soil colour, changes in texture and structures, absence of grasses and vegetation cover, and presence of exposed and bare abandoned land were mentioned as indicators of soil loss.

As recognized from group discussions, all farmers perceived soil erosion as a problem of farming. Of course, farmers acquaint with soil erosion from observations of their surroundings, accumulated experiences and by pressures and trainings from agricultural experts. Environment lends farmers with traditional knowledge that could be experienced through the passage of time and shared with each other that could be either strength or weakness of their practices.

Existence of severe soil erosion in the area has been recognized from different points of view by farmers. They are questioned to explain the existing magnitude of soil erosion, which is considered as indicators of presence of soil erosion. Considering the soil erosion in the area as "severe", "moderate", or "minor" directs the way to rank the major indicators of soil erosion. Based on the analysis of farmers

perception, about 55 (65.5 per cent) of the farmers recognized the degree of soil erosion as "moderate" to "severe-level", yet 25 (29.8 per cent) of the interviewed households put the erosion problem as "minor" on their land. Only the remaining 4.8 per cent farmers perceived as no erosion risk on their land. Thus, understanding the degree of the soil erosion helps them in order to rank major indicators of soil erosion. For the farmers who choose the erosion severity level as 'moderate' to 'severe', the existence of soil erosion is manifested on development of gullies and rills in their farms as well as the truncated topsoil.

As the analysis of the farmers' perception, the four major indicators of existence of soil erosion were rills and gully development (79.8 per cent), absence of top fertile soil (78.6 per cent), poor crop and grass growth (72.6 per cent), and the stoniness and existence of many rock outcrops on farm fields (71.4 per cent). Still other indicators of soil erosion on their cultivation land and surroundings were mentioned as accumulation of fine soil at the bottom of conservation structures and lower position (63.1 per cent) and soil colour changes from dark/black to grey or red (59.5 per cent). When the runoff lacks the capacity to transport the uploaded soil, it tends to unload it at the middle or end of the channel as sediment. If the deposit is black in colour, farmers consider it as removal of fertile soil from elsewhere in the watershed. Informal interview and observation shows that presence of severe soil erosion could be identified by observing slope steepness and root exposure (observation of roots of trees on the surface).

Table 2 : Farmers' Perception on Major Causes of Soil Erosion

*Causes of Soil Erosion	Total number of responses	Absolute %	Relative %
1	64	13.5	76.2
2	63	13.3	75.0
3	61	12.9	72.6
4	51	10.8	60.7
5	51	10.8	60.7
6	51	10.8	60.7
7	48	10.1	57.1
8	46	9.7	54.8
9	38	8.0	45.2
Total	473	100.0	

* For details of causes erosion see text on page180

A land that is poorly fertile couldn't give yield as expected and gradually turns to bare land and lacks any form of vegetation cover. In this area, it was observed that nearly 41 hectares of arable land has been left uncultivated and became rock outcrops with un-crossable gullies. The slope of these degraded lands ranges from 25 per cent to 33 per cent creating difficulty for construction of soil conservation.

Causes of Soil Erosion:

Land degradation by soil erosion is assessed based on the analysis of 84 farmers' responses. Farmers indicated multiple causes for soil erosion. Therefore, the aggregated frequency of each causes mentioned by the farmers were 473. In order to find out which cause is more frequently perceived by the farmers, relative percentages were computed as the percentage ratio of total responses of each cause to the total

number of farmers interviewed (84) as shown in table 2. The soil erosion in the study area is caused by different conditions, including 1) slope steepness of cultivation land, 2) ceaseless cultivation and absence of fallowing, 3) rainfall intensity, 4) type and erodibility of soil, 5) terms of land preparation for cropping. 6) absence and delay of soil conservation measures, 7) insufficient and delayed fertilizer, 8) deforestation and desertification, 9)overgrazing. Based on analysis of farmers' perception, it was found that slope steepness of cultivation land (76.2 per cent), ceaseless cultivation and absence of fallowing (75.0 per cent), and rainfall intensity (72.6 per cent) are the three major causes of soil erosion. Other three equally important possible causes of soil erosion are type and erodibility of soil (60.7 per cent), absence and delay of soil conservation measures (60.7 per cent), and terms of land preparation for cropping (60.7 per cent). Some portion of farmers also recognized insufficient and delayed fertilizer (57.1 per cent), deforestation and desertification (54.8 per cent), and overgrazing (45.2 per cent) as causes of soil erosion, especially in the lowland parts of study area. Over grazing has received relatively less attention as a cause of soil loss/erosion in highlands because the number of livestock is limited there than in the lowland parts of the study area. However, keeping livestock in flat sloped areas results in soil erosion by destruction of conservation structures.

Possibly speaking, as the study area is more susceptible to soil erosion and relatively populated than neighbouring districts, absence of fallowing time and repeated preparation of seed bed makes soil easy for soil erosion. This clearly provides support for the conclusion of Bekele and Holden (1998) who stated that increasing intensification and continuous cultivation on sloping lands without supplementary use of soil amendments and conservation practices poses a serious threat to sustainable land use. In addition, Brown and Wolf (1984) stated that the apparent increase of soil erosion over the past generation is not the result of farmers' ignorance but rather the result of the pressures on farmers to produce more. Hence, farmers of the study area were aware of soil erosion but they are forced to intensify and produce more food crops for their basic livelihood.

Consequences of soil Erosion:

Soil erosion with its multifaceted impacts tends to damage natural resources, agricultural productivity, wellbeing of human kind, and even it affects the habitat of wildlife. Thus, to examine the overall consequences of soil erosion, 84 respondents were sat to explain their attitude towards known impacts of soil erosion. Farmers' perception on the effects of soil erosion was assessed through the use of parameters including loss of fertile topsoil, change in soil colour, decrease of agricultural yields over time, requirements of maximum input and management, formation of rills and gullies, loss of farmland and grazing fields, loss of vegetation cover and grasses, and out migration of farming community. Farmers in this area have put the impacts of soil erosion as connected as they could produce step-wise long term effects on their lives. For all farmers, the first and foremost consequences are loss of fertile topsoil and change in soil colour. This is followed by decrease in the agricultural productivity of land. When the

land becomes unable to yield as expected, it is most probably in need of maximum input and as well high level management. As many farmers affirmed the severity of soil erosion effects on the formation of rills and gullies. As of the severity of soil erosion becomes high, the land becomes very bare and infertile, which results on loss of farmland and grazing fields. Obviously, the bare and infertile land has little or no vegetation cover and grasses. Finally, these overall impacts of soil erosion, forces farming community to migrate from the area in search for food and grazing land for their animals.

About 87 per cent of the farmers approved that the croplands are vulnerable to soil erosion than other types of land usages. The majority of farmers recognized that some crops require repeated ploughing for adequate seed bed preparation and hardly allow intercropping. As 60.7 per cent farmers responded, crops such as teff, wheat and barley require fined soil seed bed and also land has been prepared for prolonged times while waiting for chemical fertilizers; which makes it succumb to soil erosion (Table 3). For teff cultivation, for example, the land should be prepared six times and for wheat and barley four to five times, and for other crops at least two to four times land preparation is needed. As farmers noted, repeated land preparation has been done to enhance soil moisture and fertility. This in turn encourages soil erosion and lends evidence for the conclusion of Belay (1992) and Woldeamlak (2003) that illuminated the type of crop grown has important implication on soil degradation.

Table 3: Types of Crops and terms of Land Preparation

No.	Types of Crop Scientific/Botanic Names of Crops	Terms of Land Preparation for Cropping
1	*Teff Eragrostis tef.*	5-6 terms
2	Wheat *Triticum aestivum*	4-5 “
3	Barley *Hordeum Vulgare*	4-5 “
4	Maize *Zea mays*	3-4 “
5	Sorghum *Sorghum bicolor*	3-4 “
6	Potatoes *Solanum tuberosum*	3-4 “
7	Sugar beat *Beta vulgaris*	2-3”
8	Beans *Phaeolus Vulgaris*	2-3 “
9	Peas *Pisum sativum*	2-3 “
10	Oat *Avena sativa*	2-3 “
11	Potato *Solamum Tuberosum*	2-3 “
12	Lentil *Lens culinaris*	2-3 “
13	Taro *Colocasia esculenta*	2-3 “
14	Chickpea *Cicer arietinum*	2-3 “

Source: Field Survey, 2010 (Scientific names from World programme for the Census of Agriculture, 2010)

Cultivation of teff, wheat, barley and some other crops hardly allow intercropping, rather exposes the land for the effects of erosion.

Conclusion and Implication

Based on the research outcomes it was found that farmers could differentiate various indicators of soil erosion. The four major indicators of existence of soil erosion were rills and gully development, absence of top fertile soil, poor crop and grass growth, and the stoniness and existence of many rock outcrops on farm fields. Still other indicators of soil erosion have significant values. Likewise, farmers are able to distinguish different causes of soil erosion. They recognized three major causes of soil erosion as slope steepness of cultivation land, ceaseless cultivation without the period of fallowing, and rainfall intensity, respectively. Besides, there are other possible causes of soil erosion. The first and foremost consequences are loss of fertile topsoil and change in soil colour. This is followed by decrease in the agricultural productivity of land. Teff and wheat are the repeatedly mentioned facilitators to soil erosion as they need more preparation of land until seeding.

Good soil conservation leads to enriched lands, better crop yields, good financial returns and a balanced environment. Less erosion means the better soil quality, with the soil retaining nutrients and chemicals added to it, and naturally lead to better and improved crop yields.

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