



Landowners' Outlook Towards Soil Erosion Problem and Conservation Strategies in Maksegnit Province, Ethiopia

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Abstract: Soil erosion is an imperative environmental deterioration almost all over the world, which leads to reduction of crop yield. Present study investigates farmers' views of soil erosion problems and their conservation measures in the *Gummara-Maksegnit* watershed to understand inter-relationships between perception of farmers' knowledge and soil conservation practices. Data was obtained from a survey of 332 farm households and informal discussions selected by stratified random sampling from upper, middle and lower catchment at *Fertamit*, *Enkri* and *Dilkana* districts respectively. Both open ended and close ended questionnaires were employed to acquire required data. The result revealed that 81% of the local people realize the occurrence of soil erosion in their farm land. Moreover, 67% of the population recognizes the formation of rill forms of soil erosion on their farm land. 45% of the communities perceive soil erosion as primary factor for productivity reduction while 48% of them consider as second cause. Finally, there are several soil conservation measures done by the society living in the watershed. 84% of the population constructed stone bund on their farm land to control soil erosion. Other soil conservation measures like soil bund, draining ditch, tree planting and contour plowing were practiced. The varieties of conservation measures were very limited and incapable to control erosion forms like gully. Therefore it is highly recommended to teach farmers concerning different soil and water conservation measures and its relevance for tackling soil erosion.

Keywords: Farmers' View, Soil Conservation, Soil Erosion, Stratified Random Sampling, Survey

1. Introduction

The world has been grappling with how to reconcile the three objectives of increasing agricultural production, reducing poverty and using natural resources sustainably [1]. With the land frontier shrinking due to population pressure, future growth in agriculture will increasingly have to come from yield increases rather than from area expansion [1–2]. Agricultural production shall to increase in such a way that future production capacity of the natural resource is enhanced rather than diminished. Understanding and having effort to control all factors hampering intensive production is highly required in all compartment of the world.

Land degradation is one of the most severe spatial and temporal problems almost all over the world [3–6], which affects 33% of the land surface; with consequences for more than 2.5 billion peoples livelihood [4]. About 40% of the

world's agricultural land is seriously degraded, where 80% of this degradation is caused by soil erosion [4, 7, 8]. Each year about 10 million ha of cropland are lost due to soil erosion, thus reducing the soil quality and productive cropland availability for cultivation is being lost from land areas 10 to 40 times faster than the rate of soil renewal imperiling future human food security and environmental quality [9].

Even though land degradation due to soil erosion is a global environmental crisis in this century, the developing and most populated countries are suffering more because of population pressure over land [4, 8, 10–15]. In Ethiopia, one of the developing and second populous countries of the African continent, soil erosion by water constitutes a severe threat to food security [10, 16, 17]. As estimation by prior studies show soil loss due to water erosion is about 149342Mgha⁻¹ per year [18]. The estimated rate of soil loss in the cultivated fields is 42Mgha⁻¹ per year, or 4mm of soil depth per annum, which by all measures exceeds the rate of

soil formation [18]. With this rate of loss, much of the slopes of the highlands, where there is only a thin soil layer, will be totally stripped of the soil mantle in less than two centuries [18].

Soil erosion in northern Ethiopia particularly in *Tigray*, *wollo* and *Gondar* province, is the major challenge of sustainable agriculture [19–21]. It reduces on-farm soil productivity and causes food insecurity [6, 13, 14, 22]. Farmers in the *Gummara-Maksegnit* watershed (North *Gondar*, Ethiopia) suffer from severe soil erosion ranging from small rills to very large gullies and their deleterious effects increase at alarming rate. Farmers are not satisfied with the status of their current land productivity.

An attempt of soil and water conservation (SWC) work in Ethiopia was started since 1970 [16]. Thereafter, to overcome the problem of land degradation, the government has implemented soil conservation activities, such as construction of physical structures (terraces) to reduce overland flow thereby preventing removal of soil, soil fertility improvement practices (compost application), agro-forestry and reforestation of deforested hilly areas.

Effective control of soil erosion is a critical component of natural resource management when the aim is to achieve sustainable agriculture and acceptable ecosystem integrity [10, 17]. Farmers' perception of land degradation by erosion is a key social factor that is also important in deciding options for controlling soil losses [9, 10, 17, 23]. Some authors who studied in different parts of Ethiopian highlands reported that farmers are more likely to adopt conservation measures in plots that are highly prone to soil erosion, such as plots where slopes are steep and erosion features are visible [8, 10, 14, 17, 19, 24–28]. Farmers rather frequently reject newly introduced soil and water conservation technologies (SWC) even when they are aware that the measure protect and improves productivity of their lands [17, 19, 26]. Based on the literature cited above, it is obvious that the newly introduced SWC technologies need to be evaluated not only for their technical efficacy but also for the probability of their sustainable adoption and utilization by the

land users. It requires identification of barriers to and facilitators of adoption of the technologies. Once the barriers and facilitators are identified, recommendations can be made on appropriate steps that need to be taken to enhance the adoption of the technologies and to effect sustainable land use.

Understanding farmers' knowledge and their perception and factors that influence their land management practices are of paramount importance for promoting sustainable land management [1, 2, 4, 7, 28]. We attempted to understand farmers' knowledge and perception on soil erosion processes, soil fertility, acceptance and adoption of the newly introduced soil and water conservation (SWC) measures and other relevant data used for the study. The specific objectives of this research are (1) to understand the farmers' perception and awareness of erosion processes and SWC measures as a land management practice; (2) to examine the local farmers' acceptance and adoption of land conservation technologies; and (3) to identify factors affecting their land conservation decisions.

2. Description of the Study Area

The study area is *Gummara-Maksegnit* watershed which is located in the eastern part of Amhara Region of Ethiopia. This mountainous agricultural watershed, which covers an area of 63 km², is one of the most severely eroded parts of the Ethiopian highland. The study watershed has a very rugged mountainous topography, with an average slope of 21% and most of the study watershed is composed of gullies and ridges. The soil types of the watershed are predominately classified as Nitosols, which covered in the upper and central part of the area, while Vertisols in the lower parts of the watershed near the outlet. The common land use types of the watershed are mainly agricultural (crop) land, forest land and grazing land. The *Gummara-Maksegnit* watershed has three district and detail characteristics of each study village are explained in table 1.

Table 1. Major bio-physical and socio-economic characteristic of three districts in the Maksegnit watershed [29].

Characteristics of Districts	<i>Fertamit</i> (Upper stream)	<i>Enkri</i> (Middle stream)	<i>Dilkana</i> (Lower stream)
Area (ha)	520,000	456,000	542,000
Topography	Steep to very steep	Moderately steep to flat	Fairly flat
Mean elevation (m)	2001	1600	988
Annual rainfall (mm)	1958	1844	1832
Temperature (°C)	Max. 32°C, Min. 21°C	Max. 33°C, Min. 23°C	Max. 35°C, Min. 22°C
Agricultural Land (%)	65	59	72
Area under soil erosion by water (%)	54	32	22
Major soil erosion process	Rill, gullies	Sheet, rill and gullies	Sheet and rill erosion
Farming system	Multiple crops	Multiple crops	Multiple crops
Major crops' grown	Barley, pea and wheat	Wheat, barley and teff	Wheat and teff
Fertility status	Very low	Moderate	Moderate- high
Food Security condition	Insecure	Insecure	Partially secure
Average land size per households (ha)	0.25	0.88	0.90
Total number of farmers	92,700	88,400	82,750
Dominant tree species	Numerous native species	Numerous native species	Numerous native species

3. Research Methods

A total of 332 farm households were randomly selected from the three villages (*Fertamit*, *Enkri* and *Dilkana*) for interviews. A detailed characteristic of the sample households of the study is presented in Table 2. The data was collected during the period between January and May 2018. This study period was selected purposively as it corresponds to maximum agricultural activities of that province.

Socioeconomic data collection methods like questionnaires, key informants interview, focus group discussion and observation was employed to acquire necessary data. The questionnaire used in the present study is consisted of both the closed and open-ended questions. However, the most of the questionnaires were open-ended thus providing respondents with a prospect to convey their outlooks without being constrained by pre-determined reaction. The key issues incorporated in the questionnaire were farmers' perception of erosion occurrence, extent and

impact, changes in soil fertility and yielding properties of land, and knowledge of soil conservation.

Preliminary survey was conducted for a couple of objectives. The first one is just to verify the presence of soil erosion problem and secondly to train data collectors. Basic information on household size and farming practices constituted the closed type of question. Issues regarding soil degradation and soil conservation practices were put in open question format. The respondents were encouraged to mention as many indicators, reasons and practices as possible.

Total 332 households' characteristics were grouped in three classes based on knowledge of soil erosion and soil water conservation (Table 3), because perception of farmers about soil erosion problem and attempts done to control soil erosion are quite different among inhabitants. Microsoft excel software were used to analyze the data. Descriptive statistics was employed to summarize the data.

Table 1. The study villages of Maksegnit watershed and proportional sample size.

Watershed	Catchments	Districts	Study villages	Samples size (households) (n)
Maksegnit	Upper	<i>Fertamit</i>	11	118
	Middle	<i>Enkri</i>	8	105
	Lower	<i>Dilkana</i>	9	109
Total				332

4. Results and Discussion

4.1. Household and Farm Characteristics

The age of the farmers ranged between 18 and 73 years. In the study area 11% households were female headed and 78% were uneducated and 22% were literate as per the agricultural bureau report indicate in 2017. Literacy rates among the investigated villages varied according to distance from city center of the province.

The land properties size of the respondent families varied between 0.25 hectares and 3.0 hectares, with an average holding size of about 1.625 hectares. 72% households were stated that the size of land holdings were progressively more insufficient to support their households. It is due to mainly the growth of rural population. In the province, whenever any child aged eighteen they obliged families to share the land. The remaining land failed to support house heads and below eighteen age children. Households are cultivating their small land year to year without any rest period. Thus land degradation is being worse due to continuous cultivation.

4.2. Farmers View Regarding Cause and Effects of Soil Erosion

The farmers of the *Gummara-Maksegnit* watershed experience decrement of crop production for the last four decades. Since, the all time severe drought caused famine in 1984; inhabitants are disgusted by their low crop production. More than 84% of the farmers realize the occurrence of soil erosion on their farm land (Table 3). Soil erosion level

mentioned by the farmers included loss of topsoil (sheet erosion), development of small rills, sedimentation in depression area (lower slope) and flood having soil color. In addition they already know the occurrence of gullies, which are the most dangerous forms of soil erosion. Former studies in Ethiopia showed that the occurrence of soil erosion in different form at different district of the country [2, 10, 17].

Table 3. Extent of soil erosion problems, types and its impact and change over time.

Farmers' responses to:	<i>Fertamit</i>	<i>Enkri</i>	<i>Dilkana</i>	Total
	(n=109)	(n=105)	(n=118)	(n=332)
Erosion faced in own farm				
Yes (%)	79	81	83	81
No (%)	22	17	18	19
Forms of erosion in own farm				
Sheet erosion (%)	24	22	26	24
Rill erosion (%)	62	68	71	67
Gully erosion (%)	3	2	5	8
Severity of soil erosion				
Severe (%)	63	69	72	68
Moderate (%)	23	19	24	22
Slight (%)	13	10	7	10
Impact of erosion on crop yield				
Severe (%)	60	69	72	67
Moderate (%)	20	16	21	19
Minor (%)	17	14	11	14
Temporal change of soil erosion				
Increasing (%)	59	67	69	65
Same (%)	25	21	23	23
Decreasing (%)	14	12	10	12

Almost half of the land owners (51%) revealed that high rainfall is the main factors of soil erosion. And 34% of the local people consider steep slopes as the second contributor of soil erosion. Local people also stated that ecosystem disturbance during constructions like road and building were additional causes of soil erosion. As it is checked during field verification very huge soil is dumped just near to rivers.

Farmers reported that they observed decline in land productivity, loss of fertile soil, shortage of farm and grazing

land, loss of seeds and increasing fertilizer requirements. They realize the formation of gullies that inhibit agricultural activities, mobility of people and cattle, exposure of hard subsoil layers as the consequence of soil erosion. People also realized the pollution of aquatic ecosystem by chemicals and soil particles transported from farm land. A number of small seas in the watershed had changed their color due to deposition of soil particle.

Table 4. Causes of soil erosion, soil fertility status and temporal changes of soil fertility.

Farmers' responses to:	<i>Fertamit</i> (n=109)	<i>Enkri</i> (n=105)	<i>Dilkana</i> (n=118)	Total (n=332)
Causes of soil erosion				
Erosive rains (%)	51	49	53	51
Slope steepness (%)	25	37	40	34
Others (%)	17	13	15	15
Causes of productivity decline				
Rainfall shortage / drought (%)	50	47	47	48
Soil erosion (%)	42	46	47	45
Others (%)	7	5	9	7
Soil fertility status in own plots				
High fertility (%)	15	12	9	12
Medium fertility (%)	44	43	39	42
Poor fertility (%)	49	44	45	46
Changes in soil fertility in past decade				
Improving (%)	16	13	10	13
Declining (%)	60	65	67	64
No change (%)	22	21	26	23

4.3. Soil Fertility Status and Temporal Changes

Local people reported that soil fertility status is poor and decreasing from time to time. 46% farmers in the study site stated that their plots having a poor level of soil fertility while 42% respondents considered for medium soil fertility.

The remaining 12% of the people consider their farm as high fertile; probably their land is located at depression where sedimentation from upper land is happen. 64% of the cultivators observed decrement of soil fertility in the past ten years.

Table 2. Different soil and water conservation measures adopted.

Farmers' response to:	<i>Fertamit</i> (n=109)	<i>Enkri</i> (n=105)	<i>Dilkana</i> (n=118)	Total (n=332)
Type of SWC measure				
Stone terraces / bunds				
Yes (%)	86	84	82	84
No (%)	19	16	13	16
Contour plowing				
Yes (%)	87	85	83	85
No (%)	14	16	15	15
Drainage ditches				
Yes (%)	71	73	78	74
No (%)	29	24	25	26
Tree planting				
Yes (%)	82	78	80	80
No (%)	19	16	25	16
Soil bunds				
Yes (%)	83	84	82	83
No (%)	14	16	21	17

4.4. Use of Soil and Water Conservation Technologies

Water erosion control measures are land management

practices that control run-off or run-on. Soil and stone bunds are the introduced techniques which can be used alternatively based on the availability of stones and labor. The survey

showed that, 83% of households constructed soil bunds in at least one of their plots to counter water erosion. 84% of the community used to practice stone bund to tackle soil erosion. Construction of stone and soil bund is different from village to village. Stone bunds were highly used in upper stream where plenty of stone is available. The middle and lower stream of the watershed are practicing soil bunds. But several individual realize that conservation works are not enough.

5. Conclusion

The study assesses the farmers' perception and management strategy in relation to soil erosion problem in three districts- *Fertamit, Enkri* and *Dilkana* of *Gummara-Maksegnit* watershed. The study revealed that farmers in the study area are well aware of the soil erosion problem and its positive and negative impacts. They have faced soil erosion in their plots of land decades ago and soil erosion problem is being worse from time to time. This study also revealed that farmers have a holistic observation of soil erosion and turning down of productiveness as the consequence. Cultivators had superior information on soil wearing away, management, and productiveness enhancement methods. Consequently, building on farmers' knowledge via participatory resource management strategy is crucial and government should testify the appropriateness and simplicity of newly induced soil and water conservation technologies.

In conclusion, Study results suggest that policies should encourage formation of grass roots organizations such as farmer groups and community team. This will improve social capital amongst farmers. Farmer to farmer learning should be applied to enhance adoption of new technologies. It is also necessary to enhance farmer education, and increase extension outreach in order to disseminate information on new technologies and to raise awareness. Then, the adoption and use of soil and water technologies will be enhanced and sustained.

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