Farmers' Response to Environmental Problems and Factors Determining Land Resources Management Practices in the Kasso Catchment, South Eastern Ethiopia

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Abstract

The study was conducted in the Kasso catchment of south eastern Ethiopia to investigate local farmers' response to environmental degradation and factors determining their decision making and choice of land management practices. Structured and semi structured questionnaires were designed to collect information on the required data. Focus group discussions (FGDs) and interviews with key informants were also carried out to supplement household survey. Descriptive statistics was used to describe and analyse the collected data from household survey. Results indicated that contour cultivation (73.5 %), crop rotation (62.5 %), tree planting (60.7%) and rotational grazing (74.4%) were the most commonly adopted land resource management practices by local community. Respondent farmers identified some socio-economic conditions determining farmers' decision making of land resource management practices in the study catchment. It is concluded that local farmers should get better training and extension service advice on the field and some incentives to properly manage their plots and improve their livelihoods.

Key words: *cultivated land, forest land, grazing land, traditional land management, soil conservation, soil fertility, water resources*

Introduction

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The issue of environmental degradation is pressing as it has posed threat to sustainable environmental services and the livelihoods of communities in most developing countries (Tadele, 2008). Human-induced land use changes such as deforestation, overgrazing, cultivation of steeper slopes coupled with rapid population growth result in unprecedented land degradation and depletion of natural resources (Mundia and Aniya, 2006). Land degradation has social, economic and environmental implications; it is directly caused by natural processes, but strongly influenced by human action (Carvalho *et al.,* 2002).The most important negative consequences of environmental degradation are directly or indirectly related to biodiversity and water body decrease (Duadze, 2004), plant nutrients depletion (Shan *et al.,* 2007), acceleration of soil erosion (Solomon *et al.,* 2000), forest and grazing land deterioration (Tadele, 2008).

Land degradation due to soil erosion is a serious environmental problem and dangerous ecological process in the highlands of Ethiopia (Ludi, 2004). This degradation of natural resources in Ethiopia has adversely affected food security and economic development endeavours of the country (Bekele and Holden, 2000; Aklilu, 2006 ; Millennium Ecosystem Assessment (MEA), 2005).

Bale Mountain including the study catchment has economic and ecological significance for people in highlands and lowlands as well as neighbouring countries. However, unsustainable natural resource exploitation throughout the area has posed threat to the sustainability of the environment, food security and livelihoods (BERSMP, 2006; BMNP, 2007; Warra *et al.,* 2013). Scarcity of forest products (such as fuel woods), degradation and declining grazing land, biodiversity loss, severe soil erosion and run off and surface water decline were major environmental problems resulted from unsustainable use of land resources in south-eastern Ethiopian highlands. Protection and improvement of the environment is the most important issue which affects the well-being of peoples and economic development throughout the world (MEA, 2005).Thus, understanding how environmental changes affect human well-being and vulnerability is the critical basis for addressing challenges to and the opportunities for improving human well-being while protecting the environment (Desta, 2012). Since the 1970s, considerable efforts have been made to combat the problem of environmental degradation and improve rural livelihoods in Ethiopia (FAO, 2000; IFAD, 2012). However, the impacts of these precedent efforts were with little success (Bekele and Holden, 2000), as it fails to consider traditional/indigenous land management practices and less participation at grass root levels (Bekele and Holden, 2000; Desta, 2012). To narrow and possibly avoid this gap several studies engaged in land management and conservation practices/programs advise the significance of considering local perceptions of the environmental problems and their influence on land resource management (FAO, 2000; Carvalho *et al,* 2002). This is because farmers have good perception of environmental degradation as it is directly related to their daily life or are direct users of land resources in rural areas (Carvalho *et al.,* 2002). Hence, understanding farmers' perceptions of environmental issues and their responses to the environmental problems and factors that influence their land management practices are of overriding importance for promoting successful sustainable land management practices (Assefa, 2009).

Several researches that address farmers' perception of environmental degradation and their responses to resource management have been conducted in the other parts of Ethiopia (Aklilu, 2006; Desta, 2012; Assefa, 2009). This study would be used as complementary, where so far such studies were limited in Bale highlands in general and the study of Kasso catchment in particular. Therefore, this study attempted to examine local farmers' responses to environmental degradation and to analyse some socioeconomic factors affecting their decision making and choice of land resource management practices.

Materials and Methods

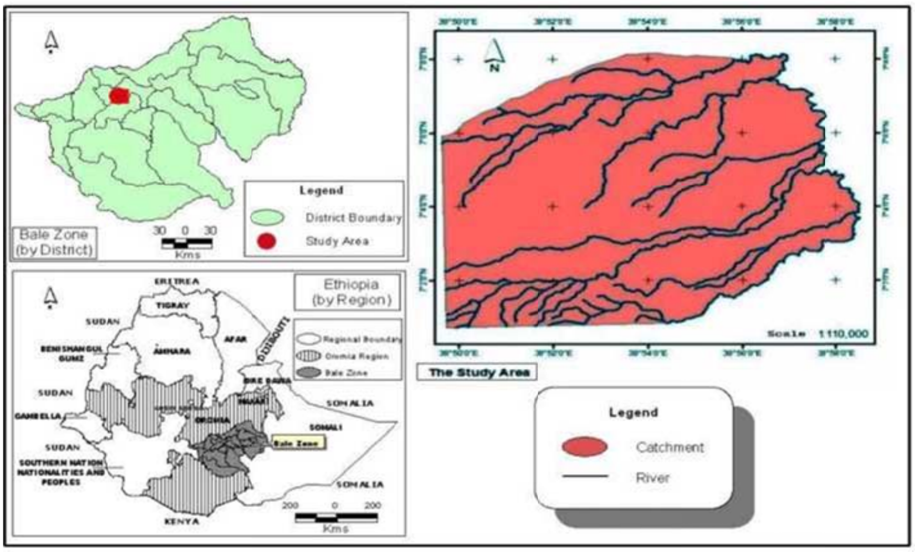
Description of the Study Area

The Kasso catchment is located in south eastern Ethiopia, forming a part of Bale Mountain catchments. It is located between 7^0 1' 10'' N to 7^0 8' 10" N and 39^0 49' 45"E to 39^0 58 15" E (Figure 1). The altitude ranges between 2450 and 3250 meters above sea level (m.a.s.l). It covers 175.95

km^2. As part of Bale Mountains, the study area shows a great variation with physiographic units and is characterized by a gradually rolling terrain towards north and south eastern Ethiopian lowlands bordering Shaya stream, a tributary of the Weybi River that drains to the Indian Ocean. It is dissected by valleys, numerous permanent and seasonal streams rising from the wetter and cooler mountains. In general, the slope gradient ranges from flat to slightly steep slopes (Warra *et al*., 2013)

The Kasso catchment experiences 16.9^0 C of mean annual temperature and a mean annual total rainfall of over 741.9 mm. The lowest temperature occurs during the dry season (November to February). The rainfall pattern shows bimodal types of distribution. A significant proportion (over 62%) of the annual rain occurs in the months from June to September forming the major rainy season with a peak in August. The months of March, April and May form the small rainy season which accounts for about 35% of the total mean annual rainfall of the Kasso catchment (Figure 2).

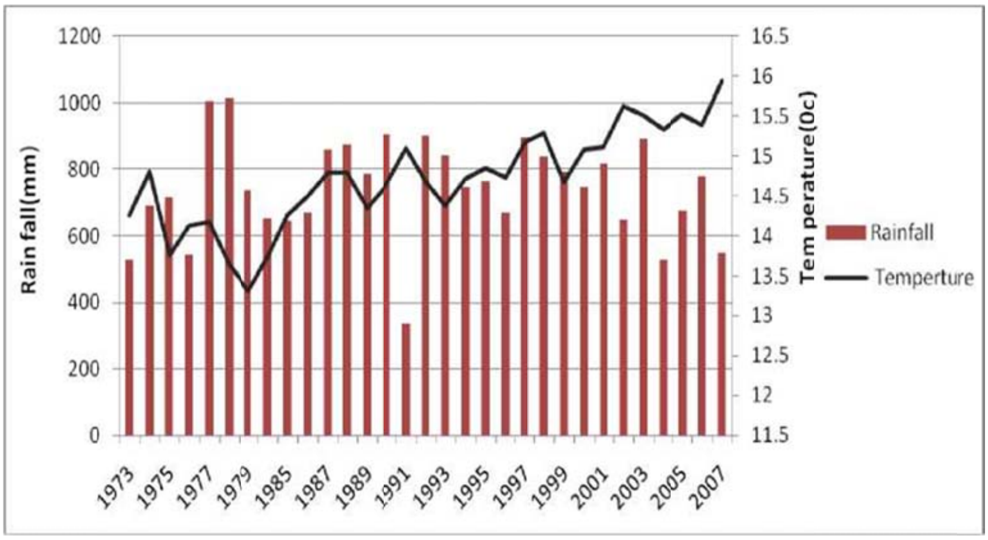
Figure 1: Location Map of the Study Area



The altitudinal variation in Kasso catchment resulted in variation of natural vegetation distribution across the landscape ranging from grassland to Afro-Alpine vegetation. The dominant tree species across the elevation are *Eucalyptus globules* (plantation tree) and *Junipers procera (montane* forest) in lower elevation, *Hagenia Abyssinia (*sub-alpine forest) in middle elevation and *Erica arborea* vegetation (Afro-Alpine) in upper elevation. These forests are essential to protect fragile mountain slopes from erosion and serve as reservoir for natural forest exploitation. However, most of these natural vegetation have been fragmented and degraded by human disturbance such as clearing for agriculture and extraction for fire wood and construction (Warra *et al*, 2013)

Nitisols and Cambsoils are the main soil types in Kasso catchment and roughly cover an area of 30% and 45% respectively (Chinnatalpathic *et al.*, 2001). Traditionally, local farmers categorize soil types into three based on colour: *biyyee guracha* (black soil) in lower area, *biyyee dalacha* (grey soil) in the middle area and *biyyee diiminna* (reddish soil) in upper slope areas respectively. The present day major land use/ land cover types are rural settlement, cropland, grassland, bush land, and woodland and sub afro- alpine vegetation in the study area. While crop land covers the largest portion of the total area, forest land cover is one among the least. A subsistence mixed agriculture, which comprises crop growing and animal rearing, forms the main economic base of the study catchment (Warra *et al*., 2013)

Figure 2: Mean annual rainfall and temperature characteristics of the Kasso catchment



Cereal crops such as barely *(Hordeum vulgare),* wheat *(Tiriticum vulgare),* oat *(Avena salive)* and *tef (Eragrostis tef)* are the major cultivated crops. Also chick pea *(Cicer arietinum),* flax *(Linum usitatisssimmum),* potatoes *(Solanum tuberosum),* onion *(Allium cepa),* and cabbage *(Brassica oleracea)* are grown. The two rainy seasons enable cultivating of crops twice a year. Locally, rainfed cultivation is supplemented with small scale traditional irrigation agriculture. Crop yields and diversity vary with elevation. Farming expands towards steeper slopes, higher altitudes and natural forests. Rearing animals serve for a variety of purposes including food, draught power, transport, manure and skin. Besides, livestock are important for social status and ritual performance in the catchment. In addition, some households were engaged in diversified off-farm income earning activities including harvesting forest products such as for firewood, lumber and other small scale seasonal business. Since migration of youth to other parts of the country and elsewhere outside such as to the Middle East and South African countries was current challenging phenomena of the inhabitants of the area, particularly the poor aimed for the purpose of survival. However, the aim of some other households was to earn additional income to enjoy better life (Focus Group Discussions).

The ever increasing price of agricultural inputs (chemical fertilizer, improved seeds, insecticides and herbicides), expansion of weeds; soil erosion due to improper farming practices, and water logging were major agricultural problems that attributed to low agricultural production and productivity in Kasso catchment. Besides, lack of long term credit, road inaccessibility to urban centres for selling their produces and scarcity of grazing land were the other factors affecting agricultural development and the livelihoods of the local community.

Methods and Procedures of the Study

The selection of the study catchment was based on observations of environmental (land) degradation features such as soil erosion (gullies and rills, sedimentation and natural vegetation cover deterioration and declining surface water over time. Both quantitative and qualitative data collection approaches were used to achieve the objectives identified in this research. This is because it has been argued that using a combination of qualitative and quantitative methods of data collection in research improves its overall strength as it gives both depth and breadth to the investigation (Ragin, 1987; Carvalho and White, 1997; Herweg *et al.,* 1999).

Socio-economic survey of households was conducted between December 2011 and February 2012. The survey included structured and semistructured questionnaire consisting of three parts. The first part was designed to gather information on the biophysical and socio-economic aspects of surveyed farm households. The second part attempted to encapsulate data on how local farmers respond to land degradation and the last part of the questionnaire was devoted to identify factors that determine farmers' decision on land resource management practices in the study catchment. For this purpose, 86 household heads using systematic sampling techniques were selected. Focus group discussions, interviewing key informants and field observation were also accomplished to supplement house hold survey and to ensure the reliability of the data. For convenience, based on agro-ecology, the study catchment was divided into upper, middle and lower slope categories. Then to increase representatives, three groups of FGDs from the catchment and one FGD from each catchment categories consisting of 6 members each from different age groups, sexes and educational background were purposely selected. Accordingly, two elders, two literate farmers and two female household head representatives were selected from each catchment categories. Two extension agents, two elders and two innovative farmers who were well aware of their environment were also interviewed. Secondary data available in different local government and non-government offices were exploited.

Descriptive statistics were used in analysing socio-economic characteristics of households, the land management practices employed by farmers as well as factors affecting farmers' land management practices. The qualitative data obtained from focus group discussions and key informants interviews were analysed qualitatively, too.

Results and Discussion

Household Socio-Economic Characteristics

Table 1 presents the socio-economic characteristics of the sample households included in the survey. Results indicate that most surveyed households owned land during the 1975 land reform, and some young households acquired recently and other few new households inherited from their families. The average household farm size by catchment category was 2.10, 1.75 and 1ha for upper, middle and lower elevation respectively. Overall at catchment level, the size of household land holding ranged from less than one to over ten hectares with an average size of 1.92ha. When the average household size is compared with average land holding size, the per capita was 0.49 ha. This shows that the existing farm land is not adequate for some households to support their family and therefore there was intense human pressure to use the land to its maximum potential. This was the main problem in lower elevation where average household land size was not above one hectare. The other problem was that households had no opportunity to expand their farm because the land was already in use. Local farmers reported that farm holding size was declining over time largely due to rapid population growth. As a result of increasing land scarcity coupled with declining agricultural productivity, there was a tendency of encroachment into natural vegetation and cultivation of ecologically fragile areas.

Table 1: Household demographic and socioeconomic characteristics

Variables		Values
Average age(N)		48
Sex (%)	Male	62
	Female	24
Aver. Family size (N)		6
Level of education (%)	Illiterate	59
	Read and write	25
	Literate	12
Average farm size (ha)		1.92
Aver. Livestock(N)		2
Aver. No. Of plot(N)		3
Extension service provision (%)	Adequate	48
	Inadequate	52
No. of plots owned(N)	One plot	10
	Two plots	26
	Three plots	47

Source: Household survey, 2012.

Farmers' Response to Environmental Degradation

There were various indigenous and introduced land resource management practices undertaken to minimize or avoid the problems associated with land degradation in the study catchment. These can be understood as soil conservation, soil fertility management, forest and grazing land management practices.

Soil Conservation and Fertility Management

Land degradation in the form of soil erosion was one of the major environmental problems in study catchment (Warra *et al*., 2013). To combat and/or minimize the effect of this land degradation problem, local farmers practiced/adopted the following soil conservation measures (Table 2).

Contour Ploughing: It is one of the most traditional soil and water conservation (SWC) practices used across the slope to minimize the effect of runoff down slope. Many farmers were aware of the importance of contour ploughing to control soil erosion. Accordingly, nearly 60% of sample households practiced contour ploughing in their fields. However, it is the most common practice in middle and upper elevation categories where runoff is prevalent. The remaining 40% of households did not practice contour farming because their farmlands are found in the low lying area and/or used other ploughing system.

Cut off drain: This physical structure is constructed in order to change the direction of the runoff before reaching the farmland. Farmers in the middle (20%) and upper (24%) elevation categories practiced this soil conservation structure as a means of controlling runoff. However, it is a general understanding that the practice of cut off drain is often influenced by willingness to receive runoff by owner of the down slope plots. Where cut off drain was not possible for this reason, plots of some farmers were affected by the effects of runoff. Moreover, the improper use of cut off drain resulted in other environmental problems. For instance, most farmers diverted the direction of runoff from their plot to communal lands such as grazing lands and road sides. This caused the development and expansion of gullies and loss of down slope soils.

Traditional ditch: Water logging caused by clayey (e.g. commonly Vertisols) nature of the soil was one of the agricultural problems in the Kasso catchment. Owing to this, a considerable number of farmers (62%) practiced traditional ditch to drain excess water from their fields. The way of draining excess water from the field is, however, determined by the nature of topography and farmers' willingness to do so either vertically or horizontally/diagonally across the slope. For instance, up-down dug installed traditional ditches were observed on some farm plots in the middle and upper elevations. This served for one harvest and designed in other site on the same plot for other growing seasons. According to FGDs, this farming practice is not only helping to drain excess water from the field but also improves soil productivity. However, this traditional ditch practice needs proper management in order to reduce soil erosion and seed removal accelerated by the high gradient of the drainage in the middle and upper elevation that eventually may lead to low agricultural production and productivity.

Soil bund: Soil bund is the commonly used soil and water conservation structure where stone is not easily accessible to use stone bund. Hence, due to lack of stones, farmers in study catchment practiced soil bund even in steeper slope areas. It is non-graded soil bund installed to break the force of runoff and used to conserve moisture in the soil. Many (58%) farmers perceived the worth of constructing either stone or soil bund structures in order to control water erosion in steep slope areas but only very few farmers (16.8%) practised it. This implies that some farmers (23%) were not well aware of the effect of soil erosion on their farms in order to take appropriate soil conservation measures. This is because perception of soil erosion as a problem and its effects takes longer and farmers would be less concerned in taking measures against soil erosion (Traore, 1998). Extension workers occasionally visit farmers' farm and subsequent lack of extension services (advice on the farm and training) and low level of education of most sample households to perceive the problem or other reasons may also form contributing reasons to this low response to SWC measures. Even most observed soil bunds in the field did not seem to have a purpose in protecting soil erosion rather serving as boundaries between plots either parallel to or across the slope. This might have been bunds that in the long run have developed to boundaries.

Check dams: Several gullies have been developed mostly on communal lands such as watering point, along foot path and on patches of communal grazing land. This development on communal land was a classic example of the "tragedy of the common" (Herdin, 1986). These gullies formation were the result of removal of vegetation cover, overgrazing, over cultivation, steeper topography and the diversion of water ways to those areas. However, intervention activities were not made for years to deter further expansion and developments of gullies. Currently, in the middle and upper slope categories of the catchment few check dams were constructed by local community and households using local materials such as stones, erecting thorns and trees branches and fencing near the initial gullies. As a result, gully prone areas were partially rehabilitated and water erosion was reduced. However, still many parts of the catchment prone to gullies were not protected and the existing check dams were not well constructed and maintained (Figure 3). If substantial intervention measures are not taken, expansion of gullies may reduce farm and grazing land and trigger the loss of soil and nutrients as well as become a barrier to movement.

Figure 3: Check Dam across Gully

Tree planting: Forest loss is affecting the livelihoods and the environment, particularly the rural poor in different ways including shortages of firewood and obtaining non-timber forest products, and fostering land degradation which affects agricultural productivity (Abeney and Owusu, 1999). Unsustainable use of forest resource in the Kasso catchment attributed to environmental degradation (deforestation) and consequently local community was affected by losing adequate services from these forest ecosystems. Hence, local community planted trees primarily to cope with socio-economic problems associated with deforestation such as the scarcity of fuel woods and construction materials (Table 2) as well as a source of income through sale. Field survey revealed that almost 72.8 % households in the low-lying area and 48.5% households in the upper parts of the catchment depend on planted trees for the same reasons. This implies tree planting in the lower elevation was very important as compared to in the other elevation categories (Figure 4 and Table 2). However, these planted trees were limited around homestead and mainly consist of *eucalyptus* tree species. Therefore, from ecological point of view they contributed little to the improvement and restoration of degraded areas. This is because, firstly, trees were not planted in areas prone to erosion including steep slopes, bare land and farm areas; and secondly, some findings showed that *eucalyptus* trees contribute less to SWC measure compared to other native and other tree species (Kumasi and Okyere, 2011). For similar reasons, farmers were not willing to plant trees on their farm as soil and water conservation measure. They argued that planted trees within the cultivated field compete for nutrient and water with crops, reduce farm size and requires intensive labour from field preparation to the stage of its maturity such as planting, watering, weeding and protecting from animals damage. As a result, the practice of agro-forestry (a combination of tree with crop) that has economic and ecological values was not introduced and adopted by farmers in the study area.

Nowadays, there is an increasing attention for local community-based forest rehabilitation as an innovative response for meeting the conflicting goals of livelihood improvement and sustainable forest management. Nevertheless, in the study catchment there was no currently planted community forest that aimed /targeted to improve wood supply to local community and concurrently reduce human pressure on natural forest. Moreover, some bare lands that could be vulnerable to erosion and degraded areas such as road sides and water points were also not covered with vegetation. There was one remnant community forest planted during the past regime for the purpose of environmental protection and woodlots to alleviate fuel wood scarcity of the area. However, as local people explained, this forest was under human and animals pressure due to unclearly stated ownership of the forest or forest use right. Illegal logging and livestock encroachment were among the main observed problems.

Figure 4: Individual Household Planted Trees

Living fence: Living fence was the most (73%) commonly used land resource management practice in the study catchment (Table 2). This is a practice of planting trees of various species mostly near and around home compound as well as in the field around crop land boundary for various reasons. For instance, where grazing land and fuel wood were very scarce, living fences were used for arranging rotational grazing land by dividing plots into different grazing lands and source of fuel wood and construction materials in the lower elevation. In the upper elevations where land for grazing and fuel wood was relatively available, living fence was mostly used for security purposes to protect fierce wild animals and other wild animals from crop destruction. In the lower elevation category, cactus *(Euphorbia Candelabrum)* and eucalyptus *(Eucalyptus globules)* were the most common vegetation species whereas in the upper elevation a variety of tree species were used for living fence (Figure 5).

Soil fertility management

Farmers' perception indicated that the overall status of soil fertility (as one aspect of soil quality) of the study catchment ranged from medium to low. A combination of factors including soil degradation, over cultivation and inappropriate farming systems attributed to such soil fertility decline in the study area (Warra *et al*, 2013). Soil fertility management is important to improve agricultural production. Hence, local farmers used to apply several approaches that could improve soil fertility in the field and thereby crop production (Table 3).

Figure 5: Living fence of various tree species

Table 2: SWC Conservation Practices in Kasso Catchment at Different Elevation Categories

Type of Soil Conservation Practice	Elevatio n c atego rie s							
	Lower N=30		Middle N=30		Upper N=26		Aggregate Total=86%	
	No	%	No	%	No	%	No	%
Contour ploughing	*	-	20	28	21	31	41	59.30
Agro-forestry	-	-	5	6.1	10	11.3	15	17.44
Stone bund	-*	-	6	7	8	9.28	14	16.28
Check dam	*		12	14	7	8.09	19	22.09
Tree planting	24	28.23	17	20	10	11.7	51	60.7
Cut off drain	*	-	17	20	21	24	38	44
Traditional ditch	15	17.5	23	27	15	17.5	53	62
Living fence	21	24.4	24	28	18	21	63	73.25

* Not practiced in lower elevation because of being almost flat Source: Household survey (2012)

Manuring: Animal manure is an important input for maintaining and enhancing soil fertility. However, in the Kasso catchment, the use of manure was practiced by few innovative households (18.6%) who had some exposure to extension service and attended trainings. The majority (89%) of households never attempted to use manure. Only 9%, 6% and 4% of the households in the lower, middle and upper elevation respectively used manure in improving fertility of their farm land. Farmers in lower elevation use much manure from other elevation categories. Households pointed out (40%) that the main reason for such low use of animal manure in their field is related to the low culture of using animal manure as soil fertility maintenance and improvement was not yet well developed. Shortage of manure (23%) due to declining livestock size, labour (plot fragmentation and distance from homestead) (15%), fear of weed intensification (2%) and manure used for fuel (20%) were the other mentioned reasons for low adoption of animals manure in their fields.

Composting: Soil fertility, water-holding capacity, bulk density and biological properties are improved with composting (Flavel and Murphy, 2006). There was an effort to introduce composting to local community through extension service. However, similar to manure the rate of adopting compost as means of soil fertility maintenance and improvement was insignificant. Accordingly, 93%, 96% and 100% households in lower, middle and upper elevations respectively did not use compost as a source of soil fertility improvement on their farm land and only about 12% households used compost in the study catchment (Table 3). Surveyed households indicated that low perception of compost use (35%), lack of knowledge (25%) on how to prepare and apply, labour intensiveness (20%) in preparing and transporting, and lack of raw materials such as animal manure, crop residues and others (25%) were some of the mentioned reasons for farmers' low adoption of compost use in the study area. On other hand, no more selection was made on which crop types is frequently applied but to save time and labour few farmers often apply compost on crops grown around homesteads

Table 3: Constraints to Use Animal Manure and Compost in the Kasso Catchment

Variable		Respondents	
		No.	%
Animal manure	Low perception of manure use	34	40
	Lack of raw materials	20	23
	Used as source of fuel	17	20
	Labour intensive	13	15
	Fear of weed intensification	1	2
Compost	Low perception of compost use	30	35
	Lack of skill	22	25
	Lack of raw materials	22	25
	Labour	17	20

*Over 100% due to multiple responses. Source: Household survey (2012)

Chemical fertilizer: A considerable number of farmers (74.4%) used chemical fertilizer to improve soil fertility and increase agricultural production. They used to apply more fertilizer on (wheat) (a cash crop in the study area) than on food crops (barely and teff) and pulses. Nevertheless, with continually increasing price and absence of long-term credit, the trend of using chemical fertilizer has been significantly declining in the study area. Owing to this, some farmers used under the recommended requirements and still other few farmers did not use fertilizer at all. Over 25% of the households were among those who did not utilize chemical fertilizer for maintaining or improving their soil fertility status and exacerbating further degradation. Key informants explained the problem to use fertilizer as "lafti waa baratte waa ol hindebistu; that means once we used to apply fertilizer, land/soil needs continuous application as it does not grow anything unless fertilizer is applied and hence, we were forced to depend on it to improve and maintain soil fertility and production." Hence, it can be suggested that the existing socio-economic conditions contributed to insufficient use of agricultural inputs to improve soil fertility and to a decrease in agricultural productivity. This in turn may have a negative implication for realization of efforts undertaking to achieve food security and alleviation of poverty in the country.

Fallowing land: fallowing land for long periods increases soil fertility, moisture level, crop yield and reduces disease and pest as well as lowers the rate of soil erosion (Burgers and Trakansuphakan, 2001). Similarly, farmers from their long experiences know the benefits of fallowing and accordingly they used to practice it for restoring soil fertility, increasing yield, reducing weeds and diseases and as short term livestock feed. However, with a rapid population increase and land use pressure there was a limited land holding size to fallow parts of their farm land and consequently fallowing practice had been reduced significantly in the study catchment in general and totally absent in the lower elevation where population density was high. An elder from low-lying area reported the impossibility of fallowing plots, and instead, the experience they used to improve (renew) soil fertility was expressed as follows: "through my life span from boyhood to old age I rarely applied fallowing but we (farmers) used to renew (improve) our soil fertility through "tilling 3-6 times in one growing season, and deep ploughing by extending the length of plough (locally maresha) in order to bring up fertile soil from sub layer to the surface." This experience might hold true through bringing up lost nutrients through leaching but may need further research on farmer's field. However, only few farmers (16%) applied fallowing as soil management and conservation measure in the middle and upper elevations where relatively population density was moderate and thus land was available. But there was a declining trend due to growing population and demand for crop cultivation.

Crop rotation: Experimental findings demonstrated that crop rotation with proper sequence of legumes increased organic carbon and nitrogen after several years cropping without manure or N fertilizer but in contrast farm plot with continuous cereal sequencing was significantly lowered in organic carbon and N content (Johnston, 1986). Crop rotation is one of the traditional farming systems practiced by most local farmers (75%) to improve soil fertility and increase production. The result indicated that the trend of crop rotation was dominated by cereal - cereal crop mainly barley and wheat. These cereal crops take up nutrients from the soil rather than improving plant nutrients. This trend may deplete the soils of certain nutrients and reduces yield. Moreover, those few farmers who had begun practicing rotation of cereal with legumes did not follow proper cropping sequence that help improve soil fertility and thereby crop production. Some farmers plant similar crops or cereal crops for years and legumes without maintaining proper sequences. Despite other factors, lack of awareness and objective of production of household farmers (Kumasi and Okyere, 2011) either for food or sale were the main reasons for not too well integration of legume crops in their farming system. The application of proper crop sequencing for example growing legume - cereal - legume crop may be considered as alternatives of crop rotation. These systems can maximize benefits of the rotation in improving soil fertility and increasing agricultural productivity as well as household nutrition and income. In such a sequencing procedure, grain legumes add nutrients to the soil and then improve yield of subsequent cereal crops. Small farm size farmers can also practice sequential crop rotation by dividing plot in to two planting cereal crop in one section and legume crop on other plot during the growing season and reverse in the next growing season. The adoption of legume crops and proper cropping sequencing has numerous attributes to help improve soil health properties such as soil aggregation, water infiltration, and nutrient cycling/ nitrogen fixation. In order to ensure food security through improving soil fertility and reducing cost of production, therefore, needs encouraging and raising farmers' perception to integrate legume crops in their farming system.

Crop residues: It is the practice of leaving crop residues on the ground after crop harvesting. Retention of crop residues on the soil surface helps to conserve soil organic matter and moisture (Giller, 2001), increase total N (Assefa and Tanner, 1998) and protects the soil from water and wind erosion (Hagrove, 1991). The use of crop residues as soil fertility management was less recognized by farmers in study catchment. Only few farmers (17%) adopted crop residues as soil and water conservation measure. Lack of awareness was the main reason stated by farmers for such low adoption rate of crop residues. The other reasons they suggested were the use of crop residues for animals feed, source of income for some households through sale in nearby towns (Figure 6) and burning in view of controlling weeds and making tillage ease. Farmers in the middle and upper elevation better practice crop residues in order to minimize the effects of water erosion (runoff). However, low decomposition rate of crop residues due to low temperature conditions as influenced by high elevation reduce the immediate availability of nutrients to the plants (crops) that could retard plant growth and hinder agricultural productivity if adequate inorganic fertilizer is not applied.

Table 4: Soil fertility management practices in the Kasso catchment at different elevation

Soil fertility management practice	Lower No=30		Middle No=30		Upper No=26		Aggregate No=86	
	No	%	No	%	No	%	No	%
Crop rotation	26	30.2	20	23.2	18	20.9	64	74.4
Manure application	8	9.3	5	5.8	3	3.5	16	18.6
Compost application	2	6.6	1	3.3	0	0	3	11.5
Fallowing	1	2	3	3.5	9	10.8	13	15.8
Fertilizer	26	30.2	23	26.7	15	17.4	64	74.4
Mulching/crop residues	2	3	6	6	7	8	15	17

Source: Household survey, 2012.

Figure 6: Crop Residues for Sale in Towns

Grazing Land Management

In the study catchment, livestock resources are important assets and means of draught and income generation. However, this study showed that there was a trend of decline in livestock number and quality associated with the deterioration of grazing land and shortage of animals feed resulting mainly from the expansion of crop land and human settlements (Warra et al., 2013). This significantly influenced the contribution of livestock sector to the improvement of the livelihood of local community. Household's income reduction and malnutrition were among these problems associated with livestock size and quality decline. Therefore, farmers have adopted different traditional coping mechanisms to alleviate the shortage of animals' feed.

All (100%) farmers used to graze post-harvest field because all fields are open access to all livestock. Some households (40%) with very scarce grazing land collect and store crop residues as supplementary feed to overcome animals feed shortage during summer and long dry season. Still other farmers (45%) practiced rotational grazing around homestead by dividing the field into two or more pieces of grazing plots (Figure 7 and Table 5). Farmers who practiced rotational grazing were those who had large land holding and better understanding about the benefits of practising rotational grazing. Some large farm size holding farmers (10%) also practiced short period fallowing (one cropping season) and used for livestock feeding. However, there was a problem to use such fallowed fields because they are fragmented and are located between other cropped plots that do not allow movements of animals into these fallowed plots. Instead, farmers often use this for grazing after crop harvesting. Besides, communities also use pockets of land in the valley, farm boundaries, and river and road sides. Some farmers (15%) also made seasonal mobility with their livestock to the peak of afro-alpine vegetation in wet season and back from October onwards and again return during winter. This includes encroachment into protected Bale Mountain National Park (BMNP). It was practised in most upper parts of the catchment where livestock herding was the main livelihood of the households. This type of seasonal mobility is locally called Godaantuu which is equivalent to transhumance. Although farmers practised such ranges of coping mechanisms with livestock feed shortage, the productivity of their herds was low to ensure food security of the households.

On other hand, farmers' perception of modern practice of grazing land management and livestock herding was low. The effort made by government to improve livestock feeding and introducing improved livestock variety was not encouraging. This indicates that still farmers in the study area have been practicing traditional livestock management methods and low returns. Farmers need improved breeding, better veterinary services and better fodder production to improve the livelihoods of their households.

Table 5: Grazing Land Management Practices in the Kasso Catchment

Variables	Respondent	
	No.	%
Post-harvest feed	86	100
Collect and store crop residues	34	40
Practice of rotational grazing	39	45
Short fallow (one year)	9	10
Seasonal mobility	1 4	16

Source: House hold survey, 2012.

Figure 7: Rotational grazing practices

Forest Resource Management

Spatial-temporal field assessment of natural forest and farmers' perception analysis indicated that forest resource was severely degraded due to human-induced factors (Warra et al., 2013). This has resulted in serious societal and environmental problems including soil degradation, water pollution, scarcity of fuel wood and construction materials, loss of biodiversity in the Kasso catchment and surroundings.

To mitigate these socio-economic problems associated with degradation of natural forest, local community implemented various coping strategies such as tree planting, changing consumption style and conserving the remaining natural forest. Accordingly, the majority (60.7%) of the sampled households planted trees in all parts of the study catchment but predominantly in the lower parts of the catchment where vegetation cover was completely degraded. The main target of forced planting tree was to solve the scarcity of fuel wood, construction materials, farm implements and to generate income. The remaining 33% households did not plant trees. Two reasons were associated with not planting trees. According to the interviewed households' opinion the main focus of some households particularly the poor was to meet immediate needs of surviving of their family members (crop production) than getting long-term benefits of tree planting. They also noted that the scarcity of land for planting trees and labour-intensiveness of the activity, from field preparation to the stage of its maturity (planting, watering, protecting from animals, etc.), were some other factors that discouraged farmers from planting trees especially in the fields away from homestead.

Eucalyptus was the more commonly planted tree species than indigenous ones. According to local people, eucalyptus tree species are preferred for different uses (fuel, timber, source of income, fence, and traditional medicine); they grow fast, have great market demand and regenerate up on repeated cutting and require easy management. The plantation of these eucalyptus trees was more observed in lower elevation where natural vegetation cover was completely degraded and a fuel wood and construction material was scarce. Hence, these planted trees were playing a profound role in reducing human pressure on natural vegetation and mitigating the scarcity of fuel wood and building materials. On other hand, local farmers and some scientific studies have reported the side-effects of eucalyptus trees on other ecosystems. For instance, a study in Tigray confirmed that eucalyptus tree consumes more water than other tree species and agricultural crops (Kumasi and Okyere, 2011). Therefore, it can affect the ability of the ground water recharge and may affect or reduce the availability of water to other plants.

The other coping mechanism with shortage of fuel wood and building materials was changing fuel consumption pattern and type. With this respect, the fuel consumption pattern and type was changed from indigenous to exotic trees. For instance, in the past olea Africana, podocurpus gracilor, Rapanea simen were preferred and they were the major source of fuel, and junipers procera was used for house construction. But today, these tree species were significantly reduced and consequently were replaced by exotic trees especially eucalyptus for both fuel wood and construction purposes. Despite some problems, the deterioration of native forests (trees) and the fast growing nature and its multipurpose uses encouraged farmers to adopt/plant eucalyptus tree species. Moreover, crop residuals and animals dung were also used by many households as the means of overcoming fuel wood problem although they have damaging effects on environment and soil quality as discussed above.

Some farmers also badly regretted from past destruction of natural forest that attributed to their unsustainable use and its impact on their livelihood and local environment. As a result, they felt that they should not pass the problem on to their children and that they should protect the remaining forest and plant additional trees. In general, private plantation has been increasing as stimulated by scarcity of fuel wood and construction materials, and increased demand for wood and wood products.

Water Resource Management

The Kasso catchment as a part of Bale Mountains is the source of many streams used by local people and downstream community for domestic (human and animals) consumption and traditional small scale irrigation mostly in the lower positions of the catchments. However, according to farmers' perception there was a decreasing trend in water volume in the rivers and streams over time and some streams were drying out before the normal dry season comes. As a result, local farmers particularly in the lower elevation areas were more affected with water resource shortage. Nevertheless, this study indicated that no substantiated water resource conservation measures (rain water harvesting, constructing ponds, etc.) were undertaken in order to minimize the problems.

Factors Determining Farmers' Land Management Practices

Socio-economic and demographic factors influence individual farmer's evaluation and awareness on the process of environmental degradation and their potential to take land resource management measures (Benin et al., 2003). Interviewed respondent farmers identified a set of factors that determined their response to environmental degradation (Table 6).

Education: A considerable proportion of interviewed households (58%) mentioned that educated households have better perception of land degradation as well as better ability to adopt new ideas and technology of resource managements and agricultural development since they have better exposure to various media sources (like bulletin, newspaper and radio). On the other hand, few literate households (12%) (Table 1) showed better resource management practices by integrating both traditional and introduced resource management technologies. Moreover, they may also be more aware of the benefits of modem technologies and be more efficient in their farming practices. Low education level of households limits farmers' access to information and their ability to understand technical aspects of innovation which largely affects crop production (Mawusi, 2004). It can be concluded that high illiteracy level (59%) of large proportion of sampled households might have resulted in the observed low level of land resource management practice of the local people.

Access to extension services: Access to extension services is assumed to improve farmers' attitude towards land management practices. Farmers were asked whether extension service is important to their livelihoods improvement. Majority of farmers (65%) believed that the governments' extension service was the major means through which they receive a range of extension services related to their daily livelihood activities and resource managements. Framers reported that the extension workers (Development Agents- DAs) were the main extension service through which most farmers particularly illiterate ones received some information related to their day to day activities. Therefore, farmers are largely dependent on extension workers and they expect from them several extension issues including frequent field visit, training and monitoring on resource management and agricultural practice, timely transfer of agriculture information, ways to improve soil fertility of their plots and thereby productivity. They also explained that communication with relatives, friends and neighbours were the other important sources of information. About 48% of households explained that they had good access to extension services. Proximity to extension workers' office, wealth status and education level of households led to such better access to extension services. On other hand, about 52% of the farmers expressed inadequate visits of extension workers to their plots in order to improve such basic expectations (Table 1). This could be the result of distance of households from extension office, terrain nature, bias related to household wealth (prestige), lack of commitments to serve their rural people and lack of supervision of their activities in the field (Local farmers, personal communication). For example, there were cultivating erosion prone areas such as very steep hillsides and valleys without applying any SWC measures in many sites and dependency on mainly single soil fertility management practice and other related issues indicated the existence of some gaps between extension workers and local people. In general, observed low level of adopting SWC measures partly could be the result of low extension service provision to the community in the Kasso catchment.

Livestock and farm holding size: The size of livestock and farm a household owned are indicators of farmers' wealth status. These household assets play a key role in influencing the decision and level of conservation investments made (Moges and Holden, 2006). About 53% of the respondents explained that wealth (size of livestock and farmland) of a household significantly influenced their decision making and choice of land resource management practices. Interviewed key informants also witnessed that farmers with large livestock holding size invested better on chemical fertilizer to improve soil fertility and crop productivity. This is because livestock is important source of farm income and enables farmers to purchase agricultural inputs (chemical fertilizer, seed and other agricultural inputs) and hire labour for constructing physical structures for soil erosion protection.

It is also expected that farmers with more livestock size have better availability of manure to improve or restore soil fertility although most farmers with similar livestock size in the study catchment were unlikely to use it. Hence, greater livestock holding is expected to have positive influence on farmers' behaviour to improve their land management practices (Bayard and Jolly, 2007). In contrast, a large number of households who had very few livestock and very few other households who did not have any livestock or own very few experienced lack of manure. These households were also unable to purchase chemical fertilizer for their plots.

Several studies identified that large farm size has also positive association with resource management practices (Place et al., 2006). Likewise, local sources and field visits indicated that farmers with larger farm sizes better participated in a range of SWC measures (such as fertilizer use, fallowing, crop rotation, tree planting and cut of drain). They said that this condition provides alternative to fallow/rest parts of their plot and also the more return (output) obtained from this large holding size in turn enables investment on different SWC measures (Desta, 2012). The practice of fallowing was also observed in farmers who owned large farm sizes. Therefore, farmers with large farm size had better perception of environmental degradation and more likely practice any conservation techniques better than small land holders. On other hand, farmers with small holding size would not have options but to adopt unsustainable land use practice. In contrast, 38% of households considered that farmers who owned small farm and livestock size gave more care for their resources compared to those who owned large farm size as they do not have other alternatives to depend on.

Land fragmentation: The result of land redistribution of 1975 and continuous inheritance at household level as well as renting and equal sharing resulted in land fragmentation in the Kasso catchment. Accordingly, the survey result showed that 10%, 26%, 47% and 20% (Table 1) households had one, two, three and four plots of farmland at different sites respectively. On average, each household had three plots of land. Most households (76%) (Table 6) pointed out that land fragmentation has significantly affected their land management practices (soil conservation and fertility management) as it requires more time and led to labour wastage. This implies that farmers give more attention or necessary care and maintenance to nearby plots.

Lack of Awareness of the Effects of Environmental Problem: There is a general understanding that the more farmers perceive problems of land degradation, the better they can act to achieve sustainable land management practices (Belay, 1992). Based on soil erosion indicators such as sheet erosion, rills and deposited sediments, households perceived the occurrence of erosion on their fields. However, no significant relationship was observed between farmers' perception of degradation problem on their own farmland and the decision they made to control soil loss. About 80% of households perceived the land degradation problem on their farms, but the response to minimize the problem was low. For instance, in areas where soil erosion occurred and soil fertility is low, the number of households engaged in SWC measures such as soil bund construction, agro-forestry, manure application on their farm was only16%, 17%, and 20% respectively (tables 3 and 4). This insignificant relationship might be due to the fact that though they were aware of the degradation problem on their land, yet they might not feel the real effect of the problem as they were not able to measure its actual loss and estimate its effects on crop yield. The majority of farmers (72%) confirmed that lack of awareness of the effects of land degradation (environmental problems) on their land significantly influenced their attitude towards soil and water conservation measures. Similar findings noted that perceptions of erosion problem had no significant influence on the decision of farmers to continue using introduced terraces (Aklilu, 2006; Desta, 2012). Moreover, low application of animal manure, compost and legumes in soil fertility management was an indicator of farmers' low awareness to use locally available options.

Table 6: Determinants of Farmers' Land Resource Management

Variables	Respondents	
	No.	Percent
Education	50	58
Extension service	5 6	65
Wealth	46	53
Fragmentation	65	76
Lack of awareness	63	72

Source: Household survey (2012)

Conclusion

The study showed that the responses of farmers towards land resource management were diverse and generally differed as a result of differences in perception, opportunities and constraints posed by socioeconomic and biophysical factors. Tree planting, contour ploughing, cut of drain, traditional ditch and check dam construction were among the major soil conservation measures undertaken by the local community, particularly in the middle and upper elevations of the catchment. On the other hand, crop rotation and inorganic fertilizer application were the most common soil fertility management options practiced to improve crop yield. However, the culture of using manure, legume crops, and agro-forestry as options of soil fertility maintenance and improvement and thereby increasing yield was not well developed.

To tackle the existing scarcity of fuel wood and construction materials most households planted trees particularly in lower catchment where the problem was very severe. These planted trees significantly reduced human pressure on remaining natural forest and vegetation. However, they were confined to homesteads and dominated by exotic species and hence they may contribute little to restore degraded environment/ecology and thereby in sustaining provision of ecosystem services and functions to local environment. Shortage of feed and inadequate veterinary services and subsequent decline in number and quality of livestock resulted in the declining of households' income thereby increasing malnutrition. Hence, to cope with these problems local farmers attempted various traditional grazing land management practices (rotational grazing, fallowing plots, seasonal movement, cut and carry, use of hills and valley sides). The findings of the study also showed that farmers' level of education, extension service, wealth status of households, land fragmentations and farmers' perception of the environmental degradation were major factors that influenced farmers' responses to environmental degradation.

In order to improve the livelihoods of local community and environmental quality there is a need to raise farmers' perception of sustainable land resource management practice and provision of technical and material support. Further research is required to investigate socio-economic and biophysical determinants that could significantly influence farmers' response to environmental management.

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