

Farmer's Perception on Soil Erosion and Land Degradation Problems and Management Practices in the Beressa Watershed of Ethiopia

Tesfa Worku Meshesha^{1,2,*}, Sangharsh Kumar Tripathi²

¹Department of Water resource and Irrigation Management, Debre Berhan University, Debre Berehan, Ethiopia

²Department of Water Resources Development and Management, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India

Email address:

hopee2011@gmail.com (T. W. Meshesh), tesfaworku.worku@gmail.com (T. W. Meshesh)

*Corresponding author

To cite this article:

Tesfa Worku Meshesha, Sangharsh Kumar Tripathi. Farmer's Perception on Soil Erosion and Land Degradation Problems and Management Practices in the Beressa Watershed of Ethiopia. *Journal of Water Resources and Ocean Science*. Vol. 5, No. 5, 2016, pp. 64-72.

doi: 10.11648/j.wros.20160505.11

Received: July 23, 2016; **Accepted:** August 2, 2016; **Published:** September 13, 2016

Abstract: In Ethiopia erosion and land degradation on the livelihood resource had become a key issue, resulted for food insecurity and difficult to break through the poverty gap using subsistence farming. Previously implemented soil and water conservation practice were not halted the threat, because it was mass mobilization without detailed study of real situation and without convicting farmers. Over sighting the past experience, community based watershed management practice was recommended as a possible option against the ongoing problem. Therefore, this paper analyzed farmer's perception on soil erosion and degradation problems and their management practice. From 92 randomly selected households using survey, formal and informal discussion with farmers and field observation were employed to generate the data. The result indicated that farmers were acknowledged the prevalence of soil erosion and land degradation in their watershed (93.5%) and affecting their livelihoods. However, mostly they noticed erosion and degradation when it forms gullies. They identified many prominent causes for natural resource degradation such as improper conservation practice, traditional farming practice, continuous cultivation without fallow periods, deforestation and over population. To tackle the ongoing problems, many ranges of conservation technologies were used by farmers. Following the intervention and rehabilitation practice, the rate of erosion and degradation overtime moderately reduced (58.7%). Though the practice was not demand driven and site specific management practice. Finally, this study concluded important points which needs immediate consideration for community based watershed management practice effort not only for the study area but also for the country at large are: Identifying and integrating technical as well as efficiency of indigenous and site specific and demand driven technology help to cope erosion and degradation hazard –hence increase short and long term benefit obtained from the practice.

Keywords: Community Watershed Management, Erosion and Degradation, Farmer's Perception, Conservation Technology, Ethiopia

1. Introduction

In Ethiopia, deforestation, rapid rate of soil erosion and degradation of land are a serious environmental problem resulting food in insecurity and reducing agricultural productivity. Natural resource and the benefits they provide in the form of income, food, and wood, watershed protection have no options and have critical role in enabling peoples to

have stable and adequate food supply [1, 2, 3, 4, 5, 6, 7].

Deforestation and natural resource degradation, therefore, are severely reducing the capacity of natural resource to contribute for food security, and other benefits, such as fodder and fuelwood in Ethiopia [2, 7, 8, 9]. Alarming rate of population growth, more demand for food and expansion of settlement resulting deforestation for expansion of agriculture, construction materials, fuelwood, and overgrazing [10, 11].

Natural resource degradation and resulted in reducing productivity, has increased poverty and food insecurity [7, 8, 12, 13]. In developing countries, the cost of resource degradation varies from less than 1% to greater than 9% of their growth on national product with estimate of Ethiopia 6% to 9% growth on national product, it implies the phenomenon is very intense in Ethiopia, even though all parts of the country is not suffering uniformly [14, 15]. The extent and severity of the problems different in spatial variations, is subject to difference in altitude, ecology, settlement, topography, and land use system [15, 16]. As of natural resource degradation is the major environmental problems resulting for decline of agricultural productivity [7]. The average rate of soil erosion in the country wide was estimated at 12 t/ha/annum, giving a total annual soil loss of 1,493Mt. The severity is much higher in agriculture land, in which 85% of the total population depends on it to get their survival [5].

Sustainable, effective and efficient methods against erosion and degradation is an integral component of natural resource management to achieve productive agriculture, food security and restoration of ecology [15, 17].

To protect the livelihoods of rural peoples which are experienced fragile ecosystems, resource degradation, loss of fertile soil and stress of soil moisture, watershed management has been convinced as strategy. It used to secure availability of water for domestic use, livestock, and irrigation, increasing fodder for their livestock, diversifying income and employment opportunity for farm households and landless through enhancing the productivity of agriculture in general [18, 19, 20].

To avert food security and environmental rehabilitation, the government of Ethiopia has been implemented different natural resource management strategies in many parts of the country. Physical and biological soil and water conservation and rehabilitation of hillsides, and area closure, have been practiced since in the early 1990s. Through food for work program in northern part of the country tremendous increment (26%) in forest and woodland cover has been registered, scaled-up to all food insecure regions through Safety Net Program during Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) and currently Growth and Transformation Plan (GTP). Rehabilitated natural resource through different physical and biological soil and water conservation work has been increased from 0.82Mha by 2004/ 2005 to 3.77Mha in 2009/2010 during PASDEP. Through community based watershed management additional 15Mh covered with soil and water conservation activities [5].

Despite tremendous efforts has been made by the government of Ethiopia to reduce natural resource degradation, still serious threat in achieving sustainable agricultural growth and stable economic development [21]. In developing countries most of the time farmers are enforced to participate in the conservation activity without any clear identification and priority needs of them [15, 22].

Natural resource degradation is closely related to the

interests of farmers, so proper identification of degradation prone area and site specific natural resource management techniques is the interests of the users [23]. Perception and knowledge of farmers about natural resource degradation is the determinant social factor which is important in deciding the options to curb the losses. Considering farmers' knowledge and conservation techniques is undeniable and effective mechanism for the sustainable implementation of soil and water conservation activities [24]. According to [25], identifying site specific problems with integrating local knowledge and available local raw materials is the key components of successful soil and water conservation programs in sustainable way. Thus, without identifying how local peoples are deciding to use their land, soil erosion, land degradation and conservation cannot be understood [26, 27]. Therefore, the study investigates farmer's level of thinking about erosion and degradation and their management techniques as well as watershed management technology employed in Beressa watershed.

The specific research objectives were (1) to evaluate what farmer's awareness about erosion and degradation hazard (2) evaluate farmer participation on watershed management practice

2. Materials and Methods

2.1. Research Site

The study was conducted in Beressa watershed, central highlands of Ethiopia, covering an area of 213.2km², the part of Abay basin which is situated at an altitude of 2200- 3600m a.s.l. It is located at 39° 37'E, 9°41'N. The average temperature of the area is 19.7°C per annum, with maximum and minimum rainfall amount of 1083.3mm/annum and 698.5mm/annum respectively, even though the area receives dual rainfall, most of the time it is highly concentrated in July and August. Cambisols (locally known as *Abolse*), vertisols (*Merere*), Fluvisols, Andosols and Regosols are the dominant soil types of the study area. The farming system is characterized by traditional mixed crop- livestock system on a subsistence scale in which majority of the population live. Barely, wheat, horse beans, field peas, lentils and chick peas are commonly growing crops in the area. Cattle and sheep are the dominant types of livestock, but goats, equines, and chickens are also common. Since the farming system is depending of rain-fed system, therefore, farmers are always worried about the duration and intensity of rainfall.

2.2. Data Collection and Analysis

Different community based watershed management practice was started in different parts of the country. On the basis of severity of the problems in the area, Beressa watershed was randomly selected for the study. A number of households are a member of the watershed. With the list, a random sampling technique was used to select a total of 92 sample households. Data were collected using survey under taken from May to August, 2015. Initially structured

questionnaire was prepared and pre-tested for quantitative information. The interview was done in the watershed while they were doing community based soil and water conservation activity. Additional information was obtained through informal discussion while community watershed management practices implementation undertaken. Structured survey questionnaires was comprised of both open and closed ended questions. The issues included in the questionnaires was farmer's view of soil erosion and degradation hazard and its cause, farmer's perception and participation in conservation activities, and willingness to continue watershed management practice, watershed management technology employed in the area and cause for productivity decline. After having the entire pertinent information descriptive statistics, frequency distribution and chi-square was used to test the relationship between literacy and age level with willingness to participate in conservation activities, perception of erosion and degradation hazard, trend of climate change and land ownership was done using SPSS version 23.

3. Result and Discussion

In this section the researchers discussed survey result conducted from June to August 2015. The following key points were discussed about household characteristic, perception of farm household on erosion and land degradation, prevailing cause for the problems, awareness about soil and water conservation practice, different conservation technology practiced.

3.1. Household Characteristics

The age of farm households ranged between 28 to 67 years, with averagely 50 years. The survey result confirmed that 93.5% of the respondents were male, the dominance on male respondents revealed that they were dominant in the participation of soil and water conservation activity. Of the total respondents, 91.3% were married, whereas 5.4% and 3.3% were single and divorced respectively. Like in most rural part of Ethiopia, the literacy rate in the study area was low. Half from the respondents (50%) were illiterate, whereas 35.9% were able to read and write and only 13% from the total got their first and second cycle education. The majority of households in the Beressa watershed have more than 5 members-positively contributed to accomplish their farming activities and soil and water conservation activities.

Even though since 1975 land reform has belong to public ownership, recently the government of Ethiopia design new policy to secure land use right of farm households. Land is the most important natural resource for achieving the aim of national food security and economic development in general, the study watershed in particular. Although the size of farm land is variables between <0.5ha and >1ha, all the interviewed farmers possess land. The mean land holding of the area was 1.8ha which is incomparable from the national average of 1.02ha [28].

Table 1. Household Characteristics.

| Household characteristic | | N=92 | Proportion of the total (%) |
|--------------------------------|----------------|------|-----------------------------|
| Gender | Male | 86 | 93.5 |
| | Female | 6 | 6.5 |
| Marital status | Single | 5 | 5.4 |
| | Married | 84 | 91.3 |
| | Divorced | 3 | 3.3 |
| | <30 | 3 | 3.3 |
| Age (year) [#] | 31-45 | 20 | 21.7 |
| | 46-60 | 61 | 66.3 |
| | ≥61 | 8 | 8.7 |
| | ≤3 | 10 | 10.9 |
| Household size ^{\$} | 4-7 | 60 | 65.1 |
| | ≥7 | 22 | 23.9 |
| | Illiterate | 46 | 50 |
| | Read and write | 33 | 35.9 |
| Educational status | First cycle | 12 | 12 |
| | Second cycle | 1 | 1.1 |
| | <0.5 | 25 | 27 |
| | 0.5-1 | 60 | 65 |
| Land holding (ha) [*] | 1-1.5 | 5 | 5.4 |
| | >1.5 | 2 | 2.2 |

* Mean=1.8, standard deviation= 2.6 # minimum age= 28, maximum age= 67

\$ Minimum= 1, maximum= 8, mean= 6, standard deviation=1.67

3.2. Perception of Erosion and Degradation Hazard

As indicated in Table 2, almost all the interviewed farm household included in the survey acknowledged the prevalence of soil erosion and land degradation, which contributed negatively for the health of their land in particular, for agricultural productivity in general. Farmers reflect due to loss of soil from farm fields decreased the thickness of topsoil and hence reduction in crop productivity. Though the chi-square test reflected insignificance difference between literacy level of the respondents and perception of farmers about the prevalence of erosion and degradation hazard ($X^2=0.146$, $P=0.986$), contrary to this statistically significance difference exists between the age of household and perception of erosion and degradation as a problem ($X^2=19.963$, $P=0.0918$). Asked to indicate about the prominent causes for the problems, majority of them replied improper soil and water conservation practice, traditional farming practice, free grazing, over cultivation and population pressure, deforestation, topography and land fragmentation was repeatedly mentioned, as a serious cause for accelerated natural resource degradation. Even though farmers were perceived erosion and degradation as a problem of their farm land, the level of understanding about the severity of the problem was confined mostly to gully formation. As can be observed from the field, sheet and formation of rills erosion caused for decline in productivity and limited perception other than gully erosion could influence their participation in the conservation activities (Table-2).

According to National Meteorological Service Agency /NMSA cited in [28], deforestation, unsustainable farming practice, and alarming rate of population growth put a great pressure on natural resource. The relationship between increasing number of population and fixed quantity of land

resource make confronting the country and underline for the difficulty of securing food for their survival. As the figure-1 depict that for over 100 years period from 1950 to 2050 the number of peoples living per km² of arable land. If the growth rate continues for the coming 2050, per km² of arable land 270 farm households will enforced to live, which is very high compared to 35 in 1950.

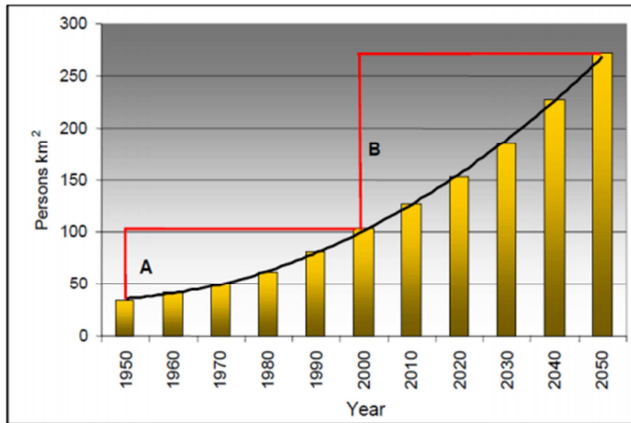


Figure 1. Estimated population per arable km², 1950-2050 sources: National Meteorological Service Agency/NMSA. (2001) as Cited in Teshome 2014.

Concerning indicator of erosion and degradation, yield reduction and poor crop performance, dissection of field and gully was repeatedly mentioned by the respondents. Rill formation, removal of top soil by runoff and poor water holding capacity of soil was less believed to be an indicator for the prevalence of natural resource degradation.

In recent year farmers also noticed that natural resource has become more susceptible to erosion and degradation because of change in rainfall pattern. The rising of temperature in the study watershed, elsewhere in the world, was increasing and become a serious problem for the survival of their livelihoods. Eighty-nine% of respondents replied

climate has been increasing for the last 30 years (see Table-2 and Figure-2) and coupled with the irregularity of rainfall making things complex to satisfy food security. The duration of dry season has been extended for long period, in reverse the rainy season has significantly decreased and with distractive rainfall when it came. The chi-square test result indicated no significance difference between the literacy level of the respondents and perception on rate of climate change over time ($X^2=3.375$, $P=0.760$). Whereas, perception of climate change overtime and age the respondents were statistically significant ($X^2=46.182$, $P=0.00905$). It was suggested that elder farmers have long experience to differentiate the trends of climate change for the area.

Table 2. Farmers' view of soil erosion and land degradation, cause and indicators.

| Farmers response: | Proportion of the total (%) | |
|--|-----------------------------|------|
| | Yes | No |
| Soil erosion and land degradation problem | 93.5 | 6.5 |
| Cause for soil erosion and land degradation | | |
| Improper conservation practice | 64.1 | 35.9 |
| Traditional farming practice | 68.5 | 31.5 |
| Free grazing | 69.6 | 30.4 |
| Over cultivation and Population pressure | 82.6 | 17.4 |
| Topography | 69.6 | 30.6 |
| Deforestation | 82.6 | 17.4 |
| Land fragmentation | 53.3 | 46.7 |
| Indicator of the problems | | |
| Yield reduction | 87 | 13 |
| Rill formation | 18.5 | 81.5 |
| Dissection of field and formation of gullies | 100 | - |
| Crops become yellowish color | 41.3 | 58.7 |
| Top soil removed by runoff | 23.9 | 76.1 |
| Poor water holding capacity | 21.7 | 78.3 |
| Trend of climate change overtime | | |
| Increasing | 89.1 | 9.8 |
| Decreasing | 9.8 | 89.1 |
| Same | 1.1 | 98 |

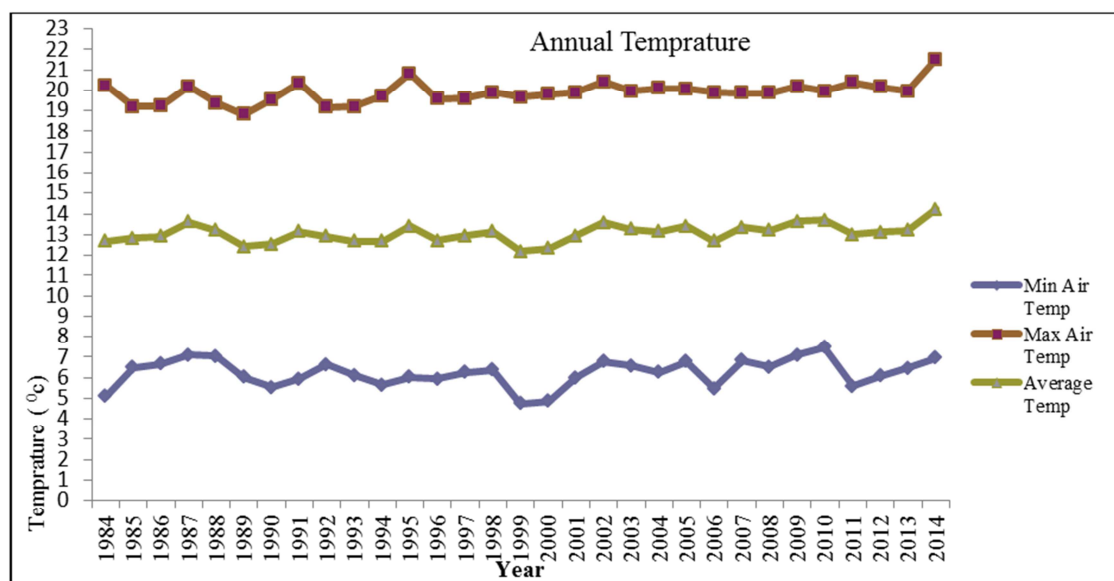


Figure 2. Annual temperature over time in study watershed.

3.3. Perception of Conservation Work

Recognizing of natural resource degradation hazard by farmers is positively contributed for the adoption of soil and water conservation practice. Respondents were asked to respond over the benefit of management practice, 75% from interviewed farmers were replied they were recognized the benefit of soil and water management practice, whereas, 25% didn't recognized the benefit of community based watershed management practice (Table-3). On the basis of chi-square test result literacy level of respondents and willingness to participate in the conservation activity was statistically not significant ($X^2=2.282$, $P=0.516$). Whereas, the age level of respondents and willing to participation in the conservation work has statistically significant relationship ($X^2=31.661$, $P=0.383$). Even though almost all the interviewed farmers were participated in the conservation work, 65.2% from all respondents use extension agent /DA/ as a driver to participate in management practice and only 20.7% were participated with their conviction and 7.6% were incentive/ food-for work used as a means for their participation in the activity. In whatever way it is, 92.4% of them were participated in their community based watershed management practice whereas, 7.6% from them were not involved in the activity. Some of them (5.4%) said they were participated due to fearing of punishment if absent from management practice without reasonable social problems.

Designing rules and regulation on the basis of farmer's knowledge, the demand they need and integrating with the available local row materials could have immense contribution for the sustainability of implemented community based watershed management practice. From the surveyed households, 83.8% replied they have rule and regulation-which was very important for effectively managing and rehabilitating their watershed. On the contrary, 16.2% from all the surveyed farmers reflected they don't know whether they have rule and regulation or not. Likewise, rules and regulation designed by the governmental bodies (62%) only 34.8% of respondents were assumed to be participated in the design of rules and regulation. Even though 63.4% of from all interviewed farmers willing to adopt soil and water conservation practice, 36.6% were not willing to adopt and continue the conservation structure. Many reasons was pointed out by farmer during interview, more than half of them replied technology was not demand driven (58%). According to [21] the context of watershed used to provide over all framework to investigate complex and reciprocal relationship between land use, soil, water and other natural resource and the inter dependence of farmers with their resource. Likewise, the immediate return of soil and water conservation did not recognized by farmers – hence provision of other means of income source to reduce continuous pressure on natural resource willingness to adopt soil and water conservation otherwise [23]. With respect to able to implement the watershed technology, 55.9% of the respondent said they were able to implement a range of

watershed management technology. Despite, 43% replied not able to implement by their own without the help and guide of watershed management expert. In this regard, identifying compatible and easily adaptable with local indigenous soil and water conservation technology should be taken to consider.

Table 3. Farmers' perception of conservation work.

| Perception on conservation work | Proportion of the total (%) |
|--|-----------------------------|
| Knowing the benefit of CBSWC practice | |
| Yes | 75 |
| No | 25 |
| Have you ever participated in CBSWC? | |
| Yes | 92.4 |
| No | 7.6 |
| Motive to participate in the activity | |
| Myself/willingly | 20.4 |
| Extension agent (DA)/ Forcefully | 64.5 |
| Food for work/ incentive based | 7.5 |
| Reason not to participate in SWC | |
| I don't have land | 1.1 |
| I don't know the benefit | 1.1 |
| Other reason | 5.4 |
| Ability to implement CBSWC practice after project | |
| Yes | 55.9 |
| No | 43 |
| Do you have rules and regulations? | |
| Yes | Yes |
| No | No |
| Responsibility to design CBSWC rules and regulations | |
| Government bodies | 62 |
| Ourselves | 34.8 |
| Willingness to adopt conservation practice | |
| Yes | 62.4 |
| No | 36.6 |
| Is CBSWC practice is gender specific? | |
| Yes | 75.3 |
| No | 23.7 |
| Is the practice is demand driven? | |
| Yes | 40.9 |
| No | 58.1 |

Seventy-five% from all the respondents replied there was sensitivity of gender in participation of watershed management as well as obtaining the benefit from it. Around 23.7% responds community based watershed management was not gender specific, mainly male were determinant in management of their watershed (Table-3). Participation of women in community watershed management and monitoring practice was limited. Previously because of social taboos, women were neglected in participating, planning and management of various decision making process, remained in the house. Independence in economic and other task had enabled them to recognize the contribution of women to their households in particular and for the society and economy in general [29].

3.4. Soil and Water Conservation Technologies

The finding of the study has examined different types of soil and water conservation practice undertaken. These are;

check dam, terracing, tree planting, counter ploughing, soil and stone bund, agro-forestry programs, water way, area closure, cut and carry, multipurpose tree plantation and percolation pit were the dominant structures under implementation in cultivated and uncultivated fields, selected and recommended by the concerned district and development agent (DAs). Majority of the surveyed farmers depicted their adoption and participation in the construction of various conservation structures were undertaken against their will, development agents was taken the lead to enforce and impose punishment for not being participate in conservation activities. The primary reason for this was not lack of awareness about hazards of natural resource degradation and shortage of householder size, but some of the revealed feeling of ownership insecurity. Farmers repeatedly pointed out if once community based soil and water conservation practice was implemented in their land they feel that losing and belongs to a communal land. Farmer possessing own farm land likely adopt and continue conservation activity. Likewise, short term tenants do no willing to adopt and invest on conservation activity because they are not likely obtaining the return [30]. The chi-square test indicated that statistically does not exist between participation in conservation activities and absolute private property of land ownership ($X^2=0.0749$, $p=0.784$). Likewise, associated with the technology recommend to implement, they assumed to some of the technology under implementation were a cause for existence of rodent (stone bund). Contrary to this, study undertaken by [31] in Tigay region, 64% of soil was trapped by stone bunds. Likewise, the study concluded that no serious long term negative effect reversing the benefit of stone bunds. Farmers were using bund for multiple objectives of which conservation of soil only one, for instance farmers using for demarcating their farm plot against the encroachment of the neighbors. This discrepancy in objectives caused difference in soil and water conservation technologies. Indigenous technologies follow boundary based, in contrast the recommended technologies follow contour based. In this regard understanding indigenous soil and water conservation practice and the logic behind them, and critically identify different conditions under which farmers invest in conservation and the constraints inhibiting such conservation technology [30].

Farmers complain were rational. It was observed that construction of percolation pit in their plots of land didn't consider the real ground situation. Development agents were simply followed the guide line ordered from the district. But they didn't consider the parcel and fragmented land, the slope angle, intensity and amount and intensity of rainfall in the area. Without having how much volume of rain fall, for how long it will stay and how much runoff will generate in the field, it is impossible to determine the size, dimension and depth of structures. In Addition to this, construction of different structures was manly carried out in lower slope, because of fearing of collapse, if it built in higher slope. But farmers still putting pressure over the steeper slope and exposed for further erosion and degradation.

Table 4. Types of soil and water conservation activities Beressa watershed.

| Types of conservation practice | Proportion of the total (%) | |
|--------------------------------|-----------------------------|------|
| | Yes | No |
| Check dam | 90.2 | 9.8 |
| Terracing | 88 | 10.9 |
| Tree planting | 95.7 | 3.3 |
| Counter ploughing | 68.5 | 30.4 |
| Soil and stone bund | 90.2 | 8.7 |
| Agro-forestry programs | 94.6 | 4.3 |
| Water ways | 87 | 12 |
| Area closure | 85.9 | 13 |
| Cut and carry | 91.3 | 7.6 |
| Multipurpose tree plantation | 96.7 | 2.2 |
| Fallowing | 21.7 | 77.2 |
| Percolation pit | 89.1 | 9.8 |

3.5. Rate of Soil Erosion, Land Degradation and Fertility Change over Time

Concerning the rat of prevailing problem over time, even though difficult for farmers to differentiate the trend of natural resource hazard and decrease in fertility of land, more than half of the respondents believed to be moderate (58.7%), mass implementation of different physical and biological soil and water conservation management practice contributed for the curbing of the problem and following the practice the hazard has become minor (20.7%), though some of the farmers believed the rate even after project implementation sever and same as the previous 3.3 and 17.4% respectively. The fertility of soil was one of the concern and determinant of agricultural production in the Beressa watershed. Over 90% of the interviewed farmers observed soil fertility problem in their farm fields over the years, only 9.8% from respondents didn't observe the problem of soil fertility in their farm plot. Yield decline was reported by farmers (81.5%), attributed to indicator of soil fertility decline the remaining few of farmers reported soil structure and color change, increased input demand and loss of soil wez¹ was subjected to soil fertility decline from their farm plots. Asked farmers about the reasons for fertility decline they give up absence of fallowing (80.4%), continuous cultivation with limited fallowing, limited use of modern fertilizer (51.1%) and absence of using intercropping practice (80.4%) was responsible factor for the decline of soil fertility.

Table 5. Perception of farmers on soil erosion, land degradation and soil fertility change over time.

| Farmers perception on: | Proportion of total respondents (%) |
|--|-------------------------------------|
| Erosion and degradation after project implementation | |
| Severe | 3.3 |
| Moderate | 58.7 |
| Minor | 20.7 |
| Unchanged | 17.4 |
| Soil fertility reduction problem | |
| Yes | 90.2 |
| No | 9.8 |

¹Wez is a local word that describes the appearance of the soil as dusty and with poor structure

| Farmers perception on: | Proportion of total respondents (%) |
|---|-------------------------------------|
| Indicator of soil fertility decline | |
| Yield decline | 81.5 |
| Soil structure and color change | 5.4 |
| Increased input demand | 1.1 |
| Loss of soil "wez" | 2.2 |
| Methods of soil fertility management | |
| <i>Intercropping</i> | |
| Yes | 19.6 |
| No | 80.4 |
| <i>Use of Manure</i> | |
| Yes | 98.9 |
| No | 1.1 |
| <i>Fallowing</i> | |
| Yes | 19.6 |
| No | 80.4 |
| <i>Use of modern fertilizer</i> | |
| Yes | 48.9 |
| No | 51.1 |
| <i>Crop rotation</i> | |
| Yes | 95.7 |
| No | 4.3 |
| <i>Grass strip and mulching</i> | |
| Yes | 54.3 |
| No | 45.7 |
| <i>Burning soil as a methods of soil fertility management</i> | |
| Yes | 82.6 |
| No | 16.3 |
| soil fertility improvement after project implementation | |
| None | 3.3 |
| Some | 72.8 |
| Much | 23.9 |

Interviewed farmers requested to respond concerning soil fertility improvement after implementation of community based soil and water conservation management, they noted that to some extent (72.8%) they observed soil fertility increase over time and 23.9% replied much increased nevertheless 3.3% said none. From the interview and group discussion, farmers recognized soil fertility change over time influenced by soil and water conservation and rehabilitation practice and other soil fertility improvement practice (Table-5). In the study watershed burning of soil (locally called "guie") as a method of traditional soil fertility management was practiced by farmers which account 82.6% but 16.3% from the interviewed didn't use (Table-5). According to different studies elsewhere burning of soil using fire had advantage and disadvantage, as [32] concluded, partial burning of soil coupled with fallowing accumulation of soil organic carbon could increase. In contrast due to long time impact of burning especially 0-2cm the layer of soil in the grass land of South Africa soil organic carbon was reduced [33]. According to [34], cation exchange capacity and total nitrogen content was reduced due to heating of soil using fire, however it used to increase for the available phosphorus.

4. Conclusion

The result of the study revealed that farmers recognized the prevailing natural resource degradation hazard cause for

the decline for productivity. Level of knowledge and awareness is the determinant factor of sustainability and adoption of soil and water conservation technologies. Even though most farmers were perceived prevalence of erosion and degradation hazard, all the asked respondents were considered the problem to be severe when gullies form of erosion and degradation appeared in their watershed. Farmers in the study watershed had undergone different types of watershed management techniques. Even though the rage of intensity in implementation of the technology was variable, the following watershed management techniques was under implementation among them check dam, terracing, tree planting, counter ploughing, agro forestry, cut and carry, area closure, multipurpose tree plantation and percolation pit widely implemented practice.

Watershed management officials must consider the design of the management practice on the basis of farmer's preference and ground reality. The concerned officials must recognize the reason why farm households not willing (36.6%) to continue and adopt management practice sustainably. Though around 62.4% of were willing to adopt the practice, farmers reported that mostly they were participated enforced by development agent (DA), instead of enforcing them to pay punishment being absent from the practice, it is batter offer education about the benefit of conserving the watershed, so concerned officials acknowledge and support the indigenous knowledge and technologies. In line with this [23], concluded in working successful soil and water conservation for farmer's indigenous soil and water conservation should take as a starting point. In addition, so as to maximize the compatibility as well as the adaptability of newly designed soil and water conservation practice, clearly identification of small holder production system and other family constraint.

Effectively rehabilitating and management of watershed resource had considerable benefit for the achievement and attaining food security of farm households. For the successful implementation the project, farmers' awareness about long term and short term benefit obtained from rehabilitated watershed on the one hand and long and short term consequence of natural resource degradation hazard on other are critical. Motivating farmers, empowering them in planning and designing watershed management policies and strategies is the critical factor for the adoption and expansion successful practice and selecting the appropriate technology on the basis of demand driven, and existing socio-economic circumstance. Gender sensitization issue must be address to empower women in planning and management of their watershed.

In conclusion, community based watershed management in Ethiopia should be designed on the basis of ground reality and acknowledgment of indigenous knowledge. Consideration of these and other important issues will improve the sustainability; expansion of successful management approach to other parts of the country- will improve the livelihoods of the farmers.

Authors' Contribution

In the acquisition of the data, data collection, data coding and entry, data analysis, interpretation of the result, and writing has been substantially contributed by TW. SKT has been involved in critically advising, revising the manuscript and made possible suggestion. Both the authors read and approved the final manuscript.

Acknowledgments

This research was supported by the Ministry of education, government of Ethiopia. Prof. S.K Tripathi, Department of water resource development and management are acknowledged for the valuable comment on the manuscript. Sincere thanks also extended to all who took part for the manuscript. For the insightful comments special thank extended for editors and anonymous reviewers.

References

- [1] Bishaw, B. (2005) Deforestation and Land Degradation in the Ethiopian Highlands: A Strategy for Physical Recovery. *Northeast African Studies*, 8 (1), 7-25.
- [2] Berry, L. (2003) Land degradation in Ethiopia: Its extent and impact. *Commissioned by the GM with WB support*.
- [3] Anemu, B. (2006) *Determinants of Farmers' Willingness to Pay for the Conservation of National Parks: The Case of Simen Mountains National Park* (Doctoral dissertation, MSc Thesis in Agricultural Economics, Haramaya University).
- [4] Tamene, L., & Vlek, P. L. (2008) Soil erosion studies in northern Ethiopia. In *Land use and soil resources* (pp. 73-100). Springer Netherlands.
- [5] Authority, E. P. (2012) National Report of Ethiopia. In *The United Nations Conference on Sustainable Development (Rio Vol. 20)*.
- [6] Wolka, K., Moges, A., & Yimer, F. (2013) Farmers' perception of the effects of soil and water conservation structures on crop production: The case of Bokole watershed, Southern Ethiopia. *African Journal of Environmental Science and Technology*, 7 (11), 990-1000.
- [7] Tesfa, A., & Mekuriaw, S. (2014) The Effect of Land Degradation on Farm Size Dynamics and Crop-Livestock Farming System in Ethiopia: A Review. *Open Journal of Soil Science*, 2014.
- [8] Sonneveld, B. G. J. S. (2002) *Land under pressure: the impact of water erosion on food production in Ethiopia*. Shaker.
- [9] Bekele, M. (2004) "Ethiopian Forestry Action Program and Its Status". In Shiferaw Eshetu (2015) In *Integrates Forestry Policy in Ethiopia. Proceeding of Public Meeting. Forum for Environment in Partnership with Inter Church Organization for Development Cooperation, Addis Ababa*.
- [10] Gashaw T. (2015) The implications of watershed management for reversing land degradation in Ethiopia
- [11] Worku, T., & Tripathi, S. K. (2015) Watershed Management in Highlands of Ethiopia: A Review. *Open Access Library Journal*, 2 (6).
- [12] Dalhatu, S., & Garba, J. (2012) Soil Resources Degradation and Conservation Techniques Adopted among the Small holder Farmers in Gusau, North-Western Nigeria. *Nigerian Journal of Basic and Applied Sciences*, 20 (2), 134-141.
- [13] Tilahun, U., & Bedemo, A. (2014) Farmers' perceptions and adaptations to climate change through conservation agriculture: the case of guto gida and sasiga districts, western Ethiopia. *Academia Journal of Agricultural Research*, 2 (10), 207-224.
- [14] Barbier, E. B., & Bishop, J. T. (1995) Economic values and incentives affecting soil and water conservation in developing countries. *Journal of Soil and Water Conservation*, 50 (2), 133-137.
- [15] Shiferaw E. (2015) Awareness and views of farming households regarding land resource degradation and conservation- the case of Bule hora, Ethiopia.
- [16] Gamachu, D. (1988) Environment and development in Ethiopia. *Beyond the famine: an examination of the issues behind famine in Ethiopia*, pp. 54-96.
- [17] Tamene, L., Park, S. J., Dikau, R., & Vlek, P. L. G. (2006) Analysis of factors determining sediment yield variability in the highlands of northern Ethiopia. *Geomorphology*, 76 (1), 76-91.
- [18] Rao, C. H. (2000) Watershed development in India: Recent experience and emerging issues. *Economic and Political Weekly*, 3943-3947.
- [19] Arya, S. L., Panwar, P., & Yadav, R. P. (2011) Role of watershed management in bridging demand-supply gap of fodder for enhancing livestock production in Shivaliks, Haryana. *Agricultural Economics Research Review*, 24 (2).
- [20] Johnson, J. N., Govindaradjane, S. and Sundararajan, T. (2013) The role of rural women in watershed development project. *International J. Engineering Sci. and Innovative Technology*, 2 (1), pp. 540-544.
- [21] Taddese, G. (2001). Land degradation: a challenge to Ethiopia. *Environmental management*, 27 (6), 815-824.
- [22] Bewket, W. (2003) *Towards integrated watershed management in highland Ethiopia: the Chemoga watershed case study* (Vol. 44). Wageningen University and Research Centre.
- [23] Amsalu, A., & De Graaff, J. (2007) Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological economics*, 61 (2), 294-302.
- [24] Daba, S. (2003) An investigation of the physical and socioeconomic determinants of soil erosion in the Hararghe Highlands, eastern Ethiopia. *Land degradation & development*, 14 (1), 69-81.
- [25] GTZ (2005) Guidelines for Implementation of the WAJIB Approach in Ethiopia. (Second Edition). Oromia Regional State, Bureau of Agriculture and Rural Development.
- [26] Mazzucato, V., & Niemeijer, D. (2000) Rethinking soil and water conservation in a changing society: A case study in eastern Burkina Faso.

- [27] Mbagal-Semgalawe, Z. and Folmer, H., 2000. Household adoption behaviour of improved soil conservation: the case of the North Pare and West Usambara Mountains of Tanzania. *Land use policy*, 17 (4), pp. 321-336.
- [28] Teshome, M. (2014) Population growth and cultivated land in rural Ethiopia: land use dynamics, access, farm size, and fragmentation. *Resources and Environment*, 4 (3), 148-161.
- [29] Gate, S. (2001) Empowerment of Women in Watershed Management Guraiya Panchayat, Madhya Pradesh. *Indian Journal of Gender Studies*, 8 (2), 247-256.
- [30] Kerr, J. M., & Sanghi, N. K. (1992) *Indigenous soil and water conservation in India's semi-arid tropics*. IIED International Institute for Environment and Development, Sustainable Agriculture Programme.
- [31] Vancampenhout, K., Nyssen, J., Gebremichael, D., Deckers, J., Poesen, J., Haile, M., & Moeyersons, J. (2006) Stone bunds for soil conservation in the northern Ethiopian highlands: Impacts on soil fertility and crop yield. *Soil and Tillage Research*, 90 (1), 1-15.
- [32] Amare, T., Yitaferu, B., & Hurni, H. (2013) Effects of "Guie" on Soil Organic Carbon and Other Soil Properties: A Traditional Soil Fertility Management Practice in the Central Highlands of Ethiopia. *Journal of Agricultural Science*, 5 (7), 236.
- [33] Fynn, R. W. S., Haynes, R. J., & O'connor, T. G. (2003) Burning causes long-term changes in soil organic matter content of South African grassland. *Soil Biology and Biochemistry*, 35 (5), 677-687.
- [34] Parlak, M. (2011) Effect of heating on some physical, chemical and mineralogical aspects of forest soil. *Bartın Orman Fakültesi Dergisi*, 13 (19), 143-152.