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Assessment of farmers' perception and adaptation mechanism to soil erosion problem in Shomba Kichib, Gimbo District, Kaffa Zone, South West Ethiopia

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Soil erosion is one of the major problems challenging farmers in Ethiopia. Though a number of soil and water conservation methods were introduced and practiced, sustaining the application of these measures is far below expectations and soil degradation is still a persistent problem. This research was conducted with the aim of finding out the type of indigenous and introduced soil and water conservation measures, determining the farmer's adaptation mechanism to erosion and biophysical factors that influence the use of these measures in the area. For this study, a total of 35 households were interviewed and farm fields were visited. The results showed that farmers in the area were mainly annual crop producers on slope farmland with traditional as well as newly introduced conservation structures. Contour farming for maize and furrow making, *gulgualo* and *gilalo* methods for millet and pepper production are the common ones. Continuous farming, tillage on slope land with no conservation structures, deforestation and frequent tillage up to 5 times for some crops are important factors aggravating soil erosion. As a recommendation, the very sloppy nature of the study area has to be given due emphasis and priority for an appropriate designed soil and water conservation practice.

Key words: Soil erosion, soil and water conservation, farmers' perception, conservation measures.

INTRODUCTION

Agriculture is a back bone of the economy of Ethiopia and a way of life for which agricultural land is an indispensable resource on which the welfare of the society is built on. The livelihood of the vast majority of the population depends directly or indirectly on this sector. Needless to mention, such dependence obviously leads to increased vulnerability of the economy to problems related to land degradation (Wegayehu, 2003). Though agricultural land in Ethiopia has provided a means of livelihoods for the majority of the population, land resources are facing increasing degradation mainly due to soil erosion by surface runoff water in the form of sheet and rill erosion. The problem is particularly severe on cultivated marginal and sloping land because such areas are generally susceptible to soil erosion (Tadesse and Belay, 2004; Greenland et al., 1994). Soil erosion is greatest on cultivated land where average annual soil loss was 42 t/ha/yr (Hurni, 1990).

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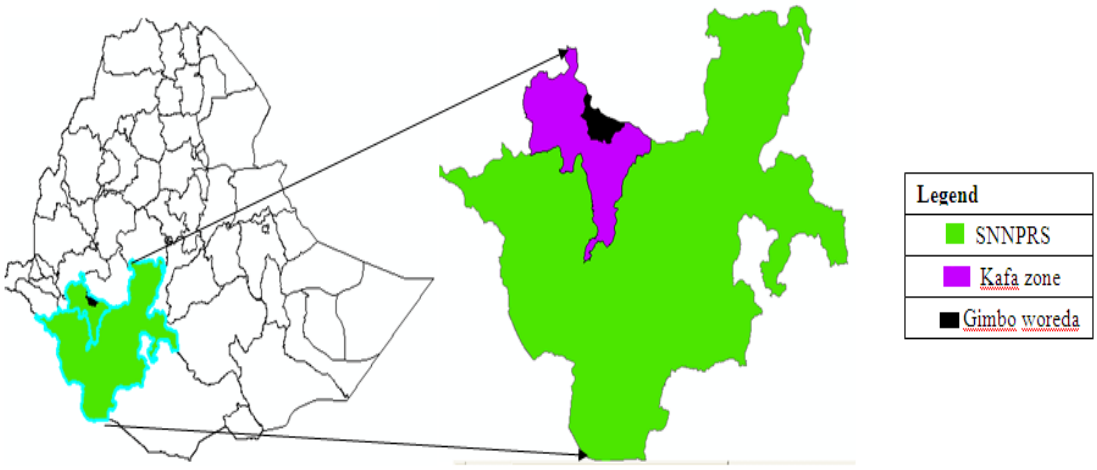

Figure 1. Map of study area.

The Soil Conservation Research Project (SCRP) has estimated an annual soil loss of about 1.5 billion tons from the highland. According to the Ethiopian Highlands Reclamation Study (EHRS, 1984) soil erosion is estimated to cost the country 1.9 billion US$ between 1985 and 2010. Soil erosion and nutrient depletion presents a threat to food security and sustainability of agricultural production in many developing countries. Betru (2003) reported that, Ethiopia losses around 2 billion tons of fertile soil and subsequently losses 2% of the annual grain production, which is roughly equivalent to 120, 000 tons of cereal per annum (Mesfin, 2004). According to Mesfin (2004), the annual loss in grain production due to erosion in 2000 was 170,000 tones. This shows the loss of income in terms of lost agricultural production of US $150 million. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile land (Abegaz, 1995).

To increase agricultural production and to conserve land resources in sustainable farming, different strategies have to be introduced targeting conservation agriculture (CA). Conservation agriculture is an interdisciplinary and synergetic set of principles to combat soil fertility loss, soil structure degradation, reduced water use efficiency and rapidly declining production levels (Kaumbutho and Josef, 2007). Conservation agriculture is not an actual technology; rather, it refers to a wide array of specific technologies that are based on applying one or more of the three main conservation agriculture principles (IRRR and ACT, 2005 cited in Kaumbutho and Josef, 2007). The application of the three principles include: minimal soil disturbance (reduce the intensity of soil tillage), cover the soil surface permanently and diversify crop rotation (Ibid).

Among conservation agriculture technologies, soil and water conservation measures (better soil erosion control, better soil water infiltration capacity), agronomic soil fertility management technologies/practices (mulching, organic matter incorporation, crop rotation, integrated soil fertility management), integrated weed management, integrated pest and disease management, post harvest techniques and mechanization (specialized) implements are the major ones. The rate of soil loss in Ethiopia was put in severity levels as, very high (>100 t/ha/yr); high (50-100 t/ha/yr); moderate (10-50 t/ha/yr); low (1-10 t/ha/yr) and no erosion (<1 t/ha/yr) (Hurni, 1983). Farmers in the area practice crop production on slope land due to different causes like shortage of land. In addition, the crops being cultivated were those requiring frequent tillage to fine the soil that could aggravate soil erosion and therefore, the importance of this research was roughly to assess and discuss how soil erosion was highly occurring especially on slop farmland and what type of conservation methods were practiced by farmers and thereby to identify farmers' adaptation mechanisms to mitigate soil erosion in the area.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Gimbo district, Kaffa zone, southern Ethiopia. It is found within the southwestern plateau of Ethiopia. The area lies within 07°00'- 7°25'N Latitude and 35°55'-36°37'E Longitude. Its altitude ranges from 1600 to 1800 m.a.s.l. The topography is characterized by slopping and rugged areas with very little plain land (Matheos, 2001). Climatically, the area experiences one long rainy season, lasting from March /April to October. The mean annual rainfall ranges from 1710 to 1892 mm. Over 85% of the total annual rainfall, with mean monthly values in the range of 125 to 250 mm occurs in the 8 months long rainy season. The mean temperature ranges from 18 to 19.4°C (Matheos, 2001). The area is known by its dense natural forest with diverse tree and wild life species (Figure 1).

The soils of the area are deep, clay red soils with an agric B-

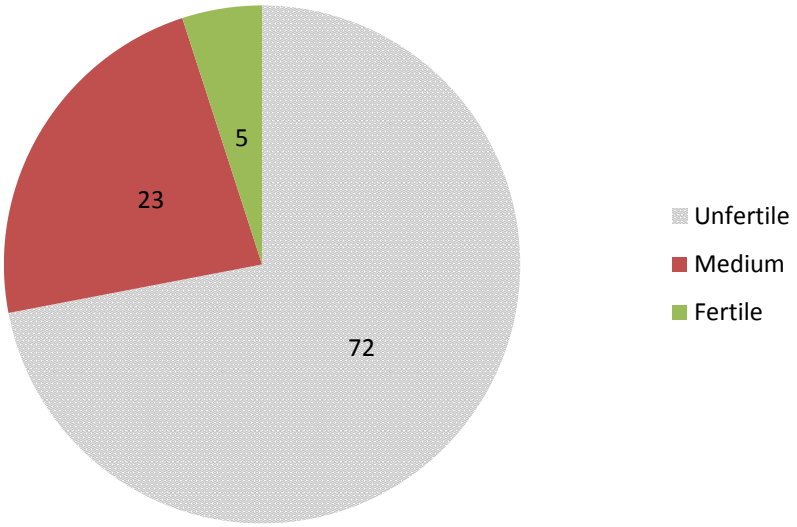

Chart 1. Land fertility level in percent.

horizon dystric nitosols. The soils have good agricultural potentialities, good physical properties and uniform profile. They are porous, clay-to-clay loam in texture and have low base saturation with less than 5.5 pH values and well drained (BoARD, 2010). Regarding the farming system of the area, it is mixed type of which crop production is dominant. It is estimated that over 62% of the total area is, or has been, under agricultural cultivation. Like in other areas, activities related to coffee production provide the largest income and employment opportunities for the local communities. Apiculture and non timber products like spices also play an important role in the household's economy of the study area.

Sampling technique

Gimbo is one of the districts, in which various cereal productions takes place. Shomba Kichib administration, (hereafter KA), was selected based on the severity of soil erosion in farmlands. Four villages namely Gojamsefer, Melligawa, Keja, and Matana were selected. To collect information on farmers' perception on soil and water conservation, a total of 35 households out of 619 were selected using systematic random probability sampling. From three villages 9 households (HHs) each while from one village 8 HHs totally contributing more than 5% of HHs were selected and interviewed.

Data collection

Both formal and informal methods of data collection were employed. Data on soil erosion problems, conservation practices (indigenous and/or introduced) and the extent to which farmers continuously use it, adaptation mechanism of erosion risks, cropping systems, responsibility of farmers and governments on soil and water conservation, farmers practice on tree and fruit plantation and their awareness on importance of land certification were collected by interviewing sample respondents with an instrument of structured questionnaire. Transect walk across the village were conducted in order to obtain all the necessary biophysical information of the area. Moreover, key informants interview (KII) was done with for detail understanding on the issues. The data was analyzed using simple descriptive statistics using SPSS software.

Table 1. Causes of soil fertility losses.

Main causes	Percent
Soil erosion	35
Continuous farming	51
Not using fertilizer	9
No decrease in soil fertility	5
Total	100

Source: own survey, 2012.

RESULTS AND DISCUSSION

Fertility status of soil in the area

The fertility level of farmland in the area was assessed physically as well as using interview. Most of the farmers, 72% of the cases, responded their soil fertility status being under medium (Chart 1). Respondents explained that the main causes of the soil degradation are dominantly continuous farming and soil erosion respectively. However, 74% of farmers do not consider soil degradation as priority problem because of different economic (input cost) as well as social (land rent and share cropping) reasons (Table 1).

Farmers' perception on soil erosion occurrence, its cause and risk

As it was indicated in Table 2, farmers have different understanding and explanation about the soil erosion occurrence. However, it is clear from the data that a farmer could observe whether soil erosion exists when,

Table 2. Farmers perception on defining soil erosion occurrence on farmland.

Explanation from the respondents	Frequency	Percent
Top soil color change to red	6	17
Crop yield reduce annually	3	9
Black soil collected on furrow in farm	6	17
Sandy soil occur on top of farmland	4	11
Fertile soil seen down slop in furrow	5	14
Rills observed on farmland after rain	2	6
Deposited soil seen on tree root	4	11
Red soil upslope and black soil down slop in furrow	1	3
Deposited soil on level land after rainfall	3	9
Indifference	1	3
Total	35	100.0

Source: Own survey, 2012.

Table 3. Response for causes for soil erosion on farm land.

Causes raised by farmers	Count	Percent
frequent cultivation	8	23
High tillage frequency or (ploughing 4 to 5 times before sowing)	7	20
Heavy rainfall during sowing time	8	23
Absence of SWC on slope land	8	23
Deforestation on the top catchment	3	8
Unreliable and erratic rainfall due to climate change	1	3
Total	35	100

Source: own survey, 2012

how, and why it occurs on his land and its preventive measures. All the ideas raised by farmers about soil erosion occurrence are true definitions unless it varies from farmer to farmer depending on real event on his farm land. Almost all of the farmers justified that soil erosion was very high during millet and chili pepper production. Since the topography of the farmlands were mostly sloppy and also farmers were very interested to produce these crops on their limited sloppy land it was not uncommon to see erosion occurring there The reasons raised were; they plough the land for these two crops 4 to 5 times during land preparation which can pulverize soil particles making it simple for transport by runoff; they cultivate slope farm land for these crops with no advanced conservation structure except traditional furrows which fills soon after first rain allowing the soil to be eroded thereafter; the crops were planted with wide spacing which expose the land to rain drops. In addition to this, time of cultivation for these crops is during high rainfall period. Some of them explained their reason in relation to deforestation because the forest on top slope of their land was cleared resulting to higher runoff to damage the land at down slope. According to the response, due to climate change problem, erratic or unpredictable rainfall occurs resulting to unexpected erosion on the farmland (Table 3).

Soil and water conservation practices

Various soil and water conservation practices (indigenous and improved) have been identified in the study area. The area has practice of both introduced and traditional soil and water conservation activities. 74% of respondents practice either of the above methods however, 26% did not have any conservation practice because of less awareness of farmers on the risk of soil erosion on yield of crops (Chart 2).

Indigenous soil and water conservation practices

Farmers in Shomba Kichib used different types of indigenous soil and water conservation measures to conserve and maintain their farm land. From the study it was observed that farmers were resistant to construct physical structures and give priority for indigenous ones because, the introduced one compete for land, it requires

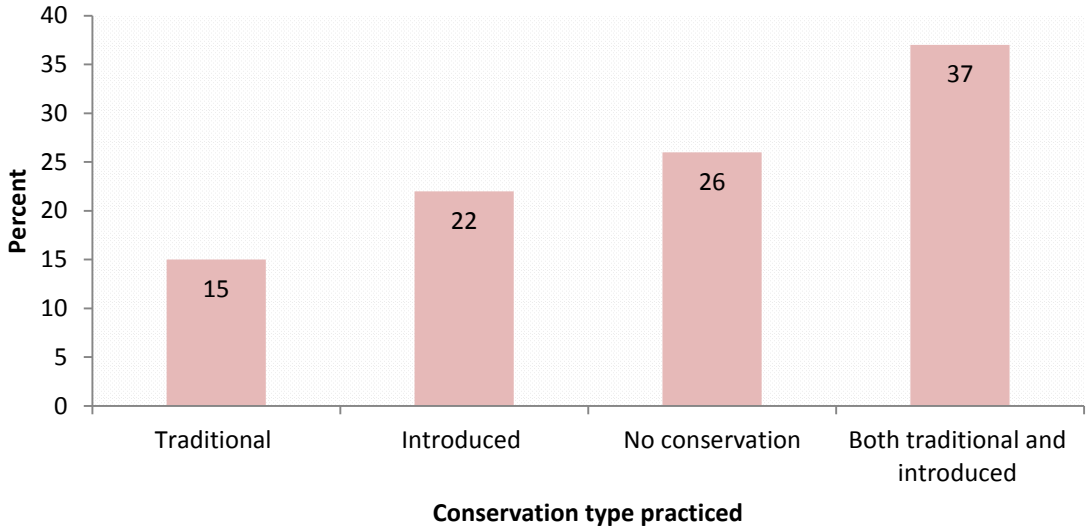

Chart 2. Conservation methods practiced by farmers.

labor, difficulty to plough by oxen and intensive machinery farming between constructed bunds. Due to this, farmers apply traditional soil conservation practices assuming that it does not have significant difference in terms of controlling soil loss from farmland. Less interest to adopt introduced soil and water conservation practice was also related to less awareness on sustainable and long term importance of the farmland. However, there were appreciable indigenous methods of soil erosion control. These include contour farming, making furrow (locally called *boie*), making trash line across slope on contour, *gulgualo*, *gilalo* and leaving crop residue on farmland. The drawback of traditional methods is; its application did not follow the watershed management approach/ soil and water conservation design requirement which highly depends on land survey result/. Traditional method has temporary advantage like for a given season. This indicates that tradition conservation method is not sustainable way to solve soil erosion problem. The common traditional methods practiced in the area include:

Contour farming: Farming the field across the slope following hypothetical contour line.
Furrow making (locally called *boie*): Farmers make furrow (channel) with undefined interval after last tillage and during sowing time. They assume that the furrow will collect soil eroded from above furrow interval (catchment). It was observed that the furrow was full of soil deposit.
Laying trash line: Trash is residue of crop or rubbish in the farmland. The name *trash line* stands for laying trash on contour line. It is applied with given interval on contour line. The trash decomposes for the coming season and its decomposition is used as good fertile soil for the coming season.

Gulgualo: Farmers put undisturbed clot of soil mass across slope in the field during sowing. These soil mass was thought to obstruct germination of seed if they are left in the field as they are. Thus they pick them from field and put on contour line to use it for soil erosion control.
***Gilalo*:** It is a farmers practice during weeding period of crops specially millet and pepper. It was the method by which the uprooted weeds are laid across slope following contour to control soil erosion.
Residue management: Leaving crop residue on the farmland when any crop is harvested without consideration of contour line (opposite to putting residue as trash lines on contour).
Strip cropping: Cultivating the strip of a similar crop at least with 10 meter wide space but not limited length of strip. A farmer can have a strip of two or more crops planted at the same time in a given farmland area. One strip having short duration and the other long; one with short height and the other long height. The difference in strip can help to reduce erosion like strip of millet with maize.

Generally, most of the farmers use *contour farming*, *furrow making*, residue laving on farmland, and strip cropping methods for maize sowing while *furrow making*, *gulgualo*, *trash line, gilalo* and contour farming methods for millet and chili pepper sowing.

Integrating the traditional and introduced conservation practices

It was suggested by farmers that one of the main factors for resisting construction of terrace was top down approach which strictly follow only the principle of technical design prepared on the manual than the participatory approach. The introduced soil and water

Table 4. Ranking of Farmers' adaptation mechanism for soil erosion control.

Rank	Adaptation mechanism+	Respondent's										TRS**
		Number					Relative score*					
		1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	
1	Furrow making with given interval	29	6	-	-	-	21.56	1.03	-	-	-	22.59
2	Crop residue leaving	10	22	3	-	-	2.56	13.82	0.17	-	-	16.56
3	laying trash line on contour	-	5	25	5	-	0	0.71	11.17	0.11	-	11.99
4	Putting *gulgualo* across slope	-	-	5	22	18	-	-	0.48	4.3	5.85	10.6
5	Introduced Soil conservation structure	-	-	6	10	17	-	-	0.38	1.49	7.23	9.1
6	Putting *gilalo* across slope	-	-	8	25	2	-	-	1.23	7.18	0.1	8.51
7	Strip cropping	-	2	5	25	3	-	-	0.67	7.18	0.23	8.08
		39	35	52	87	40						

Source: own survey, 2012. *Relative score was calculated by multiplying the number of respondents in each rank by its proportion (e.g. (29*29/39), **Total Relative Score, +Couture farming was commonly used by farmers who apply the above seven adaptation mechanism and this was the reason not to include it in the list in the above table.

conservation measure did not appreciate the traditional practice and resulted in failure of integrating both practices. Similar findings was reported by Mekonnen and Abiy (2014), that in southern Ethiopia, absence of integrating indigenous SWC with exotic one is one of the main constraints that exists in the country. Farmers try to follow indigenous practice than advanced because advanced ones need much labor, it also looses wide land for embankment due to its technical requirements, it needs more attention during ploughing not to be destructed by oxen and it need experts be available on field for planning and survey before construction. Some farmers apply both traditional and introduced practice at the same time. This include preparing furrows on the surveyed contour, planting grass strips on the contour with the help of survey points and preparing *gulgualo* and trash lines across the slope (along contour) during cultivation. These practices can be said as integration of indigenous and introduced practices. It can also motivate farmers to protect their land from erosion. According to Kessler (2006), the planners and implementing agencies of physical soil and water conservation interventions should not ignore local level biophysical and socio-economic profiles of the area under consideration.

Farmers' preference on soil erosion prevention measures

To evaluate farmers' preference on soil erosion prevention measures, respondents were asked to rank the five most preferable mechanisms for soil erosion controls and then total relative score (TRS) was calculated. As it is shown in the Table 4, furrow making with given interval, residue leaving, laying trash line on contour, putting *gulgualo* across slope and terracing were the five most preferred mechanisms.

Introduced soil and water conservation practices

The farmers who constructed the soil bund were highly eager on soil productivity increment and for new technology adoption. The introduced soil and water conservation practices in the area include soil bund, fanya- juu terrace, bund stabilized with biological measure and fanya-juu stabilized with biological measure. Fanya-juu terrace differ from soil bund by the principle of throwing dug soil material upslope (upward direction) opposite to soil bund which uses throwing dug soil material downward direction. 71.5% of the respondents in the area have practiced introduced physical soil and water conservation structures while 28.5% of the cases integrate physical and biological conservation measures to reduce soil erosion. Physical conservation measures in the area were constructed with help of Sustainable Land Management (SLM) Project. Crops planted on physical structures as biological conservation measures were multipurpose grasses such as vetiver grass *(Vetiverial zizanioides)*, used for stabilizing soil bund, thatching house, mulch material and forage; Desho grass ((*Pennisetum pedicelluatum*) used for stabilizing soil bund, and forage; and elephant grass (*Pennisetum purpureum)* used for stabilizing soil bund, mulch material and forage. The project provides fruits and coffee seedlings for farmers who construct physical soil and water conservation structures on their land to build up their farm income.

Responsibility of farmers and government for land management

As elsewhere in the country, farmers do have responsibility for the proper management of their land. 40% of the respondents explained that awareness

Table 5. The response of farmers on their expectation from the Government for land management.

Farmers' expectation from the government for land management	Percent
Monitoring and evaluation of land management	8.6
Surveying and layout preparation of SWC	31.4
Providing important materials for us	14.3
Awareness creation	40
Providing technology and experts,	5.7
Total	100

Table 6. Response of farmers on their awareness, their responsibility of land management.

Response on farmers' awareness on their responsibility of land management	Percent respondents
Properly managing land according to experts advice	14
Controlling soil erosion is my mandate	3
Contributing for labor for activities done on my land	40
Construction of soil bunds	43
Total	100

Source: Own survey, 2012.

Table 7. Farmers' awareness on the issue of land certificate and their knowledge about its content.

Farmers' awareness on the issue of land certificate	Percent
Did not read	37
Have no land certificate	9
Yes I read	54
Total	100

Source: Own survey, 2012.

creation and technical support is expected from the government. As it is indicated in Table 5, farmers' understanding on what is expected from the government differ from individual to individual farmer. Regarding soil erosion control, 31% responded that they need support from the government during surveying and layout preparation of soil and water conservation activity. Similarly, they explained that they are responsible in contributing of labor and implementation of the advice of technical agricultural experts (Table 6).

Extension service provision to farmers

90% of the respondents have access to agricultural extension services in terms of technical support, awareness creation and provision of agricultural inputs on time on credit and kind basis. Only 10% of the surveyed farmers were not benefitted from such services. This could be due to the problem of top-down approach which did not consider farmers priority interest. On the other hand, farmers in the area have been complaining on the increased cost of fertilizers which motivate them to economize their farming system.

Awareness on land certification

As it was responded by 77% of farmers, they have good awareness on land certification that has been given since 2006. It has an advantage of increasing sense of ownership on the land. When they were asked about their knowledge on the written sentences about the mandate of land owner to conserve or manage his land from degradation, only 54% respondents said that they know about it. However, 37% of the land certificate holders have never read the contents of the certificate (Table 7). This shows that 41% of the land certificate holders have

Table 8. Farmers' knowledge on the issue of soil erosion vs vs land certificate.

Knowledge about issue of soil erosion written in the certificate	Percent
Tells about my mandate on soil erosion control	23
It says about advantage of land ownership	77
Total	100

Source: own survey, 2012.

never read the contents of the certificate (Table 8).

Farm and home garden tree planting practice

Farmers in the study area have practice of protecting natural trees on their farm. In addition, according to this study 94% of respondents have at least four tree species on their farm as well as in their home garden. The tree species found were *Milletia ferrugina, Ficus vasta, Cordia Africana, Albizia schimperiana,Grevillea robusta, Eucalyptus camandulensis, Acacia spp.,Prunus Africana, Olea welwitschii, Ficus sur, Sapium ellipticum, Azadirachta indica and Sesbania sesban.* They also plant agro forestry fruits which include Banana (*Musa* spp.), Mango (*Mangifera indica*), Avocado (*Persia americana*), Orange (*Citrus sinesis*) and papaya at their home garden. The source of seedlings for trees and fruits species was from office of Agriculture and different Non-governmental organization.

CONCLUSION AND RECOMMENDATIONS

Soil erosion is a threat to the decline of agricultural productivity in Kafa zone Gimbo district as it affects the crop production significantly. The study area, Shomba Kichib, is characterized by steep and undulating terrain being cultivated for annual crop like maize, millet, chili pepper. The area also receives intense and heavy rain during rainy season concentrated in few months (June to September). The low fertility of the soil in the area was due to continuous cultivation and soil erosion from sloppy farmland. Farmers revealed that cultivating slope land is due to shortage of land for crop production. Their indigenous system to cope up with soil erosion was observed as the method with two advantages, that is, controlling erosion temporarily and increasing fertility for next season by decomposed trashes.

Besides, the heavy dependence of society on agricultural sector mainly on production of millet and pepper, cultivating millet and pepper aggravates soil erosion due to its requirement of very fine soil. Combined with heavy rainfall during the same period, fine soils are washed away, that demands soil and water conservation intervention. In this regard, the result of assessment in the study area showed a range of conservation measures were introduced with the objective of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production and/or availability. These measures were categorized into indigenous and introduced types. Indigenous methods used were contour farming, furrow making, making trash line across slope on contour, *gulgualo*, *gilalo* and leaving crop residue on farmland. Similarly, introduced measures practiced in the area include soil bund, fanya- juu terrace, bund and fanya- juu stabilized with biological measure. The biological measures planted on physical structures were multipurpose grasses such as vetiver grass, desho grass and elephant grass. Farmers who have good awareness to sustainable land use have an interest to adopt introduced soil conservation structures to be more effective in preventing soil erosion and ensuring sustainability of yield.

Based on the assessment result of soil and water conservation activities in the area the following recommendation could be forwarded. Farmers whose land slope is more than 8% should get continuous awareness creation (get knowledge about the erosion risk and controlling methods through training at Farmers Training Centers (FTCs). Training at FTCs should focus on main factors aggravating soil erosion such as the slope of the farmland, type of crops exacerbating soil erosion and intense rainfall. The training should also focus on problems of using traditional soil erosion control methods, role of integrating physical and biological soil and water conservation practices.

Cultivation of crops which need fine textured soils should be treated with proper slope selection and supporting with proper physical as well as biological soil and water conservation measures. Since farmers are very sensitive with ownership principle of land, special attention should be given on filling the farmer's knowledge gap on the importance of land certificate as well as rules and regulations written about erosion control in land use certificate. The farmers, who complain about the fragmentation of farmlands during construction of soil and water conservation structures, should frequently learn using FTC with practical observations or occurrences at the field in a participatory approach. Farmers also need to be made aware of the economic losses due to soil erosion from the cultivated fields. Farmers who try new technologies by themselves on their

own land should be targeted for technically supported. Those who did not understand about the impact of soil erosion should get field visit program for experience sharing from other nearby farmers.

Conflict of Interest

The authors have not declared any conflict of interest.

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