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Assessment of Farmers Participation and Their Knowledge on Sustainablity of Improved Soil and Water Conservation Activities in Enebsie Sarmidir District: A Case Study of Guansa and Shola Watersheds, Ethiopia

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Abstract: Soil and water conservation (SWC) is a key issue in Ethiopian for improved land resources and development in agricultural economy. This study examines the farmers' participation and their knowledge on sustainable use of improved SWC activities in Enebsie Sarmidir District: - the case of Guansa and Shola Watersheds. Formal and informal surveys were undertaken for data gathering. Guansa (where SWC structures are better maintained) and Shola (not well maintained) watersheds were purposively selected to understand and compare the farmers' participation and their knowledge on the sustainability of SWC practices. Three-stage stratified random sampling methods were used to select sample farmers. A total of 160 households were interviewed. Data were analyzed with descriptive statistics and cross tabulation. The results revealed that most farmers (85.6%) were participated in SWC practices. However, most of them involved through enforcement (59.9%) at implementation phases (75.2%) of SWC practices. Farmers were more interested in participating SWC activities when they have steep slope of farmland and they also observed short term effect of conservation to arrest soil. On the other hand, poor effectiveness of the structures and unfair selection of farmers for layout and design activities are reluctant farmers to participate. There is significant difference on benefits of SWC ($P<0.01$) and effectiveness of SWC ($P< 0.01$) between the study watersheds. The study concluded that farmers should have awareness on the benefits of conservation measures and on how to design SWC technologies before being involved in planning, implementation and evaluation of the outcomes for the sustainability of SWC technologies.

Key words: Guansa · Participatory · Shola · Sustainability · SWC · Watershed

INTRODUCTION

Agriculture is an important engine of long-term growth and food security in Ethiopia [1] and the livelihood of the vast majority of the population depends directly or indirectly on this sector [2]. This sector contributes to 85% of employment of the population, 43% of GDP and 90% of foreign exchange earnings [3, 4]. It depends on soil and water which are vital natural resources for human survival. Since the soil and water resources are finite, their optimal management without adverse environmental consequences is necessary, if human survival is to be assured and development is to be sustained [5]. However, soil erosion by water is the major constraint for sustainability of economic development in the country due to vast areas of fertile land unproductive especially in sloping agricultural lands which contributes to food insecurity and constitutes a serious threat to sustainability of the existence of subsistence agriculture [6, 7].

Soil and water conservation (SWC) is a key issue in Ethiopia, not only for improvement and conservation of the environment, but it also in development of agricultural economy as it can have a huge impact on addressing issues of poverty and food security particularly where there is a high population pressure which derives their livelihoods from agricultural activities and land fragmentation [8]. Therefore, to reduce and/or to reverse land degradation in general and soil erosion in particular, different soil and water conservation measures have implemented throughout the country [9].

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The local people in the study watersheds implemented different SWC activities repeatedly on the same plot of land every year to mitigate land degradation problems and to ensure the sustainability of land resources. However, these practices were carried out in unsustainable way of the massive conservation efforts and make natural resource unsustainable.

Thus, it is vital to understand the underlying causes of the poor sustenance of constructed conservation measures depends on the farmers' knowledge and their genuine involvement in any conservation intervention as participatory approaches. Therefore, this study was carried out to assess farmers' participation on SWC practices and their knowledge on sustainable soil and water conservation activities in Enebsie Sarmidir District: A case study of Guansa and Shola Watersheds, Ethiopia.

MATERIALS AND METHODS

The Study Area: The study was conducted in Enebsie Sarmidir Woreda, East Gojjam Zone of the Amhara Region, Ethiopia. The Woreda town (Mertule Mariam) lies 370 km Northeast direction from Addis Ababa and 180 km southeast from Bahir Dar (the Regional Capital City). The Woreda is located at 10° 52' N, 38° 17' E and at an average altitude of 2650 m.a.s.l. The Woreda is bounded with South Gondar Zone in the North, Enarj Enawuga Woreda in the South, Goncha Siso Enesie Woreda in the West and South Wollo Zone in the East. It has 35 administrative Kebeles (33 rural and 2 urban Kebeles*)*.

Description of the Case Watersheds

Guansa Watershed: This watershed is located in Enebsie Sarmidir Woreda. It lies in the North direction at 4 km from the Mertule Maraim. The mean annual minimum and maximum temperature of the watershed ranges from 22.5 to 25 °C and mean annual rainfall ranges between 941 and 1203mm. Its altitude range varied between 2650-3410 m.a.s.l. The area has Weyna Dega (36.23%) and Dega (63.77%) agro-climatic zone (Agriculture *District* 2013).

The total area of the watershed is about 435 hectares. The main land use types were 374 ha (85.97%) farm land, 4 ha (0.92%) grazing land, 21 ha (4.84%) forest and shrub land and 36 ha (8.27%) settlement and institution land. The numbers of households in the watershed are 570 of which 474 are male headed, while the rest 96 are female headed households. The total number of beneficiaries/ population/ in the watershed are 2620, out of which 1304 (49.78%) are males and 1316 (50.22%) are females. The dominant farming system of the area is mixed farming system. Crop and livestock production dominate the farmer economy. The main crops grown include teff, wheat, barley, beans and peas and dependent on rain fed. Cattle, sheep, goat, equines, as well as poultry and bees are among the common types of livestock in the area. SWC measures such as bund (302 ha), cut-off drain (8.7 km), waterway (12.45 km), check dam (2 ha), hillside terraces (52 ha), trench (25 ha) and plantation (87 ha) were practiced in the watershed.

Shola Watershed: Shola watershed is located in Enebsie Sarmidir Woreda. It is found at 3 km Northwest of Mertule Maraim. The mean annual minimum and maximum temperatures of the watershed area ranges from 22.5 to 25°C, with mean annual rainfall ranges between 941and 1203mm. Its altitude range varied between 2523-2950 m.a.s.l. The area has to Weyna Dega (30.23%) and Dega (69.77%) agro-climatic zone (WAO 2013). The total area of the watershed is about 230.5 hectares. The main land use type includes 255 ha (73.70%) farm land, 19.5 ha (5.64%) grazing land, 30 ha (8.75%) forest land, 36 ha (10.40%) settlement land, 3.75 ha (1.08%) institution and 1.5 ha (0.43%) others. The numbers of households in the Shola watershed are 495 of which 438 are male headed and the rest 57 are female headed households. The total number of beneficiaries /population/ of the watershed is 2167, out of which 1077 (49.70%) are males and 1090 (50.30%) are females. The dominant farming system of the area is mixed farming system. Crop and livestock production dominate the farmer economy. The main crops grown include teff, maize, wheat, barley, beans and peas and dependent on rain fed. Cattle, sheep, goat, equines, as well as poultry and bees are among common types of livestock in the area. SWC measures such as bund (263 ha), cut-off drain (2 km), waterway (2.25 km), check dam (0.34 ha) and plantation (27.3 ha) were practiced in the watershed.

Sampling Methods and Data Collection: For the purpose of assessing the farmers' participation and their knowledge on SWC activities, Guansa (better maintained) and Shola (poorly maintained) watersheds were selected purposively from Enebsie Sarmidir District. These two watersheds were selected to understand and compare the farmers' participation and their knowledge on the sustainability of SWC activities between Guansa and Shola watersheds under similar agro-ecology and socio-economic situations in two adjacent Kebele that mostly improved SWC structures were done. From the total of 1060 household heads residing in the study area, 160 (15%) household heads were selected to collect the primary data. Three-stage stratified random sampling methods were used to select sample farmers. First,

the total sample size required was proportionately divided between the two watersheds (85 households from the Guansa watershed and 75 households from the Shola watershed). In the second stage the watershed areas were stratified into three categories, i.e., the upper, middle and lower part of the watersheds since farmers` knowledge on benefits of SWC varied across the watershed. Finally, from each stratum sample households were selected by simple random sampling techniques. From the upper watershed area, 22 and 17 household heads, from the middle watershed area 36 and 33 household heads and from the lower watershed area 27 and 25 household heads were selected randomly from Guansa and Shola watersheds, respectively.

The data were generated by employing multiple methods of social research. The techniques employed include formal household survey and informal discussions with individual farmers, DAs and Woreda SWC experts and group discussion. The data were designed to generate information farmers' participation and their knowledge of sustaining SWC structures was incorporated. In addition to this, information was collected on household demographic and socioeconomic characteristics, as they are relevant for explaining the sustainability of the SWC conservation measures.

Data Analysis: Data collected were organized, summarized and analyzed using SPSS version 16 data package. Depending on the type of information collected, descriptive statistics and cross tabulation was applied. For non-parametric variables, Chi-square (χ^2) (cross tabulation) analysis was applied to show whether there exists any statistical significant difference on different categorical responses between the two contrasting watersheds. Finally, the primary data obtained from different sources were presented in the form of tables, percentages and bar graphs, line graphs.

RESULTS AND DISCUSSION

Farmers' Participation in Soil and Water Conservation Activities: Farmers' participation in SWC activities is an indispensable tool for sustainable SWC measures. SWC structures were implemented by involvement of local community in the study watersheds (Fig. 1). These structures were selected by DAs for controlling soil loss. Farmers did the physical work while Kebele administrators and DAs were involved in the facilitation of the conservation activities. Similarly, other study revealed that farmers were not involved in the selection of soil bund and fanya-juu technologies constructed at Gununo Watershed, Southern Ethiopia [10].

Table 1 indicated that 85.6% of farmers participated in SWC activities. However, 14.4% of farmers' did not participate. SWC technologies were done in 45 days by 1:5 teams of the local community mobilization system. Each 1:5 teams have given measured work to implement in a day base. The team is built based on their residence. During field survey, it was observed that most farmers participated in the SWC practices to avoid penalty from Kebele Administrators rather than they did the real work. Most farmers arrived in the watersheds early in the morning and left immediately. About 92.9% of farmers participated in SWC practices in the Guansa watershed while in Shola watershed 77.3% of farmers participated. There is a statistically significant difference in the chi-square analysis between the watersheds in farmers participation (χ^2=7.886, P= 0.005). A similar study by [11] indicated that almost 80% of the respondents participate in SWC measures in the highlands of Amhara National Regional State.

On average, (59.9%) of the farmers have participated in soil conservation against their interest while 40.1% were voluntarily participating in the work. At the watershed level, 76% and 48% of the farmers felt that they

Fig. 1: Community participation in SWC practices in Shola watershed

were enforced to participate in SWC works against their will in Shola and Guansa watersheds, respectively. Reasons for reluctance of farmers to participate in such works were poor effectiveness of the structures and unfair selection of farmers for layout and design activities. The chi-square results showed statistically high significant (χ^2= 10.727, P= 0.001) between the two watersheds. This result is in agreement with other studies [12, 13] that reported most farmers participated in fanya juu construction not for the sake of conserving soils and lands, but they were forced to participate by the Kebele administration and the development agents to meet demands of the Government's development program. Also [14] in the Southern Ethiopia reported that farmers were forced to implement the introduced SWC interventions mainly with top down approach with full of enforcement. During the focus group discussion we came to the understanding that farmers who have cultivated farm land in steep slope had more interest in participating SWC than those who have land in the gentle to medium slope. This is true because of the fact that these types of farmers have a better understanding of soil loss and a decline in soil fertility when slope increases. They also observed short term effects of the conservation measures to arrest soil on steep slope than other lower slope.

As far as farmers' participation in different phases of soil conservation activities is concerned, almost three fourth of farmers were participated in the implementation phase whereas only 12.4% of farmers involved in the planning and 12.4% in all other stages (Table 1). From this result it can be easily concluded that most farmers participated in implementation stages in both watersheds.

Farmers' Knowledge on Improved Soil and Water Conservation Activities: In order to arrest soil erosion by water erosion, SWC activities are widely implemented in the study watersheds. The result of this study showed that 95% of the farmers knowing SWC practices. In Guansa watershed (96.5%) farmers knowing SWC activities while (93.3%) in Shola watershed. However, the chi-square analysis showed that there is no significant difference found between the watersheds regarding practices of SWC measures (χ^2= 0.826, P= 0.364).

Most farmers (78.1%) believed that SWC structures control soil erosion while one fifth of them did not believe so (Table 2). Farmers' understanding was better in Guansa watershed (83.5%) than in Shola watershed (72%). The chi-square test showed that the perception difference was significant (χ^2= 3.099, P= 0.078). [15] also found that farmers believed SWC measures reduced soil loss. In Guansa watershed, soil erosion occurred because of high rainfall and cultivation of steep farmlands which produced excess runoff but farmers gained training and extension services. [16] reported that steep terrain and erodible shallow soils were causing severe soil erosion.

As shown in Table 2, about 85.6% of farmers acknowledged benefits of SWC structures. The stated benefits include control of soil erosion, protect the land from storm damage, improving soil fertility and boost up of crop yield on their farm land, increasing infiltration and developing of ground water recharges. However, 14.4% of farmers did not perceive the benefits of SWC structures. The chi-square test indicated that there is significant difference between the watersheds regarding perception on the benefits of SWC structures (χ^2= 7.886, P= 0.005).

Table 1: Public participation in SWC activities in the study watersheds

	Watersheds				
Participation of SWC	Guansa %	Shola %	Overall %	χ^2	P-value
Participation SWC					
Yes	92.9	77.3	85.6	7.886	0.005***
No	7.1	22.7	14.4		
Stages of participation					
At planning	12.7	12.1	12.4	0.179	0.914
At implementation	75.9	74.1	75.2		
At evaluation and monitoring	-	-	-		
At all stages	11.4	13.8	12.4		
Motives of participation					
By interest	51.9	24.1	40.1	10.727	0.001***
By enforcement	48.1	75.9	59.9		

***denotes significant at 1% significance level.

Table 2: Farmers' awareness on SWC measures in the study watersheds

	Watersheds				
Awareness of SWC	Guansa %	Shola %	Overall %	χ^2	P -value
Know SWC				0.826	0.364
Yes	96.5	93.3	94.5		
No	3.5	6.7	5.1		
SWC control erosion					
Yes	83.5	72	78.1	3.099	0.078*
No	16.5	28	21.9		
Benefits of SWC					
Yes	92.9	77.3	85.6	7.886	0.005***
No	7.1	22.7	14.4		
Status of SWC benefit					
Very high	40.5	35.6	38.4	8.824	0.032**
High	44.3	39	42		
Moderate	7.6	23.7	14.5		
Low	7.6	1.7	5.1		
Effectiveness of improved SWC structures					
Less than the traditional	3.5	5.3	4.4	17.100	0.000***
Same as the traditional	10.6	37.3	23.1		
More effective than the traditional	85.9	57.3	72.5		

***, **, * denotes significant at 1%, 5% and 10% significance level, respectively.

Farmers were more observed short term effects of SWC structures on steep slope to reduce soil loss in Guansa watershed than Shola watershed. As far as the level of understanding the benefits of SWC structures is concerned, about 80% of farmer understood high to very high while 20% of farmers sensed low to moderate (Table 2). This is more recognized in Guansa watershed than Shola watershed. There is statistically significant difference (χ^2= 8.824, P= 0.032) between the two watersheds regarding this. Farmers were more likely to practice short term SWC technologies on the steeper slopes because the benefits of SWC practices were greater on steeper slopes [17].

The effectiveness of the improved SWC structures was an important factor for farmers to sustain the structures on farmlands. The study result indicated that watersheds, respectively. Fig. 2 showed the differences for the majority (72.5%) of farmers, introduced structures are more effective than traditional conservation measures in arresting soil erosion (Table 2). This was perceived by (85.9%) and (57.3%) of farmers in Guansa and Shola between the watersheds about effectiveness of improved SWC structures. The chi-square analysis indicated that there is significant difference (χ^2= 17.1, P= 0.000) between the watersheds farmers in perceiving the effectiveness of introduced SWC structures. This result is in line with the previous study conducted by [18] who found that most farmers recognized the improved SWC structures had improved the soil and crop production by reducing soil loss and conserving water. [19] reported that the improved SWC technologies were effective in arresting soil erosion. On the other hand [20] reported that soil bunds, hillside terraces, reforestation and stone bunds were considered by farmers to be the most

Fig. 2: Contrasting views of the study watersheds.
Source: Camera image (2015)

effective for SWC. In contrast, introduced SWC structures had little or no effectiveness in arresting erosion than the traditional SWC measures [21, 22].

CONCLUSIONS

A better understanding of farmers' participation and their knowledge behavior is vital for designing plausible policies that could encourage the sustainable use of improved SWC measures. The study show that most of farmers participated in SWC works. However, farmers believed that SWC works were done through enforcement. These farmers participation in SWC works to avoid penalty rather than they do real SWC work for sustainable land management. Most of farmers' participate in the implementation phase of SWC practices in both watersheds. This indicated that the practices did not consider the participatory principles.

Most of the farmers are well aware about the SWC measures and they also believed SWC measures can control soil erosion problems in the study watersheds. Farmers more recognized SWC measures can control soil erosion problems in Guansa watershed than Shola watershed. Farmers in Guansa watershed are also well aware about the benefits of SWC technologies to reduce soil loss and a potential for sustainable land management than Shola watershed. The knowledge level of farmers varied between watersheds in the status of SWC benefits and the effectiveness of improved SWC structures. Thus, policy makers should emphasized to provide better extension and training in benefits of SWC to raise farmers' awareness.

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