Enhancing Farmers Participatory Decision Making for Improving Land and Water Management Practices at Enkulal Watershed

Gizaw Desta [a, b]

[a]Senior Researcher, Soil and Water Management Research Directorate, ARARI

[b]Knowledge Management Director, Water and Land Resource Centre (WLRC) (current address)

Abstract

Many land-users in the highlands of Ethiopia do not make soil erosion a top priority problem until it reaches the stage of gully formation on their farmlands. Most soil conservation planning and implementation approaches therefore rely on empirical assessment methods by experts and

supporting and facilitating the adoption and transfer of improved erosion control technologies and innovative land management practices through bu

knowledge along with genuine participatory approaches is essential. The purpose of the study was to assess land and water management practices, improve the efficiency of soil conservation practices, and facilitate the knowledge transfer and adoption of improved measures through farmer-expert joint learning approach using farm ditches and gullies as a learning site. The farmer participatory problem identification and their involvement in collective decision-making process described here has provided positive impacts on the local knowledge and attitude of farmers. These were widely demonstrated by self-actions and change in practices. It has also brought an impact in generating innovative practices, minimizing sense of dependency, increasing knowledge of soil erosion and soil conservation, and understanding the consequences of ditch induced erosion for on-site and off-site long-term land degradation. In addition, the farmers have been empowered through the ownership of the erosion assessment, planning of conservation measures and practicing soil conservation improvements. Thus, the methodology enhances the participation of farmers in problem identification, planning and implementing efficient erosion control measures by themselves and orient them towards long term and sustainable erosion protection strategies by integrating farmer and expert knowledge, and using ditch erosion, crop residue, and gully erosion indicators as a tool for assessing and prioritizing severity of erosion.

Key words: Ditch erosion, Farmer-expert joint learning, improved soil conservation, Enkulal watershed

Introduction

In the highlands of Ethiopia, where intensive agriculture is practiced, land resources are being depleted at an alarming rate. Failure to balance soil and water conservation measures (SWC), with the use of effective technologies and farm management practices, against the current level of land degradation is a growing challenge to small-holder farmers who are striving to meet immediate economic objectives on one hand and sustainable environment on the other hand. Land degradation is the result of increased pressure on land use beyond its capability. Severe soil erosion in association with inappropriate farm management practices which is the main factor causing degradation that again leads to low efficiency of SWC (Mitiku *et al*., 2006).

Past soil and water conservation programs focused more on land degradation and less on the land user and used a top-down approach for information dissemination and SWC extension techniques. In the past, top down programs tended to focus primarily on symptoms of erosion through subsidized terracing than responding to the root causes of land resources degradation such as land use change and livelihood improvements. Soil conservation programs that aim to reduce land degradation problems, through treatment of causes, require a long term, bottom-up and interactive approach as well to supporting farmers who generally have detailed knowledge of their farm, know a wide range of potential interventions (although they can still learn new ideas from experiences elsewhere) and choose between these interventions on the basis of the resources and pressures on the farm household.

In recent years, it has become increasingly evident that the change in human dimension or socio-economic plays a key role in resources management. Problems are complex, uncertainties are high, prediction is possible to a limited extent only and integrated approaches to resources management are advocated. This implies that management is not a search for the optimal solution to one problem but an ongoing learning and negotiation process where a high priority is given to questions of communication, perspective sharing and development of adaptive group strategies for problem solving (Pahl-Wostl 2002a, 2002b). According to Bandura (1977) social learning refers to individual learning based on observation of others and their social interactions within a group, for example through imitation of role models. It assumes an iterative feedback between the learner and their environment, the learner changing the environment, and these changes affecting the learner.

Through such interactive exercises and iterative processes, the knowledge which is difficult to articulate can be explicit. So far, systematic methods to articulate local soil erosion knowledge and use it for sustainable technology development are not well understood and integrated in the formal soil conservation technology development. For the purpose of this study, in order to evaluate pattern of changes in attitude, skill and knowledge, we made use of local erosion indicators such as traditional ditches, crop stubble left in the farm, and protection of improved soil conservation practices as a learning object and the perception of participants before and after the learning process.

This paper provides information on the participatory learning processes for collective decision making to explore changes in soil conservation practices through farmer-expert joint learning approaches (JLA) taking case studies at Enkulal watershed, one of the operating micro-watershed in the Tana and Beles Integrated Water Resources Development Project. The centre of emphasis of the participatory decision making was to protect gully formation and development through the control of the causes like runoff from traditional ditches.

Objectives:

- To enhance bottom-up and farmer-expert joint decision making in order to assess, evaluate and improve the efficiency of land and water management practices using locally applicable indicators
- To identify limitations, strengths and improvement options for land and water management practices

Methodology

Description of study site

The study area, Enkulal watershed, is found in South Gondar Zone, Dera Woreda in Glawdios Kebele. The study site is located within Enkulal micro-watershed that drains about 398 ha area. It is located at $11^{0}37'59''$ N and $37^{0}47'48''$ and an altitude of 2300 m asl. Preliminary assessment of the watershed was undertaken in order to identify active land degradation problems. Finally, a catchment was purposely selected that drained by an active gully to use it as point of participatory decision making. About 22 households who own land within the drainage area of the gully were selected and involved in the subsequent participatory processes.

Enkulal watershed has a relatively mean high annual rainfall of 1577 mm and remains cloudy during most of the rainy season. Maximum observed daily rainfall is 89 mm (Bezawit, 2011). The study catchment is dominantly covered by crop followed by degraded patches of land used for grazing and small settlement area. Cereal cultivation is the dominant cultivation system and most of the cultivated fields are usually planted with barely, teff, wheat, fingermillet, maize, linseed, and lupin. Because of increasing land pressure, fallow periods are shortened and this results in decreasing yields due to decreasing fertility of the soil, increasing erodibility and ultimately total degradation.

Participatory and collective decision making strategies and procedures

In recent years, the role of human and social dimensions and integrated approaches to resource management are advocated through interactive learning among stakeholders (Pahl-Wostl, 2004; Sanginga et al., 2004; Palomo et al., 2011, Dile et al. 2013) under conditions when problems are complex, uncertainties are high, and predictions are only possible to a limited extent. This implies that adaptive participatory methods are not only enhance resource management but also drive the generation of social capital and social innovations. Thus, the participatory processes described below are built on the local contexts and help to explore and systematically articulate local knowledge.

The participatory process involved the following implementation procedures

***Self confidence building measures*:** awareness and attitude change activities to motivate and increase the level of participation of farmer households during the process through informal group discussion and question and answer was conducted. This step was key to build the confidence and trust on the process and to encourage individual farmers activly involve in the collective decision making process.

***Team/Group formation*:** since age, gender, and education of household members are the main determinants for the adoption of land and water management practices, based on these characteristics, among the participant farm households there were mix of 18 men and 4 women households. During field visits, two groups were formed: one group include land users who own land on the left side and group two who own land on right side of gully. All participant farmers either women or men household member are agreed to involve in every field visits arranged during exterme rainfall events, in key collective decision processes and in the monitoring and evaluation activities. Moreover, three member team was selected who were responsible to lead and manage the participation and decision processes and record minutes of the decision processes. The extension agents and/or researchers played a role of facilitation, motivation, and collection of evidences in the process.

Collection of baseline information : baseline information was collected on family size, productive labor force, crop type and productivity of each parcel of the participant farmers, number of livestock species per household, plot and terrace characterisitcs, number of ditches practiced per parcel, and dimension of gully.

***Practical oriented knowledge sharing and practicing*:** during the field visits, meetings, and monitoring and evaluation activities, participant farmers explored their practical experience and share their knowledge on selected issues such as gully formation and rehabilitation, traditional ditch management, improving efficiency of bunds, tillage management, and crop residue management. This process gradually facilitated a collective understanding of land management practices and the associated problems and constraints with its solutions. Eventually, through continous dialogue and discussions the land users gain environmental knoweldge that would help to protect the agricultural ecosystem sustainably.

***Monitoring and evaluation*:** annual monitoring were conducted on key performance indicators set in the bylaws such as terrace performance, ditch improvement, crop stubble management, control of free grazing, and collective action and change in practices.

***Arrange incentive mechanisms*:** different in kind incentive mechanisms were provided. Among these incentives improved crop varieties and improved lupine seed and improved fallow practices were included.

Results and Discussions

Initially, two meetings were conducted with participant farmers to brief objectives and procedures of the project activities, motivate and encourage farmers for their active involvement in the participatory decision making processes. Next to the awareness creation, a micro-catchment drained by an active gully was identified for a study site through discussion with the participant farmers. It was selected because gully damage is a common problem in the area. Once the micro-catchment was selected, the potential problems were also identified. Gully erosion, excessive traditional ditches per parcel, poor soil fertility, damage due to concentrated runoff drained from road, and lack of improved technologies were among the identified problems at the study site. As it was identified during group knowledge exploration process, concentrated runoff from traditional ditches drained to the border of two adjacent farms and runoff from road ditches are the major causes of gully formation.

Two groups of farmers were formed according to the position of their land holding relative to the gully (right and left sides) to assess problems, evaluate practices, do implementation and monitoring and evaluation activities in each farm plot every one or two weeks after heavy storms. This process enables farmers to share their knowledge of land management practices. They also exercised consensus based decision making through dialogue during the field visit. Of course this takes time and a continuous process to bring change and empower farmers to make decision by themselves.

The groups have leader and secretary who took responsibility to coordinate during field visit and discussions. They also recorded every discussions and decisions the group has made. Notebooks and pens were given for each group for recording the minutes.

Baseline Information on Household Characterisitcs, Farm Practices and Erosion Indicators

Household based labor, crop and livestock characteristics

Household labor, crop productivity per parcel and livestock holdings were collected as baseline for the purpose of analyzing the impact of the interventions at the end. Accordingly, the average family size and productive labor of the participant farmers was about 5 and 2.2 respectively. The total family size and productive labor of all households summed up to 91 and 38 respectively. The productivity of local crop varieties cultivated in the catchment range from 1-1.5 quintal per parcel or plot (Table 2). The total livestock number in the catchment was about 172 constituting 20 cows, 24 oxen, 35 other cattles, 45 sheep, 10 equines and 38 chicken (Table 3). This baseline information used to assess the balance of feed supply and feed requirement in the catchment and then plan for forage development to fill the deficit.

Table 2. Family size, productive labor and productivity of local crop varieites

	Family size	Productive family labor	Productivity in tons per parcel (0.05-0.26 ha)				
			Barley	Wheat	Teff	Maize	Other crops
Min	1.0	1.0	0.05	0.05	0.05	0.10	0.05
Max	8.0	6.0	0.30	0.30	0.25	0.10	0.20
Mean	5.1	2.2	0.13	0.15	0.13	0.10	0.13
Total	91.0	38.0					

Table 3. Individual household's and total number of livestock holding in the study catchment

	Cow	Ox	Other cattle	Sheep	Equines	Chicken
Min	1.0	1.0	1.0	1.0	1.0	1.0
Max	2.0	2.0	5.0	12.0	2.0	5.0
Mean	**1.4**	**1.6**	**2.2**	**3.8**	**1.4**	**2.7**
Total	**20.0**	**24.0**	**35.0**	**45.0**	**10.0**	**38.0**

Terrace/bund conditions

The catchment area had a total of 106 terraces. The respective minumum, maximum and average number of terraces per parcel were 2, 12 and 4. The length of terraces also varied from 11-38 m (average 18m). However, the terraces or bunds are not in a better condition. The runoff basin area of most terraces were filled up by sediment and the runoff from top areas overtopped the terraces. Parts of stone terraces were also damaged by livestock.

Ditch survey and erosion assessment

Initially in 2011, a total of 256 ditches were recorded in the study catchment. The density of the ditches and its dimension is dependent on the nature of the soil, slope of land and type of crop cultivated. Coarse textured soils were found to be drained with widely spaced ditches while clay soils were drained with closely spaced ditch systems. High density of ditches is commonly observed on teff covered fields planted on gentle and flat slopes. A minimum of 3 and a maximum of 52 ditches per individual farmer plot were recorded irrespective of the type of crop cover. The average initial depth and top width of ditches were 19 cm and 38 cm respectively (Table 4 and Fig. 1). The gradient of ditches was on average from 5 to 9 %. After the start of erosion the ditch channel is dynamic depending on the sediment concentration coming into the ditch. The ditch monitoring has revealed that depth of ditches was decreasing over rainy season due to splashing of the unconsolidated soil on the ridges and accumulation of sediment on furrow bed. It has been observed that the change in depth and width in two months period indicates accumulation of transported sediment along the channel. The results further showed that ditches, especially during erosive rains, encouraged runoff erosion the extent of which was further aggravated by increasing land and ditch slopes.

Ditches serve as a sediment transporting channel. The transport efficiency of the ditches was observed by measuring sediment accumulation area in the channel per unit length. It is the change in the cross section of the ditch. The sediment transport rate per unit length was increased from top to down end of the ditch and over the rainy season. In the middle of July, the sediment transport rate per ditch was 0.19, 1.33 and 1.52 cm^2m^{-1} at the top, middle and bottom of the ditch, respectively. The transport rate increased to 0.93, 3.39 and 4.32 cm^2m^{-1} in the middle of August. However, in September the transport efficiency was at decreasing rate most likely due to the decreasing of erosive rainfall events (Table 5). From a single farm ditch, on average, sediment is transported at a rate between 0.5 cm^2 and 4.0 cm^2 per meter of ditch. The average seasonal sediment transport rate was 1.27, 2.70 and 3.97 cm2/m per ditch at the upper, middle and lower part of the ditch (Table 5 and Fig. 2). Under heavy rain storms and combined with excessive ditch gradients, they serve as hot spots for accelerated erosion. Unless there is proper construction it provided high risk of erosion downstream in the form of rills and gullies, and leads to conflicts among adjacent land owners. The negative impacts of this practice are apparently observed in the field by forming gullies along adjacent farm boundaries, damage the terrace structures and serving as a sediment transporting channel where sediments accumulated at the outlets. Consequently, many land users who are practicing open farm ditches do not notice the risk of traditional open ditches to properly address erosion problems since they are constantly struggling only against the control of highly recognized and visible forms of erosion (Aklilu and de Graaf 2006). However, properly constructed drainage ditches can prevent erosion and gully on slopes by catching surface runoff before it reaches the critical stage. This indicated the importance of protecting and controlling ditch erosion without compromising the need to drain excess runoff.

Photo 1: Erosion and sedimentation of farm drainage ditches

Table 4. Mean dimensions of drainage ditches at Enkulal micro-watershed, 2011

Date	Mean Depth, cm	Mean Width, cm	Mean cross-sectional area, cm2	Mean vol. per ditch, m3
17-Jul	19.09	38.28	735.2	**2.30**
1-Aug	17.63	36.35	649.9	**1.99**
16-Aug	16.70	36.38	617.4	**1.89**
30-Aug	16.13	35.88	616.0	**1.76**
9-Sep	14.03	36.63	530.0	**1.61**

Table 5. Mean sediment transport rate per ditch (cm^2/m), 2011

	Rate difference between ditch positions		
Date	[Middle-Top]	[Bottom-Middle]	[Bottom-Top]
17-Jul	0.19	1.33	1.52
1-Aug	0.26	3.31	3.57
16-Aug	0.93	3.39	4.32
30-Aug	1.77	3.82	5.59
9-Sep	3.00	0.59	3.58
Mean	**1.27**	**2.70**	**3.97**

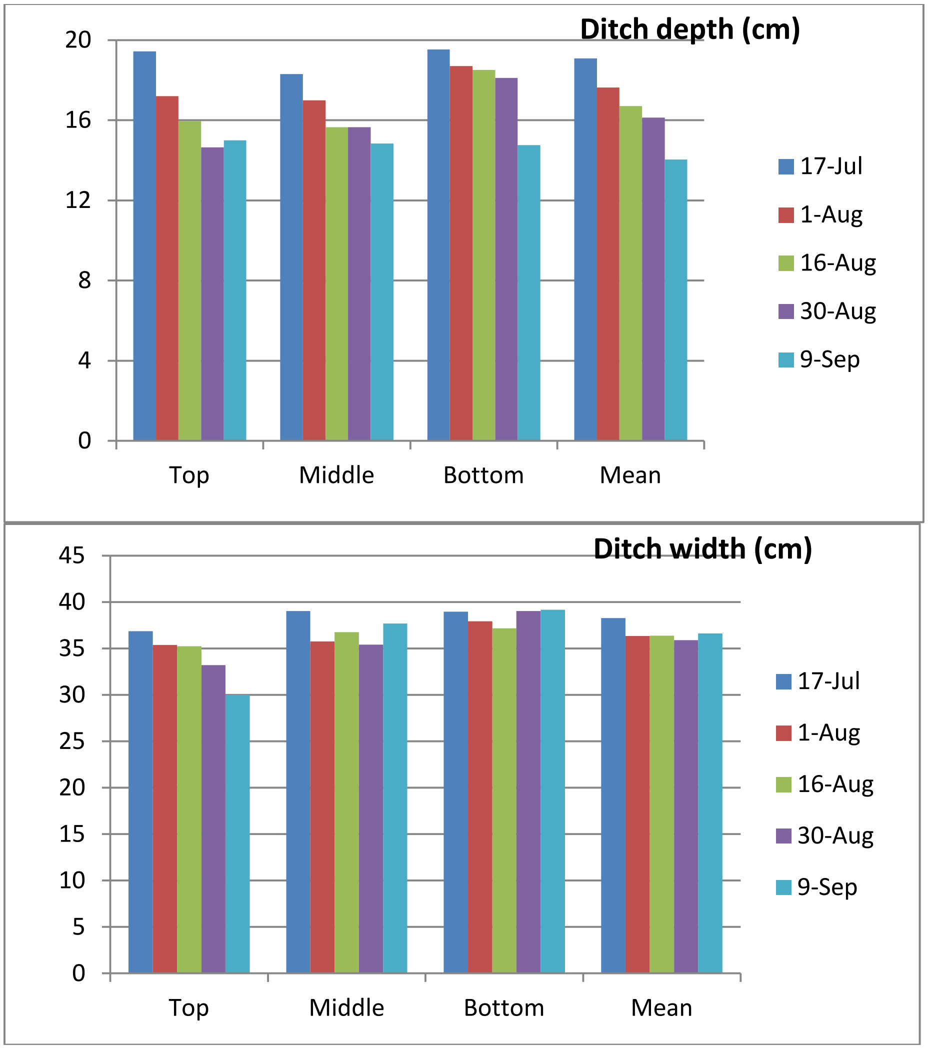


Figure 1. The change in depth and width at upper, middle and lower position along the
in 2011 rainy season

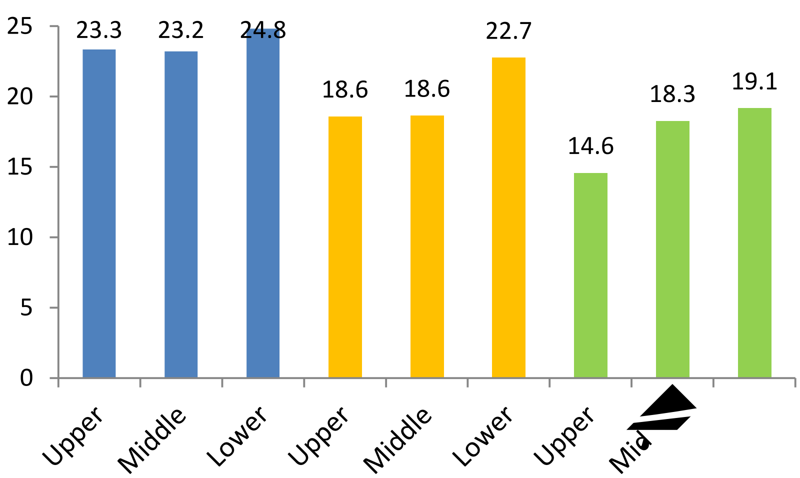


Figure 2. Ditch cross sectional area along the longitudinal section of ditches

Gully development

The gully was formed in the early 1990's (nearly 20 years of age) serving as a waterway for runoff discharged from adjacent farm ditches. The gully is still active and progressively developing. It has more than 378 m length. During the rainy season, bed erosion was more important whereas in the post rainy season collapse of gully side walls was active due to cracking problem. In the rainy season, the bed width was increased over the length of the gully (Fig. 3, 4 and 5). The depth increment has not shown clear trend. This is most likely due to the heavy sediment load that led to accumulation of sediment on spots where there is low gully bed gradient. Though the main cause of the gully erosion is runoff from road, the runoff discharged from farm ditches contributed to fast development of the gully and very dynamic too. The high longitudinal variation of the gully dimension and the dynamic changes (side head cuts) of the gully was as a result of the runoff drainage from farm ditches into the gully (Fig. 4 and photo 3).

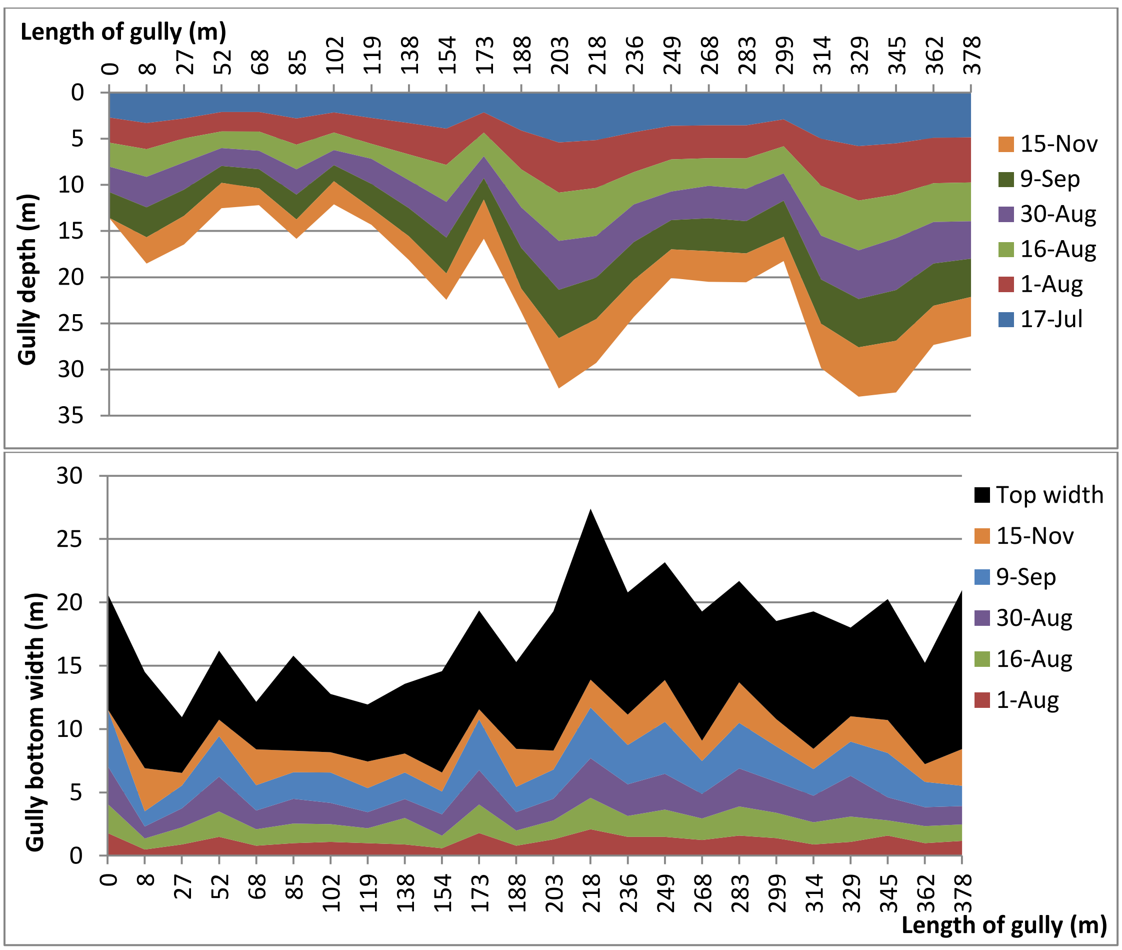


Figure 3. Cumulative development of depth (upper) and width (lower) of gully sections, 2011

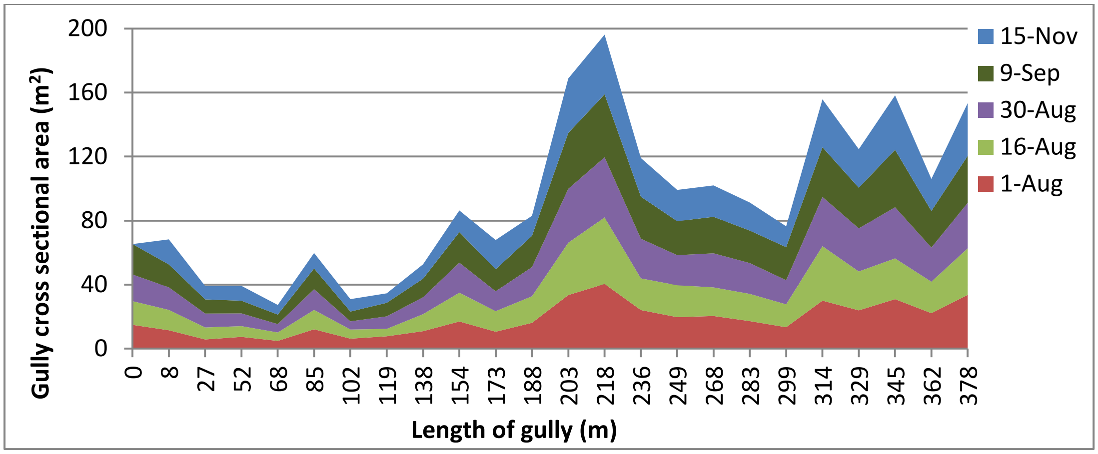
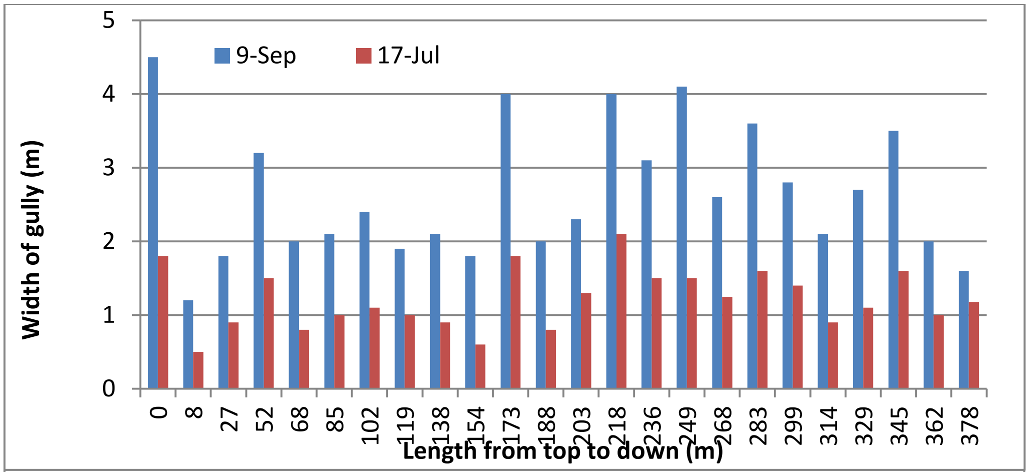
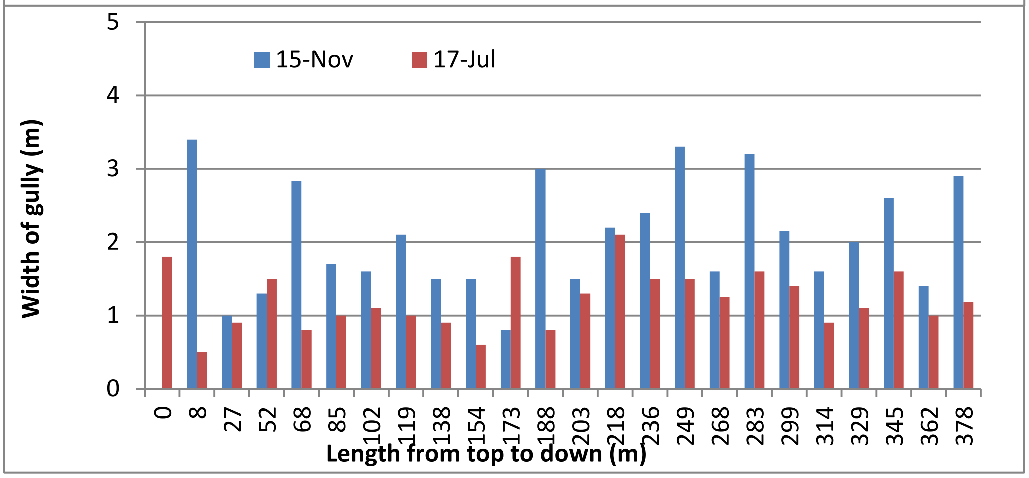


Figure 4. Cross-sectional gully development, 2011

Photo 2. Gully morphology due to runoff from farm drainage ditches


9-Sep
17-Jul
Width of gully (m)
Length from top to down (m)
0
1
2
3
4
5
0
8
27
52
68
85
102
119
138
154
173
188
203
218
236
249
268
283
299
314
329
345
362
378


15-Nov
17-Jul
Width of gully (m)
Length from top to down (m)
0
1
2
3
4
5
0
8
27
52
68
85
102
119
138
154
173
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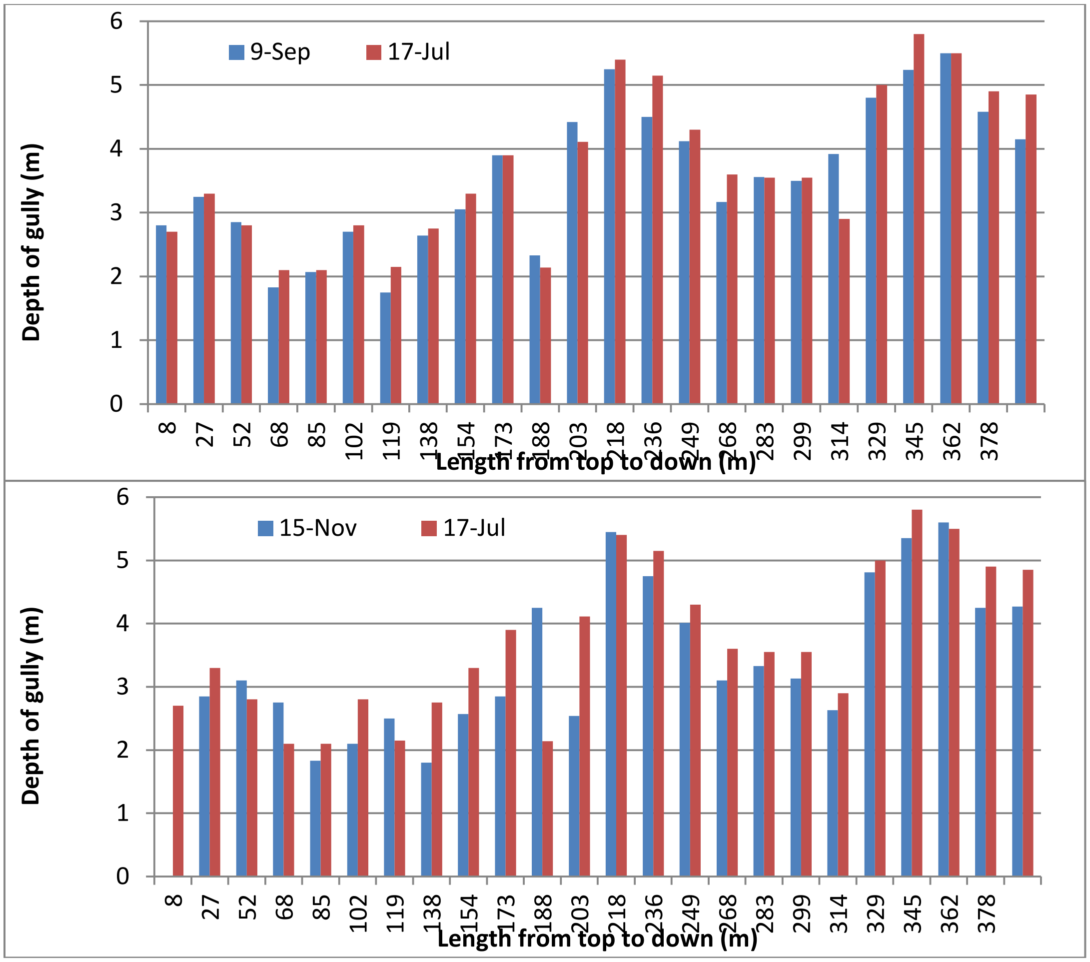

Figure 5. Comparson of periodical development of depth and width of gully, 2011

Assessment of Land Management Practices and Associated Problems

Weekly (sometimes every two weeks) field visits by all participant farmers resulted in the identification of key problems. The groups assessed and evaluated the efficiency of terraces, traditional ditches and crop residues against erosion reduction. They identified the shortcomings of terraces on each farmer plot, damage due to drainage ditches and removal of crop residues. The following were major problems identified and the respective solutions suggested after continous discussions.

Problem 1: Most of the terraces and bunds were damaged and poorly peformed. The most common causes for the damage were lack of adequate maintenance every year, ditches constructed across bunds, and tillage underneath the terrace.

Solution 1: All farmers agreed to maintain terraces or bunds on their plots during dry season. They agreed on the layout and design specifications with 50 cm width, 75 cm lower side height, 15 m maximum terrace spacing on gentle slopes, 20 cm distance of tillage operation on the lower side of terrace, sufficient gradient of bunds for adequate runoff disposal, and trenches on the upper side for traping silts as well to avoid waterlogging problem.

Problem 2: Erosion damage from traditional ditches were identified as associated problem of field drainage ditches.

Solution 2: Reduce the number of ditches per plot or parcel, reduce the ditch gradient so that it becomes non erosive, and avoid ditches that cross terraces/bunds are suggested solutions to control erosion from traditional ditches.

Photo 3: Runoff drainage ditches practiced by farmers

Problem 3: Land users often left none or minimum crop residue over the field. Even the remaining samll amount of crop residue left in the field was extensively open grazed during the dry season. The soil surface then expose to trampling and easily washed by water and wind erosion.

Solution 3: Currently, farmers left approximately 45 cm stubble of wheat and barley after harvest. Participant farmers then engaged in discussion and agreed to increase the hieght of stubble at least by 10 cm for wheat and barley,that increased to 55 cm after harvest. They also evaluated the order of importance of different crop residues for their contribution to the improvement of soil ferility (Table 6).

Table 6. Height of crop stubble of the different crops currently left on the surface after harvest and suggested height improvement agreed by participant farmers,

Crop	Planting season	Tillage frequency	Height of crop stubble left after harvest (cm)	Importance of residue to soil fertility (Rank)	Height of improved crop residue (cm)
Teff	Mid June-July 10 EC	4-5	5	8	10
Wheat	July 8-July 12 EC	5	45	7	50-55
Millet	Rain onset -June 12 EC	1-3	7	6	10-12
Noug	Rain onset -June 13 EC	1	68	5	75
Linseed	Rain onset- June 14 EC	1	7	3	10-12
Barley	June 1-June 15 EC	2-3	45	4	50-55
Potato	March - April	4-5	N/A	2	N/A
Lupin	Aug - Sept	No tillage	37	1	45-50

N/A Not applicable

Implementation of Improved Practices

The following sections present results obtained through interactive knowledge exchange during regular field visits and discussions carried out by the participants and team of farmers organized for controlling the activities. The procedures have showed change in practices and perception of the participant farmers.

Agreed bylaws

To start with the implementation of proposed solutions that address the observed problems, bylaws and implementation modalities were discussed and arranged to control erosion and soil fertility depletion as well as to protect and monitor the implementation of improved land management practices. Specifications of terrace and ditch construction and height of crop residues left after harvest (Table 7) are determined and strictly implemented during the construction period. Each of the participant farmers had taken the responsibility to respect and implement the agreed bylaws**.** Three member task force elected among the participant farmers was the main controlling body of the agreed bylaws with the support given by the DAs in the Kebele.

Table 7. Agreed specifications of improved terraces, ditches and crop residues

Implemented Activities	Specifications
Terrace construction	
• Max. Spacing (m)	15
• Height (cm)	75
• Top width (cm)	50
• Bottom width (cm)	Variable
• Tillage away from terrace (cm)	20
Ditch construction	
• Ditch count condition	Decided on field
• Ditch length (m)	Maximum 25 m
• Ditch gradient (%)	< 6 %
• Crossing of terraces	Prohibited
Height of crop residues left after harvest (cm)	
• Teff	10
• Wheat and barley	50-55
• Millet and linseed	10-12
• Lupine	45-50
• Niger seed	75

Micro-catchment treatment with terrace/bund construction

Since January 1 2012, the farmers started to implement improved terraces including maintenance of the existing bunds, construct new terraces on plots where there was wide spacing between existing terraces, and construction of waterways beginning from top part of the catchment. A total of 1684 person days (865 male and 819 female) were mobilized for 34 working days. The daily work norm per person was decided by the Kebele. Based on this norm, the development group leaders distributed the total work load to individual work force. The work load per person per 3 effective working hours was 5 m of bund construction. Women and men had given equal work load but implement together with appropriate division of work. Using the total mobilized labor a total of 6290 m (ca. Volume 2562.5 m^3) graded soil bunds (sum of 1300 m stone faced soil bund and 4990 m soil bunds), nearly 180 m narrow waterways, more than 100m cut-off drains and some check dams were constructed. The average dimension of the trench of soil bunds was 43-45 cm depth and 50-52 cm width (ca. volume 1411.5 m^3). The embankment was constructed with top width of 30-35 cm, bottom width of 80-100 cm, and distance between embankment and trench was 30-35 cm (ca. 1151 m^3). All the newly constructed and maintained bunds were covered with susbania and treelucern forage legume species which covers half of the catchment area.

Photo 4. Bunds and waterways constructed in 2011/12

Plantation of shrub cuttings in the gully

The side wall of the gully was planted with cuttings of "*Mogn Enchet*" brought from Chilga woreda. This shrub is new for the area and frequent follow up about its biological characteristics was made for its survival and adaptation. It has a very high biomass and stay green throughout the year. It is very fast propagating shrub species. It can be used not only for gully rehabilitation but also for compost making as it has huge biomass and green throughout the year. More than 1215 cuttings of `*Mogn enchet*` were planted on July 7, 2003 EC (July 14, 2011). Until 9th of September the rate of survival was increasing. After September of the same season, the side walls of gullies started to crack and slide down and resulted in fall of the planted cuttings. Accordingly, the survival rate was decreasing to about 752 plants (average of 62 %) (Fig. 6). Survival was nil on very steep slopes and on highly fragile gully sections which implies the importance of gully shaping on such critical sections.

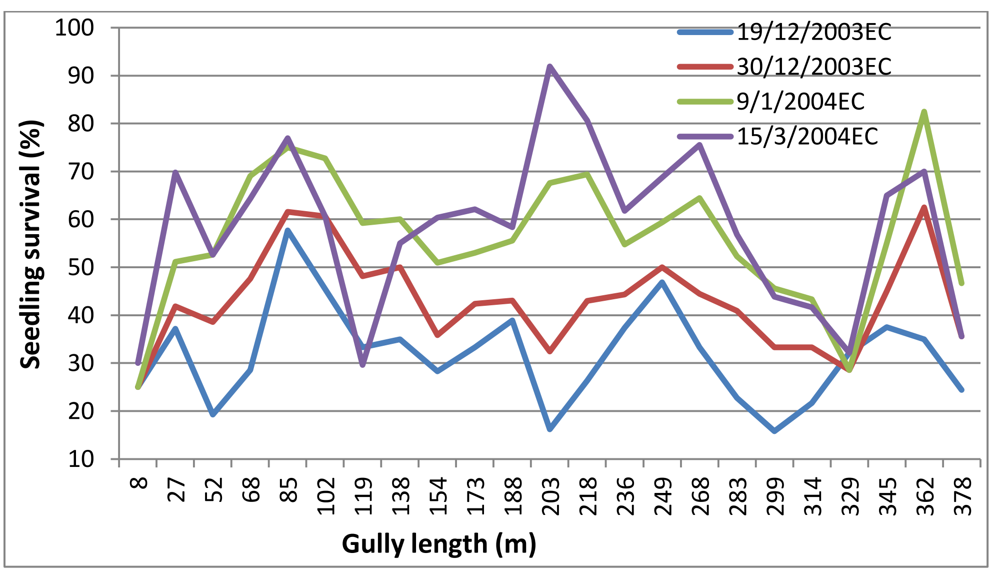

Figure 6. Survival rate of planted cuttings over the season, 2011

Monitoring and Evaluation of Improved Practices

The progress and performance of improved practices as well as the participatory processes were periodically monitored in order to evaluate the effectiveness of knowledge transfer, continuity of the change in improved practices and the collective decision making process. The following sections explain the results of the monitoring activities.

Improvements on ditch practice

Inventory of number of ditches per parcel, ditch gradient and length were monitored every season to evaluate whether the farmers respect the agreed bylaws. After one rainy season, i.e. in 2012 most of the farmers respect the ditch specification and reduced significant number of ditches per parcel (Fig. 7). The baseline data collected in 2011 indicates that the total number of ditches was about 256 (average of 10.7 ditches per parcel) of which 77% contributed from teff fields. After one rainy season in 2012, the total number of ditches was reduced to about 74 (average of 2.4 ditches per parcel). About 53 ditches (72%) recorded from plots covered with teff crop. However, the number of ditches again increased to 263 in 2013, of which 95% of the ditches were constructed on teff plots. More than 52%, 23% and 58% of the parcels were planted with teff in 2011, 2012 and 2013 respectively. Therefore, the reason for increased number of ditches is often associated with increase in the area coverage of teff. But most of the farmers who experience to construct many ditches significantly reduce the number of ditches. This of course needs continuous follow up and discussion with farmers why some farmers still construct ditches within the terraced fields. Except on few plots, significant number of farmers improved ditch gradient below 6%. None of the farmers construct ditches crossing bunds.

Figure 7. Comparison of number of ditches recorded in 2011, 2012 and 2013

Protecting terraces from damage

All the newly constructed terraces were found in good condition both in terms of stabilized embankment and the drainage ditches. Out of total parcels monitored, 45.5% (total of 42 terraces) are found in better condition. However, 51% (total of 61 terraces) of the parcels did not respect the agreed tillage distance, 20cm away from the upper and lower side of terraces (27% till upper side and 24% till both sides). The trenches-4(des)7(t)-4(t69(che)-2(o)9(f)-3 (ne)1-4(l)-4yd)11((cons)-3(t64(r)-3(cs)9(t)-4(edae)-2(n)11d (m)17(ai)-5((t)-4(a

Controlling free grazing

All the newly constructed terraces were planted with legume species. However, the farmers did not able to regulate free grazing. Almost all planted forage species are eaten and damaged by livestock including the Napier and other species planted inside the gully. This was a serious issue not only for the study site but also for the whole terraces in the cultivated areas of the watershed.

Collective monitoring and follow up of the elected task force

The main objective of the study was to increase farmers' capacity towards self evaluation and for collective decision and actions and ultimately empowered themselves. Although they got a lot of experience and exchange of knowledge among each other during the process in the two year period, they now tend to decrease their motivation and discussion in group about common implementation activities like controlling free grazing and gully maintenance. In 2013, some farmers were also increased the number of ditches per plot compared to the number of ditches recorded in the second year, 2012. Indeed, at individual level, some farmers changed their usual practices like harvesting crops at height above the usual harvesting height for some crops like wheat in order to increase soil organic matter or reduce soil depletion.

Views of selected farmers on the farmer participatory decision making processes

Twelve randomly selected participant farmers were interviewed by an independent interviewer about their view on the farmer-expert joint learning process and their attitudinal changes on the soil erosion processes and soil conservation practices. The views of some of the participants were extracted and presented as follows:

1. *I do not trust and accept the way of learning because I felt it is what we knew. Now we learned good lessons and new practices. I learned how much the ditches damage or wash* said by ***Fentie Mandie (male)***

2. *e somehow* said by ***Dires Tebabal (male)***

3. *have learned its importance. I learned to avoid diverting runoff from ditches to adjacent land. We managed to protect communal lands and pathways together. I was* said by ***Birkie Zewdie (Female)***

4.

rills, loss of seeds and fertilizer by erosion, negotiate and mange conflicts raised among adjacent farm owners, aware of damage due to livestock trampling. I learned a lot that helps to apply on my own land. But i expected mills, water wells, more improved ***Lakew Mesel (male)***

5.

understood that seeing is believing. I learned lupine improves soil fertility. Now, I give said by ***Aragaw Muche (male)***

6. I was not actively participating. But after some time I learned that improved terrace construction is interesting because our land is protected from erosion. However, I fear that there is no land left for our by ***Manhal Ewnetu (female)***

7.

from damage and learn how to make decisions in common. Taking lessons from our discussion I will protect terraces from animal damage and now I feel responsibility to ***Marie Yimam (female)***

Incentive Mechanisms

For the purpose of motivating farmers to actively participate in the continuous implementation and monitoring activities, improved sweet lupine seeds (approximately 0.5 kg) were distributed to the participant farmers and recommended to plant on bunds, along the ridges of ditches and open lands for purpose of improving land and feed sources. In addition, about 5kg lupine seeds were provided for seed multiplication at FTC sites. They were also advised to select one or two sheep and feed them and further disseminate seeds to other farmers. Improved crop varieties were also offered. Teff (Kuncho variety) and potato (Belete variety) were distributed to 15 farmers and 1 farmer respectively. Technical support was also provided on compost preparation, and construction of terrace and waterways.

Conclusion and Recommendations

If land degradation processes and problems are to be understood and effective land management practices planned, local contexts that govern decision making need to be considered. As context is so diverse from place to place and time to time, local understanding can provide insights into the contextual issues. Therefore, in order to sustain appropriate land management practices, farmers must involve and acquire capacity to respond to these local changing situations. Drawing on this concept, the participatory learning and collective decision making process can be conceptualized as the interaction and integration of biophysical dimensions with the human dimensions. This interaction determines the limits within which sustainable land management practices are physically possible, viable, and socially acceptable.

It is evident that in the process of participation and interactive exercises among farmers with the facilitation of experts, participant farmers build capacity, understood and aware of less visible and seasonal/ short-term erosion indicators which can be used as early warning erosion indicators and as monitoring tools. Use of combination of erosion indicators, for example ditch erosion and low harvest height of crop residues in this case study, is a useful means of gaining an overall impression of the land degradation situation and limitations of soil conservation technologies, as well as the adaptation conditions of sustainable technologies.

In many instances, participants developed awareness that they gained a more holistic understanding of the negative impact of their land management practices and specific erosion processes. They also realized the importance of working together (interactive knowledge) towards a common goal. In fact, it was observed that building common understanding for action and more effective knowledge systems for sustainability takes time and patience, and need continuous engagement. Unless care has to be taken on the continuous motivation and facilitation, the changes gained at one time may be reverting back. A good example observed in this study was the extreme reduction of farm drainage ditches during the initial learning stage and increasing again when the engagement of facilitators reduced.

The participatory learning approach applied in the current study supported to monitor and quantify evidences on the positive and negative effects of existing land management practices, build capacity of farmers through knowledge sharing procedures, and improve practices and collective actions and decision making. It helps to motivate and engage those innovative farmers to practice the knowledge and skill gained during the interactive learning, gradually others will follow them. This approach eventually builds self-confidence, enhances capacity of the farmers, and reduces the burden of development agents. It is therefore recommended to test and apply this approach, i.e., the land user participatory learning approach/method for collective decision making, in other watersheds where community mobilization based soil and water conservation works.

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