Soil and Water Conservation

On-farm Demonstration of Physical and Biological Soil Conservation Measures for Gully Stabilization and Biomass Production in the Wag-Lasta area of Amhara Region

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Abstract

A demonstration study was conducted on gully stabilization using physical and biological soil conservation measures. In the study, multi-purpose trees (MPTs), shrubs and grasses were used as biological materials, whereas the physical structure is only the stone fencing check dam. To conduct these experiment three gullies of similar length, width, depth and slope were selected on cultivated and grazing lands. As a result, root collar diameter and height of Acacia Saligna and Susbania Susban was increasing through time in gullies of both the cultivated and grazing lands. But it can be definitely concluded that Susbania Susban was well performed than the Acacia saligna in the gullies. On dry-land areas, like Wag-Lasta, planting trees and shrubs in gullies have a mutual advantage, conserving the soil and water and the other is getting forages from the gullies.

Keywords: Wag-Lasta, Gully, physical structures, biological structures, Acacia, Sesbania

Introduction

Although erosion is a natural process, man induced factors, such as improper land use and management (ploughing of shallow soils on steep-sloped lands), non-conservative grazing practices (open grazing and over grazing), removal of natural vegetation, and clearing and development of new farm lands, have accelerated the formation of gullies (Elliot *et al*., 1993). Among the causes of gully formation, unprotected water ways and steep-slope cultivation are the most important (Shertz *et al*., 1989)

Gully formation begins with the formation of small rills. During intense rains, the walls of these rills crack, and the loose soil material is washed down-slope. As this process continues small rills gradually increase in size to become larger rills, or small gullies. Unless counter measures are taken, these small gullies will become progressively longer and wider making intervention with stabilization measures more and more difficult.

One of the major reasons for the reduction of farm size in Ethiopia is erosion. Gully formation, an example of extensive erosion, rapidly decreases the area available for cultivation. In Wag-Lasta area, gully formation contributes to major losses in productive farm and grazing lands.

Wag-Lasta area is characterized by antique settlement tradition, severe land degradation, and a multitude of socioeconomic problems. The current ploughing technology dates back to medieval times. This archaic ploughing technique coupled with land fragmentation is causing irreversible land degradation vis. gullies. This land degradation is a very serious problem in Wag-Lasta, removing a substantial amount of land from production.

Fortunately, nowadays, gully treatment endeavours have received greater attention. Unlike in the past, conservationists have given greater emphasis on vegetative means of gully treatment. Structural measures, in spite of their effectiveness in silt trapping, are not sustainable because they have to be supported by vegetative means. Only constructing structures, trapping the sediment and see what it happens afterwards is considered as conservation. But the surcharge of the sediment causes failure on the structure. The sediment trapped stayed without use giving no production for the immediate problem of the farmers causing un-sustainability. With this introduction the following objectives were set:

- To recommend interventions for the stabilization of gullies in local watersheds.
- To obtain concrete information about the methods, including their stability, survivability, and amount of sediment trapped,
- To evaluate the efficiency of temporary structures, multipurpose trees (MPT), grasses and shrubs in gully stabilization.
- To collect farmers opinion about sustainable gully stabilization and biomass production

The vegetation was requiring time for establishment and their effectiveness will change as time passes. Therefore, the study were looking at the progress of vegetative establishment along and across with gully stabilization.

Materials and Methods

On the execution of the study, farmers were participating in protecting the gully structures, multi-purpose trees (MPTs), shrubs and grasses from damages due to grazing animals . Two types of gully treatment methods were used: mechanical or physical, and biological gully stablizations in combined and separate manner. The mechanical gully structure to be tested was constructed from stone fencing check-dam. Multi-purpose trees (MPT), shrubs, and elephant grass were the biological materials tested in combination with the physical structure and separately.

To conduct these experiment three gullies of similar length, width, depth and slope were selected. Adjacent check dams were spaced with a vertical interval of one meter that was equal to the height of the spillway. Check dams were trapezoidal in shape. They had 0.5m top width and 1m bottom width. Shrubs were planted with 0.5m spacing between rows and 0.2m spacing between shrubs, and the rows were planted perpendicular to the flow of run-off. Grasses were broadcasted as per recommended rate per hectar.

In case of check-dams, sediment depositions behind the dams were measured by the use of graduated sticks (Foster, 1988)

Through a thorough discussion on how to manage the gully (Check dam construction with the farmers, establishment of the biological measures, maintenance, follow up/ protection of the study treatments, sharing benefits derived from gullies and others were done accordingly among the participating farmers.

The treatments were:

T1= Mechanical structure with grasses, Shrubs and MPTs (Length-wide alignment)
T2= Mechanical structure with grasses, Shrubs and MPTs (Cross-section alignment)
T3= Mechanical structure alone for a control

Data collected:

- For shrub: Survival rate, number of sprouts, biomass yield and height
- For MPTs= Survival rate, root collar diameter, height and DBH, For mechanical structures: Silt depth, gully width and depth, side slope, soil type,

Result and Discussion

From Tables 1, 2 and 3, it can be observed that the RCD and height of Acacia Saligna and Susbania Susban was increasing through time on both the cultivated and grazing lands. But it can be definitely concluded that Susbania Susban was well performed than the Acacia Saligna in the area.

Furthermore, the height and RCD of Sesbania sesban was better in the grazing land than on the cultivated land, this may be due to the difference in soil type and the size of the catchments. Where as the height of Acacia saligna on the cultivated land was much better than the height on the grazing land.

Table 1. Root collar diameter and plant height (Data taken at 28/6/98)

Species	Cultivated Land		Grazing Land	
	RCD (mm)	Height (cm)	RCD (mm)	Height (cm)
Acacia Saligna	13.4	106.35	12.5	94.1
Susbania Susban	17.85	200.85	21.8	254.4

Table 2. Root collar diameter and plant height (Data taken at 7/10/98)

Species	Cultivated Land		Grazing Land	
	RCD (mm)	Height (cm)	RCD (mm)	Height (cm)
Acacia Saligna	18.45	125.9	14.93	103.73
Susbania Susban	27.1	187.9	29.8	272.3

Table 3. Root collar diameter and plant height (Data taken at 9/1/99)

Species	Cultivated Land		Grazing Land	
	RCD (mm)	Height (cm)	RCD (mm)	Height (cm)
Acacia Saligna	26.9	187.18	19.67	141.23
Susbania Susban	30.6	257.35	40.0	345

Table 4 indicates that the sticks were installed along the gullies. Multi measurements were taken along the check dams and silt depths indicated on the table were the average depths of five reading along the check dams. Silt depths were taken in each month through out the years from the start of the experiment and figures in the above table were the final reading which were taken in September 1998 E.C.

Table 4: Depth readings from the graduated sticks for the grazing land and cultivated land (15/1/1998)

Graduated stick	Silt Depth (cm)	
	Grazing land	Cultivated land
Stick 1	35	20
Stick 2	35	40
Stick 3	35	28
Stick 4	38	42
Stick 5	65	20
Stick 6	30	28

Conclusions and Recommendations

From the above result and discussion constructing only physical structures on gullies will have no value for the farmers. In dry-land areas, like Sekota planting trees and shrubs in gullies have a mutual advantage, one is conserving soil and water and the other is getting forages from the gullies. Especially Acacia Saligna and Susbania Susban were well adapted in the gullies and having a large biomass for livestock feeding. Farmers opinion during demonstration were very encouraging, and now in the water-shed farmers were rehabilitate gullies so that gullies now are not problem areas rather they are productive once.

References

Elliot, W.J., J.M. Lafle, and G.R. Foster. 1993. Soil erodability nomographs for the WEPP Model. Paper No. 932046, American Society of Agricultural Engineers, St. Joseph, MI.

Foster, G.R. 1988. User requirements, USDA-Water Erosion Prediction Project (WEPP). USDA-ARS National Soil Erosion Lab. W. Lafayette, IN.

Schertz, D.L., W.C. Moldenhauer,S.J. Livingston, G.A. Eesies, and E.A. Hintz. 1989. Effect of past soil erosion on crop productivity in Indiana. *J. Soil Water Conserv.Soc*.44(6): 604-608.S

Appendix Tables

Table 1: Base line data of the gully on the grazing land

Stru. No	Width at the back of each structure (m)	Depth at the back of each structure (m)	Side slope (%)	Land use system
1	5.80	1.70	90	
2	6.00	1.70	90	
3	7.00	2.20	85	
4	7.00	2.50	90	Grazing land
5	5.50	2.50	60	
6	7.00	3.50	45	
7	OUT LET	OUT LET		
Ave	7.133	2.35		

Table 2: Base line data of the gully on the cultivated land

Stru. No	Width at the back of each structure (m)	Depth at the back of each structure (m)	Side slope (%)	Land use system
1	5.50	1.45	45	
2	4.00	1.50	45	
3	4.00	1.70	50	
4	4.00	1.65	50	
5	6.00	1.50	30	Cultivated land
6	4.80	1.55	30	
7	6.20	1.80	30	
8	5.30	1.63	30	
9	OUTLET	OUTLET		
Ave	5.75	1.6		