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Pre-Extension Demonstration of Rehabilitation of Degraded Land with the Recommended Soil and Water Conservation Structure and Selected Grass Species in Borana Zone, Gomole District, Southern Oromia, Ethiopia

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Abstract **Original Research Article**

The study was conducted in Borana zone at Gomole district of Borana zone with the objectives to evaluate the productivity of degraded land and improve the knowledge of pastoralists on the application of the rehabilitation techniques. Two treatments; T_1=SWC (Soil level bund followed by Half-moon + Rhodes) and T_2= Enclosure (Control) were applied on a plot size of 20m * 20m that has been exposed to soil erosion and no grass over. A seed rate of 6kg/ha of Rhodes grass was used with manure application at the rate of 10 ton/ha. Both quantitative and qualitative data were collected and analyzed using descriptive statistics and paired and an independent sample t-test and narration and interpretation. The result of the demonstration revealed that the dry matter yield of SWC (Soil level bund and half-moon techniques followed by reseeding of Rhodes grass was significantly higher (3.93 ton/ha) ($P<0.001$) compared to the Enclosure (0.88 ton/ha). Moreover, the result of paired sample t-test revealed that the percentage of respondents for the correct answers is increased after intervention. As a result, the percentage of respondents for the incorrect answers is decreased implying that knowledge improved as a result of training provided to them before the start of research activity. Finally, the pastoralists ranked T1 (Soil Level Bund and half-moon application followed by Rhodes reseeding) as the 1st as it rehabilitated degraded land and controlled soil erosion compared to its counterparts (enclosure). Therefore, SWC (Soil level bund and half-moon) followed by reseeding of Rhodes grass on degraded land is recommended for pre-scaling up in Gomole district of Borana and other similar agro ecologies.

Keywords: Productivity, SWC, Degraded land, Gomole, rehabilitation, Soil erosion.

INTRODUCTION

Land degradation is widespread and a serious threat affecting the livelihoods of 1.5 billion people worldwide of which one sixth or 250 million people reside in drylands (Yirdaw *et al*., 2017). Globally, it is estimated that 10–20% of drylands are already degraded and about 12 million ha are degraded each year. Similarly, in Ethiopia land degradation remained the major challenges causing food insecurity and instability for both human and animals feed both in terms of quantity and quality (FAO, 2025). Driven by poor land management system, overgrazing of pasture lands, population growth, insecure land tenure, ineffective government policies and programs, unsustainable land use practices, adverse climatic conditions remained the major driver for land degradation in Ethiopia (Yirdaw et al., 2017; FAO,2025). Land degradation has been well recognized as major threat to human-wellbeing and environment due to the resulting loss in biodiversity, soil degradation &significant contribution to greenhouse gas emission, food insecurity, social and political instability and reduction in the ecosystem's resilience to natural climate variability (FAO,2025). Several global initiatives have been launched to combat land degradation, including rehabilitation of degraded drylands (UNCCD, 1994; Yirdaw *et al*., 2017). Moreover, Livestock pressure and poor stock management (mainly based on the free grazing system) were recognized as other major sources of land degradation. These in turn violate the soil nutrient cycle seriously depleting soil quality, increasing erosion and eventually reducing soil productivity (MoARD, 2007).

The ecological degradation remains today and continues to harm rangeland productivity in Ethiopia in general and Borana rangelands in particular. Most of

these degraded areas have been under great pressure for a long time to the extent that they have been changed into harsh environment. In spite of these impacts; the adoption of alternative restoration techniques in the country in general and Borana rangelands in particular is highly insufficient (Daniel, 2010; Mussa *et al*., 2016). It has been reported that introduction and adaptation of multipurpose agroforestry tree species and reversing rangeland degradation through grass reseeding technology has been used successfully as a means of rehabilitating degraded rangelands in East Africa (Mganga *et al*., 2010).

In recognizant of these problems, Yabello Pastoral and Dry land Agricultural Research Center (YPDARC) has undertaken an introduction and adaptation of Soil and water conservation structure (SWC), followed by reseeding of Rhodes grass species for rehabilitation of degraded rangelands. The result of adaption of previous research activities indicated that the application of SWC structures: level bund and half-moon followed by reseeding of Rhodes grass was recommended as the best performed soil and water conservation structure for the rehabilitation of degraded land (Kelil *et al.,* 2023). Moreover, the result of adaption indicated that there is a high possibility of restoring degraded rangeland with reseeding of Buffel and Rhodes grasses in Borana rangelands with simple tillage and manure application (Tebeje *et al.,*2014). As a result, undertaking this activity would solve the current serious land degradation problem of the study area through participation of pastoralists, agro-pastoralists and other stakeholders in the study area for further promotion of the technology to a wider pastoral community. Therefore, the present study was designed to demonstrate and evaluate those recommended SWC structured followed by reseeding of Rhodes grass with the following objectives.

The objectives of the study were:

- To evaluate the productivity of degraded land through rehabilitation techniques under pastoralists condition
- To improve the knowledge of pastoralists on the application of the rehabilitation techniques
- To assess pastoralists' feedback on the technologies in the study area

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Gomole District of Borana zone. Gomole District in the Borana Zone of Southern Ethiopia's Oromia regions is a pastoral and agro pastoral areas located about 535 South of Addis Ababa and roughly 42 km Northeast of the Yabello (the Borana zone Capital). Geographically, Gomole district is roughly located 5000'N to 5020'N latitude and 38000'E to 38030' longitude. The elevation of the district is typically 1,350 to 1,685 meter above sea level, with a semi-arid climate. It has an estimated average annual rainfall of about 300-900mm and the average annual temperature ranges from 28^0C – 32^0C.

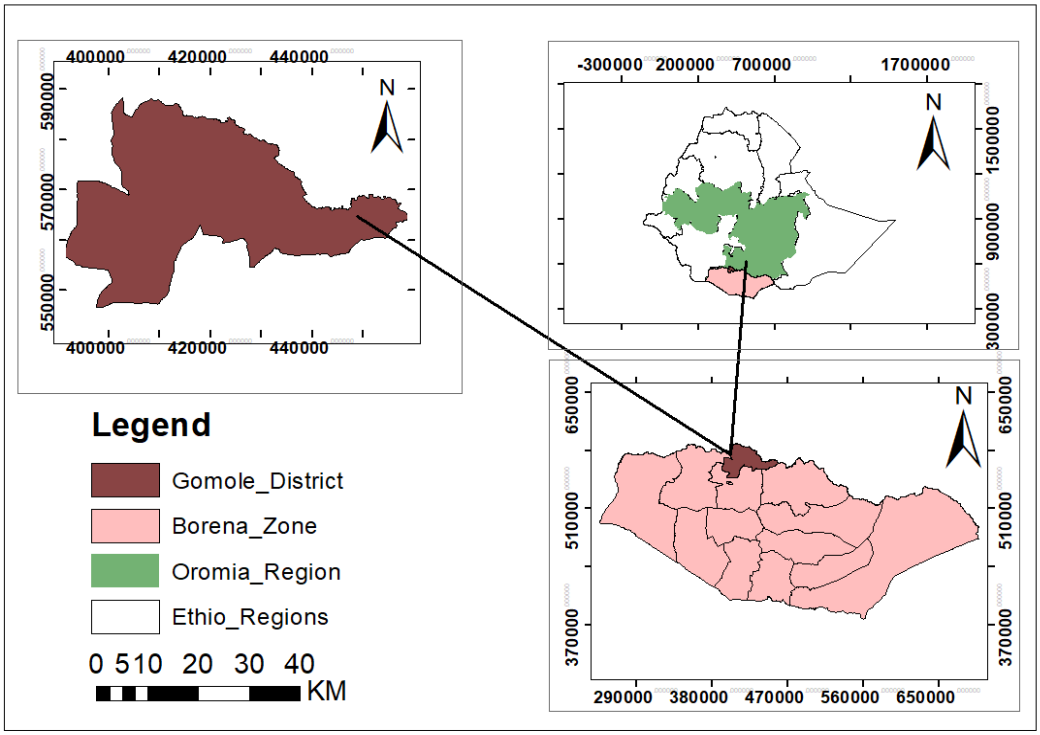

Figure 1: Description of the Study Area

Site and Pastoralists Selection

The study was conducted in Gomole district of Borana zones. Discussion with the pastoralists, Development Agents, rangeland experts and kebele leaders was held. Awareness creation was made on detail of what, who and for whom the activity would be done and also their participation as well. Following these discussions, a study site was selected purposively based on its severity of bare land and that was subjected to soil erosion together with community leaders, Development Agents (DAs) and rangeland experts of the respective office of agriculture. The selected site in the district was fenced firmly with locally available materials to exclude livestock grazing. The best performed soil and water conservation structure (level bund and half-moon) was constructed in staggered manner based on the recommended depth and width. Rhodes grass was sown on the degraded plots.

The pastoralists were also selected based on their interest to work in a group, manage the degraded land, to share the knowledge gained during the demonstration to both participant and non-participant trial pastoralists. Two Pastoralist Research Group (PRG) consisting of 40 members were established at Gomole district considering crosscutting issues (gender) and considering 40% for both women and youth to keep gender balance.

Research Design

Prior to conduct the research activities, a SWC techniques (Level band) followed by half-moon water basin was constructed to prevent soil erosion. A plot size of 20m * 20m that has been exposed to soil erosion and no grass over it and the Enclosure (Control) that has been adjacent was planted with a Rhodes grass. The research study comprises two treatments; T_1=SWC (Soil level bund followed by Half-moon + Rhodes reseeding and T_2= Enclosure (Control) were applied. A length of 10m Soil level bund depending on the slope of erosion was digged horizontally to prevent soil erosion and at distance of 2m a micro basin (Half-moon) structure was also prepared. A seed rate of 6kg/ha Rhodes grass was used with manure application at the rate of 10 ton/ha.

Training

Training is an important central component of this activity. Before the start of the activity, training was given for the selected pastoralist by a multidisciplinary team of YPDARC on: the importance of technologies, management practices with regard to rehabilitation of degraded land through SWC followed by reseeding of Rhodes grass concept of Pastoralists' Research Group (PRGs).

Data Types and Method of Collection

Quantitative data like Dry matter yield, total number of pastoralists participated in training, pastoralists' knowledge on application of technology before and after trial were collected through: direct measurements, checklists, spread data sheet while qualitative data like pastoralists' feedback on the technology was collected through focus group production.

A quadrate of a four-sided (square) frame of welded metal of 0.5 × 0.5 m (0.25 m^2) following the procedure recommended by Whalley and Hardy (2000) to measure the biomass during data collection in the field. Quadrates were purposively put from four corners and at the center of the field. Rhodes grass species reaped manually using sickles from plots were identified on the field and separately put into plastic bags and were brought to YPDARC laboratory. Then, oven-dried at 105^0C for 24 hours to determine the biomass (Adesogan *et al*.2000; ILCA, 1990; Rau *et al.,* 2010). Lastly, the dry matter of grass species was weighed after 24 hours using a sensitive balance and converted from g/0.25m2to ton/ha.

Knowledge Data Collection Method

A simple knowledge test items were developed based on the contents of: training given to participant pastoralists regarding rehabilitating degraded land through rehabilitation techniques was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers.

Methods of Data Analysis

The collected data was entered, coded and analyzed using MS-excel and SPSS version 20. Quantitative data was analyzed using descriptive statistics (Mean, frequency and percentage. Qualitative data was analyzed through interpretation and narration. An independent and paired sample t-test was employed to check the significance difference between: dry biomass and seed yields of two demonstrated grass species finally the total mean of the knowledge improvement before and after intervention respectively

RESULTS AND DISCUSSIONS

The result of the demonstration revealed that the dry matter yield SWC (Soil level bund and half-moon techniques followed by reseeding of Rhodes grass was significantly higher (3.93 ton/ha) compared to Enclosure (0.88 ton/ha) as shown in Table 1 below. This might be justified by the fact that the constructed soil level bund and half-moon fully controlled soil erosion (degradation) followed by reseeding of Rhodes in the degraded land. This study was in agreement with the findings of Gilo *et al.* (2017) and Nimona *et al.* (2021) who found that range land treated with bush controlling techniques gave the highest biomass yield compared to enclosure and SWC (Nigriam micro catchments with mulch have recorded 38.1 ton/ha compared to normal pit without mulch (24.65 ton/ha)

Table 1: Dry Biomass yield (ton/ha) of Rhodes grass with the demonstrated rehabilitation techniques

Treatment applied	N	Mean	Std. Deviation	Minimum	Maximum	t-value
SWC Structure + Rhodes	5	3.93	0.078	3.85	4.02	86.67***
Enclosure	5	0.885	0.016	0.86	0.91	
Source: Own survey, 2025. *** Indicate significant at 1%level of significance= Number (Sample size)						

Photo taken during application of SWC	Rehabilitated degraded after treatment application
	

Figure 2: Performance of degraded land during and after treatment application at Gomole district of Borana zone

Figure 3: Photo taken after rehabilitation of degraded land through reseeding of Rhodes grass and the application of SWC Practices at Gomole

Soil Level Bund and Half-moon constructed	Soil Level Bund + Half-moon Structure followed by Reseeding of Rhodes grass	Enclosure (Control)
		

Figure 4: Performances of the forage during Soil Level Bund and half-moon structure, Soil Bund, half-moon structure followed by reseeding of Rhodes grass and Enclosure as shown from left to right respectively

Capacity Building

Before the start of the research activity, training was given for the selected pastoralist by a multidisciplinary team (animal breeder, Ecologist and Extensionists) of YPDARC on: the importance of technology, management practices with regard to rangeland rehabilitation of degraded rangelands through SWC (Half-moon and soil bund level) and reseeding of Rhodes grass, and concept of PRGs. Accordingly, the number of pastoralists', DAs and agriculture experts who attended training on rehabilitation of degraded land and its management before starting the research activity is presented in Table 2 below. A total of 43 participants: 34, 4 and 5 pastoralists', DAs and agriculture experts were attended the training on the importance of technology, management practices with regard to rangeland rehabilitation of degraded rangelands through reseeding of Rhodes grass, concept of Pastoralists' Research Group (PRGs). Out of the total participants, female participants accounted for 39.5% while the remaining 60.5 % were male participants.

Table 2: Training given for the pastoralists, experts and DAs on rehabilitation of degraded lands through Rhodes grass

Participants	Gender		Total
	Male	Female	
Pastoralists	20	14	34
DAs	3	1	4
Experts	3	2	5
Total	26	17	43

Source: Own computation, 2024/25

Result of Knowledge Test

The result of knowledge improvement of pastoralists' before and after training is presented in the Table 3 below. As one can observe from the Table 3, the percentage of respondents for the correct answer increased while that of incorrect decreased. Moreover, the result of paired sample t-test revealed that there is statistically mean difference between the before and after intervention ($P<0.001$) the percentage of respondents for correct answers is increased after intervention (Table 4). As a result, the percentage of respondents for incorrect answers is decreased implying that knowledge improved as a result of training provided. This study agrees with the findings of (Amare, 2023) who found that the knowledge of farmers improved as a result of trainings provided and field days organized on desho grass demonstration.

Table 3: Percentage of Respondents for each Knowledge Items

No	Test items	Respondents' Percentages (%)			
		Before		After	
		Correct	Incorrect	Correct	Incorrect
1	The name of recommended grass species	30	70	80	20
2	Know about the importance of newly introduced SWC techniques and their role degraded lands	40	60	70	30
3	Know about different SWC basin mechanism (soil basin half-moon)	20	80	40	60
4	Had information the Rhodes grass species that are highly adaptive in our environment	50	50	80	20
5	The application of different SWC techniques on a ground	30	70	70	30

Source: Own survey Computation, 2024/25

Table 4: Paired sample t-test for knowledge on Rehabilitation of degraded lands

	Mean	N	Std. Deviation	T-value
Total Score of knowledge before intervention	1.70	10	0.949	4.385***
Total Score of knowledge after intervention	3.60	10	0.966	

Source: Own computation Survey 2025. N=Sample size. ***Indicates significance at 1% probability level

Pastoralists' Feedback on SWC Techniques

Pastoralists set their own criteria before judging the demonstrated SWC (Soil Level Bund and half-moon followed by Rhodes reseeding and the enclosure one. Their criteria were rehabilitation of degraded land and controlled soil erosion for both treatments. Accordingly, all participated pastoralists preferred and selected the SWC (Soil Level Bund and half-moon followed by Rhodes reseeding first as the plots treated with these techniques rehabilitated the degraded lands and fully controlled soil erosion and Enclosure as the second option which in turn better than open grazing land.

Table 5: Rank of grass species based on Pastoralists' selection criteria

Treatments	Rank	Reasons
SWC (Soil Level Bund and half-moon followed by Rhodes reseeding	1st	Rehabilitated degraded land, controlled soil erosion
Enclosure	2nd	Less likely to be rehabilitated degraded land, control soil erosion as compared to the recommended rehabilitation techniques of degraded land

CONCLUSION AND RECOMMENDATIONS

From the study result it can be concluded that the average dry biomass forage produced from SWC structure (Soil level bund and half-moon) followed reseeding of Rhodes gave significantly higher dry biomass yield (3.93 ton/ha) with a minimum and a maximum of 3.85 and 4.02 ton/ha respectively as compared to grazing enclosure (0.885 ton/ha). Based on the criteria they set, participated pastoralists preferred and selected the SWC (Soil Level Bund and half-moon followed by Rhodes reseeding first as the plots treated with these techniques rehabilitated the degraded lands and fully controlled soil erosion and enclosure as the second option which in turn better than open grazing land. In the study district training given to pastoralists enhanced their knowledge on rehabilitation of degraded land through the recommended SWC techniques followed by reseeding of Rodes grass species after the intervention. Therefore, applying recommended SWC practices followed by reseeding of Rhodes grass in the Gomole district had successfully rehabilitated the degraded land. Therefore, SWC (Soil level bund and half-moon) followed by reseeding of Rhodes grass on degraded land is recommended for pre-scaling up in Gomole district of Borana and other similar agro ecologies. The study also suggests that concerned bodies like research centers, NGOs, Borana University should give emphasis for the achievement of rehabilitation of degraded through recommended technologies.

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