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Research Article

Selection of Soil and Water Conservation Technologies and Native Tree Species for Rehabilitation of Degraded Arid Lands in Southeast Ethiopia

Abeje Eshete, Shambel Teshome, Aliyi Edaso, Getaw Yilma, and Gemedo Furo

Ethiopian Forestry Development, P.O. Box 24536 Code 1000, Addis Ababa, Ethiopia

Correspondence should be addressed to Abeje Eshete; abejeye@gmail.com

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The large-scale commercial agriculture, mining, expansion of sedentary agricultural settlements, and overgrazing in Ethiopian pastoral areas have become a major cause of land degradation. Such activities reduce grazing capacities and impoverish already fragile living conditions of the pastoralists. Such an increase in land degradations necessitates urgent calls for interventions. The main objectives of this study were to select the best performing soil and water conservation technologies and native tree species to restore degraded lands of arid and semiarid conditions in Liben District of Guji Zone, Oromia Reginal State, Ethiopia. Four locally grown and locally preferred tree species, namely, *Cordia africana*, *Acacia tortilis*, *Acacia goetzei*, and *Combretum molle*, were planted in five soil and moisture conservation structures (control, half-moon, spot hoeing, mowing, and trench). The survival rate and height and root collar diameter (RCD) growth of planted tree species were collected two years after planting. A significantly higher survival rate, RCD, and height growth of planted seedlings were recorded from half-moon (52.44 ± 12.48%; 1.66 ± 0.31 cm; 51.57 ± 2.79 cm) and trench (64.00 ± 11.49%; 1.92 ± 0.27; 69.67 ± 2.62 cm) moisture conservation structures, respectively. *Acacia tortilis* (58.22 ± 12.38%) and *Acacia goetzei* (42.99 ± 8.81%) had better survival rate than *Cordia africana* (4.00 ± 1.91%) and *Combretum molle* (24.22 ± 7.34). *Cordia africana* attained the largest RCD (2.50 ± 0.34 cm) and height (95.83 ± 17.25 cm) growth, followed by *Acacia tortilis* and *Acacia goetzei*. It is concluded that *Acacia tortilis* and *Acacia goetzei* are better species to grow in degraded lands. The half-moon and trench moisture conservation structures have a great potential for degraded areas of the arid and semiarid conditions of Ethiopia for better tree establishment, survival, and enhanced growth thereby rehabilitation of degraded lands.

1. Introduction

The Ethiopian government claims about 15.5% forest cover that comprises different types of forest ecosystems [1]. However, Ethiopia is among those countries with a relatively high rate of deforestation—around 1.0% per annum [2]. The recent results of national forest inventory in fact indicated that the average annual rate of deforestation from 2000 to 2013 is about 92,000 ha—around 0.53% [1]. The variation in the annual rate of deforestation indicates the variation in the dynamics and extent of forest cover change with time and space. The different types of forest resources located in different parts of the country are subjected to different biophysical and socioeconomic descriptors that can help to determine the drivers and dynamics of forest cover changes [3, 4].

The lowland dry land areas of the country have low population density relative to the highland areas [5] due to harsh environments for living and poor infrastructures (road, water, electricity, and telephone). A newly formulated economic policy focused on facilitating the commercialization and export orientation of the agricultural sector. To realize the policy, a number of subsidiary policies, strategies, and programs were introduced to promote the expansion, commercialization, and export orientation of the agricultural sector. The major strategy to achieve this goal is to attract direct foreign investment in large-scale commercial agriculture through allocation of mainly extensive forest lands and provisioning of tax incentives to private investors [6, 7]. Accordingly, the government of Ethiopia has been leasing large forested areas in lowland areas to establish commercial agriculture, with the support of a favorable incentive structure [8]. Following this, Government of Ethiopia has leased about three million hectares of land to investors [9, 10]. This large-scale investment is identified as the main direct driver of deforestation and land degradation in lowland areas of Ethiopia [11]. This is simply confirmed by the higher deforestation rate of Acacia-Commiphora and Combretum-Terminalia woodlands biome than the other three biomes in recent times [1], suggesting the economic development policies and strategies are also bearing significant costs to the country's land and forest resources [8]. In addition to the large-scale investment, expansion of sedentary agricultural settlements and overgrazing due to a mounting population has become a major cause of land degradation [12]. The increase in land degradation brought a growing concern for policy makers who fear that land degradation might reduce grazing capacities and impoverish already fragile living conditions of the pastoralists [13]. Such an increase in land degradations necessities urgent calls for interventions.

Very recently, Ethiopia has developed a new strategy called the Climate Resilient Green Economy (CRGE) strategy that take Ethiopia to middle income status by 2025 through low carbon, resilient, green growth actions [14]. The strategy emphasized agriculture and forestry. The CRGE strategy targets 7 million hectares for forest expansion through protecting natural forests, restoring degraded lands, and promoting sustainable use of terrestrial ecosystems by managing forests, combating desertification, and halting and reversing land degradation and halt biodiversity loss [1]. Forest restoration is now regarded as a cornerstone of national biodiversity conservation and sustainable development [15]. The CRGE clearly targeted to rehabilitate one million ha of degraded lands. In addition to the national strategy, Ethiopia has also pledged to restore 22 million ha of degraded lands following the Bonn challenge, New York declaration, and the Africa Forest Landscape Restoration (AFR 100) initiative [15]. Ethiopia is striving to achieve restoration goal through implementing a number of programs that includes reducing emissions from deforestation and forest degradation (REDD+) and a 10-year national forest sector development program [15].

Following this, the country has been undertaking different types of restoration activities that include exclosure, afforestation, and reforestation [15]. National tree planting campaign is also being practiced every year. While these political commitments have acquired wide support, there are huge knowledge gaps to achieve the country's ambitious restoration targets so far agreed, and a set of efficient restoration approaches will be necessary to achieve these targets. Among others, selection of suitable native tree species from the national species pool and soil and water conservation structures is the most critical step for rehabilitation of degraded forests and reforestation programs to be successful.

In arid and semiarid areas, water availability is one of the limiting factors in tree growth [16], and thus, the adoption of erosion-control measures is a highly recommended technique for successful restoration in degraded dry land areas [17]. The soil and water conservation structures in dry land areas enhance soil water infiltration, soil organic carbon, and promote its availability for agricultural and forest species during the dry period [18–20]. In addition to the soil and water conservation structures, the choice of suitable tree species can also determine the effectiveness of the rehabilitation program. Tree species vary in their performance and adaptation in areas with low fertility soils, high temperature variation, and extreme drought conditions. Thus, selection of native tree species with high early growth potential that can quickly restore degraded lands is very important for long-term reforestation success.

The motivation of this study stems from the lack of research on species selection and soil and water conservation structure for restoration of degraded forest lands. However, the ecological information necessary to select species and conservation structures which are appropriate and adapted to local conditions is inadequate in developing countries. This lack of data has limited the success of forest restoration programs [21, 22]. To address this knowledge gap, research on the restoration potential of soil and water conservation structures and diverse native tree species is urgently needed. Thus, the main aim of this study was to select the best performing tree species and conservation structures on the degraded lands of arid and semiarid conditions in Ethiopia.

2. Materials and Methods

2.1. Description of Study Site. This study was conducted in Liben District of Guji zone, Oromia Reginal State, Ethiopia (Figure 1). The district is located at about 630 km south of Addis Ababa and has a total area of 741,752 ha. The dominant landscape of the district slopes gently from the north-west to the south-east and the altitude range from 1000 to 1600 m.a.s.l [23]. The arid and semiarid agroclimatic zones are the dominant climatic zones in the district. The mean monthly minimum and maximum temperature is 16°C and 28°C, respectively, with annual rainfall of 460 to 790 mm with an annual average of 609 mm. The rainfall distribution is bimodal where the main rainy season is between February and June and accounts for 55% of the annual rainfall. The short rainy season is between September and December that accounts for 41% [23]. Drought is common in the study area every five to ten years. Both pastoralism and agropastoralism are the dominant livelihood in the district where most of the communities are predominantly dependent on livestock production [24]. The area is characterized by moisture deficit, resulting on water shortages that reduced the livestock and crop production potential of the area and thus the livestock production and crop cultivation are subsistence type (Guji Zone Administration Report, 2016).

Acacia-Commiphora woodland is the dominant vegetation type where large areas are characterized by extensive grazing lands covered mainly by grasses with scattered acacia

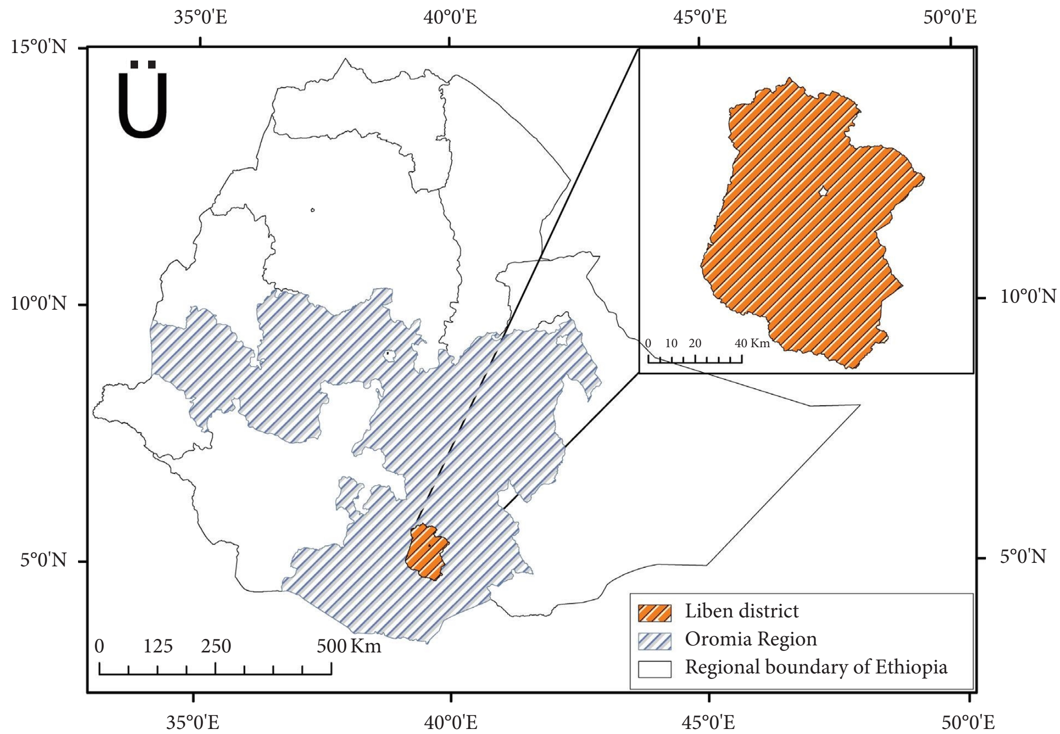

Figure 1: Map of the study site.

and some noxious species. The vegetation is an important source of income through production and marketing of forest products such as gum and resin, charcoal, and fuel wood. Forest products from the vegetation have also a significant role as a coping strategy at times of drought. However, a number of research reports indicated that the vegetation which is used as a rangeland in the district is shrinking significantly and severely degraded for the last 30 years. Recurrent drought, expansion of crop cultivation, overgrazing, charcoal and fuel wood production, and bush encroachment are the main drivers of degradation while human population growth, settlement, and bans on use of fire are reported to be the underlying drivers of degradation [25, 26].

2.2. The Study Tree Species. Four native tree species that have been growing in the study area were initially selected from the list of native plant species based on the preference of the local people through group discussion, forest ecological knowledge, traditional uses, and availability of seeds. The four species were *Cordia africana*, *Acacia tortilis*, *Acacia goetzei*, and *Combretum molle*. The local use of native species was surveyed through a traditional ethnobotanical approach. The habitats of the selected species were also documented.

2.3. Experimental Design. A factorial experiment with randomized complete block design and three replications were employed for the current study. The first factor was the soil and water conservation structure with five levels (control (pitting), half-moon, spot hoeing, mowing, and trench). Pitting which consisted of digging a planting hole at a depth and width of 30 × 30 cm. This is a common practice in the area and hence considered as a control. Spot hoeing is done in 1 m diameter circle and all root remnants of all plant species were removed from the soil. This practice is expected to loosen the compacted soil and facilitate the seedlings root penetration. Half-moon structure was established to facilitate moisture retention. Trench structure was also established by digging a trench (40 cm deep) with a contour ridge (40 cm high) used for tree planting. Mowing is the last treatment level which involves cutting of the grasses (weeds) around the seedlings two times per year during the rainy season. The mowing is expected to decrease the above ground competition of the grass with the seedlings. The second factor was tree species with four levels (four tree species) as indicated above.

Three experimental blocks (considered as replications) of 4104 m^2 each (72 × 57 m) with 5 m spacing between blocks were set up on a gentle slope in 2017 and followed up until 2019. In each block, 20 experimental plots with 3 m spacing between plots were established that measure 12 m × 12 m. Each plot has a treatment combination of tree species and soil and water conservation structure. Nursery-raised seedlings were out planted in randomly assigned plots and 49 (7∗7) seedlings that measure ± 30 cm height per species were planted with a spacing of 2 m in each plot (Table 1). Altogether 2,940 seedlings of four species were planted in June/July 2017, which is at the beginning of the wet season. After planting, weeding was carried out three times (May, July, and September) a year.

Table 1: Experimental layout of the experiment.

Species	Treatments				
	Control = C	Half-moon = HM	Spot hoeing = SH	Trench = T	Mowing = M
Replication I					
Acacia tortilis—AT	*ATC*	ATHM	ATSH	ATT	ATM
Cordia africana—C	*CC*	CHM	CSH	CT	CM
Combretum molle—CM	*CMC*	CMHM	CMSH	CMT	CMM
Acacia goetzei—AG	*AGC*	AGHM	AGSH	AGT	AGM
Replication II					
Acacia tortilis—AT	*ATC*	ATHM	ATSH	ATT	ATM
Cordia africana—C	*CC*	CHM	CSH	CT	CM
Combretum molle—CM	*CMC*	CMHM	CMSH	CMT	CMM
Acacia goetzei—AG	*AGC*	AGHM	AGSH	AGT	AGM
Replication III					
Acacia tortilis—AT	*ATC*	ATHM	ATSH	ATT	ATM
Cordia africana—C	*CC*	CHM	CSH	CT	CM
Combretum molle—CM	*CMC*	CMHM	CMSH	CMT	CMM
Acacia goetzei—AG	*AGC*	AGHM	AGSH	AGT	AGM

2.4. Data Collection. The field performance of the four planted species was evaluated based on data from a restoration planting trial. Twenty-five inner trees in every plot were considered for survival and growth data collection, and the rest were not considered to avoid the border effects [27]. Seedling survival, root collar diameter (RCD), and seedling height were recorded every six months after planting over the two-year period. The survival rate of planted seedlings on each plot was assessed by counting both live and dead individuals at the end of the annual growing season. RCD was measured with calipers while height was measured with a measuring tape at the stem base.

2.5. Data Analysis. The survival rate of the planted trees within the study plot over the two-year period was calculated using the following formula [28]:

$$X = \frac{Z \times 100\%}{Y}, \quad (1)$$

where X = survival rate of planted seedlings, Y = total number of planted seedlings, Z = total number of survived trees after two years.

The survival percentage data were then arcsine transformed while RCD and height data were square root transformed to meet the normality assumptions of analysis of variance (ANOVA). Two-way analysis of variance (ANOVA) was employed to test the significance of species, structures, and species vs. structure interaction effect on mean performance of planted species measured in terms of mean annual growth rates of RCD and height using a linear model. All tests were performed with *R* statistical software, version 2·15·0 (R Development Core Team, 2012).

3. Results

3.1. Survival Rate of Tree Species. The overall survival rates for almost all species and structures tested were very low (>31%). However, the survival rates varied significantly among species and structures at $P < 0.05$ (Tables 2 and 3). As can be seen from the survival rate of each species, the highest survival rate was recorded for *Acacia tortilis* (58.22 ± 12.38%) and the least survival rate was recorded for *Cordia africana* (4.00 ± 1.91%). *Acacia goetzei* also presented a relatively higher survival rate (42.99 ± 8.81%) when compared to the *Combretum molle* (24.22 ± 7.34%) and *Cordia africana*. *Acacia tortilis* showed a significantly higher ($P < 0.05$) overall survival rate than the other two species, *Combretum molle* and *Cordia africana*, across all moisture-conserving structures, but with *Acacia goetzei*. There were no significant ($P > 0.05$) differences in the survival rate between *Acacia goetzei* and *Combretum molle*. *Cordia africana* has shown a significantly ($P < 0.05$) lower mean survival rate than the other three species (Table 2).

Almost all species planted in half-moon and trench moisture-conserving structures showed a very high survival rate than the other structures (Table 2). The survival rates of all species grown in trench (64.00 ± 11.49%) and half-moon (52.44 ± 12.48%) structures were significantly higher (at $P < 0.05$) than the control (18.69 ± 7.46%), spot hoeing (12.40 ± 5.54%), and mowing (17.50 ± 8.48%), suggesting that water conservation structures are very helpful to enhance survival rate of planted seedlings in arid and semiarid agroecological zones. However, there was no significant difference ($P > 0.05$) between the mean survival rate of all species planted in the pitting (control), spot hoeing, and mowing. The analysis of variance revealed that the interaction of species survival with moisture conservation structures was found to be insignificant ($P > 0.05$).

3.2. Growth Performance of Tree Species. The overall highest growth in height was recorded for *Cordia africana* (95.83 ± 17.25 cm), followed by *Acacia tortilis* (63.40 ± 2.54 cm) and *Acacia goetzei* (57.59 ± 2.08 cm). The lowest height was recorded for *Combretum molle* (24.36 ± 1.19 cm) at the end of the trial. Similarly, the overall growth in RCD was the highest for *Cordia africana* (2.50 ± 0.34 cm), followed by *Acacia goetzei* (1.55 ± 0.18 cm) and *Acacia tortilis* (1.19 ± 0.19 cm). The lowest RCD value

Table 2: Survival of planting seedlings under different treatments.

Species	Structure					Grand mean
	Control	Half-moon	Mowing	Spot hoeing	Trench	
Acacia goetzei	35.00	56.00	30.67	22.67	70.67	42.99 ± 8.81^{ab}
Acacia tortilis	16.00	86.00	—	24.00	90.67	58.22 ± 12.38^{a}
Combretum molle	16.67	56.00	24.33	4.00	—	24.22 ± 7.34^{b}
Cordia africana	—	10.00	—	—	14.00	4.00 ± 1.91^{c}
Grand mean	18.69 ± 7.46^{b}	52.44 ± 12.48^{a}	17.50 ± 8.48^{b}	12.40 ± 5.54^{b}	64.00 ± 11.49^{a}	31.89 ± 5.01

Note. Similar letter in the last row and last column shows no significant difference and different letters indicate significant difference between moisture harvesting structures and species, respectively, at $P \leq 0.05$.

Table 3: Analysis of variance for survival rate of seedlings of tree species planted in different moisture-conserving structures.

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	6.484^{a}	17	0.381	3.858	0.001
Intercept	11.845	1	11.845	119.806	0.000
Species	2.641	3	0.880	8.905	0.000
Structure	2.619	4	0.655	6.623	0.001
Species * structure	0.386	10	0.039	0.391	0.939
Error	2.669	27	0.099		
Total	21.051	45			
Corrected total	9.153	44			

Dependent variable: arcsign of survival percentage.

Table 4: Growth performance of tree species in root collar diameter (cm) across moisture-conserving structures.

Species	Treatment					Grand total
	Control	Half-moon	Mowing	Spot hoeing	Trench	
Acacia goetze	1.29	1.71	1.10	1.33	2.05	1.55 ± 0.18^{ab}
Acacia tortilis	0.83	1.32	—	0.81	1.60	1.19 ± 0.19^{b}
Combretum molle	0.78	0.77	0.53	0.10	—	0.75 ± 0.19^{b}
Cordia africana	—	2.82	—	—	2.19	2.50 ± 0.34^{a}
Grand total	0.96 ± 0.20^{bc}	1.66 ± 0.31^{ab}	0.81 ± 0.23^{c}	1.08 ± 0.17^{abc}	1.92 ± 0.27^{a}	1.34 ± 0.14

Note. Similar letter in the last row and last column shows no significant difference and different letters indicate significant difference between moisture harvesting structures and species, respectively, at $P \leq 0.05$.

Table 5: Growth performance of tree species in height (cm) across moisture-conserving structures.

Species	Treatment					Grand total
	Control	Half-moon	Mowing	Spot hoeing	Trench	
Acacia goetzei	63.51	52.81	40.59	44.02	66.79	57.59 ± 2.08^{c}
Acacia tortilis	34.18	57.22	—	50.16	71.79	63.40 ± 2.54^{b}
Combretum molle	22.41	27.25	21.38	26.50	—	24.36 ± 1.19^{d}
Cordia africana	—	128.80	—	—	72.29	95.83 ± 17.25^{a}
Grand total	44.15 ± 3.71^{c}	51.57 ± 2.79^{b}	32.71 ± 2.72^{d}	45.26 ± 3.62^{bc}	69.67 ± 2.62^{a}	55.65 ± 1.60

Note. Similar letter in the last row and last column shows no significant difference and different letters indicate significant difference between moisture harvesting structures and species, respectively, at $P \leq 0.05$.

was recorded still for *Combretum molle* (0.75 ± 0.19 cm), far below half of those tested together (Tables 4 and 5). The height and RCD growth of species varied significantly among species and structures at $P < 0.05$ (Tables 4 and 5). *Cordia africana* showed a significant height growth than the three species; *Acacia tortilis* showed a significant height growth than *Acacia goetzei* and *Combretum molle*, while *Acacia goetzei* showed a significant height growth than *Combretum molle*.

The effect of moisture conservation structures on seedling growth in height and RCD was highly significant at $P < 0.05$ (Tables 4 and 5). The average growth in height of seedlings of all planted species was significantly higher in trench (69.67 ± 2.62 cm) than the other four moisture conservation structures. The average height growth of planted species in half-moon (51.57 ± 2.79 cm) was significantly higher than mowing (32.71 ± 2.72 cm) and control (44.15 ± 3.71 cm), but not with spot hoeing (45.26 ± 3.62 cm). The average height growth of planted species in mowing was significantly lower than species planted in spot hoeing and control.

With regard to seedling growth in RCD, seedling planted in trench (1.92 ± 0.27 cm) and half-moon (1.66 ± 0.31 cm) had higher growth performances than the other moisture conservation structures. There were a significantly higher average growth of seedlings planted in trench, half-moon, and spot hoeing (1.08 ± 0.17 cm) than the control (0.96 ± 0.20 cm) and mowing (0.81 ± 0.23 cm). Similarly, there were a significantly higher growth of seedlings planted in spot hoeing, half-moon, and control than mowing. However, no significant difference was observed in RCD growth between seedlings planted in trench, spot hoeing, and half-moon. Similarly, the growth in RCD of seedlings planted in spot hoeing, half-moon, and control did not differ significantly.

4. Discussion

Our results show significant differences in survival rates among the tree species. Based on the survival rates, *Acacia goetzei* and *Acacia tortilis* showed a significantly higher overall survival rate than the other two species across all moisture-conserving structures. These results agreed with the results of Kasaye et al. [29] who have demonstrated better performance of Acacia species in degraded dry lowland areas, such as Abergelle District of Amhara Regional State, Ethiopia. This might be due to the nature of the dry land Acacia species which are classified as drought avoiders [30] and their ability to fix nitrogen that helped them to perform better in degraded soil [31]. The overall lower survival rates of *Cordia africana* and *Combretum molle* among the studied tree species in the same study suggest that their level of adaptation in the degraded arid and semiarid condition is very low [32]. The lowest survival rate of *Cordia africana* seedlings in the non-water harvesting structures might not be due to an insufficiency of rainfall but due to reduced soil moisture conditions or an insufficiency of moisture available within the rooting zone [33, 34]. Reduced soil moisture conditions or an insufficiency of moisture available within the rooting zone are commonly viewed as a significant barrier to artificial reforestation in moisture-stressed areas [34]. A similar result was reported by Donoso et al. [35], who indicate that high water restriction affects the physiology of some tree species, provokes a reduction of stomatal conductance, net photosynthesis, and transpiration, and produces lower leaf and root biomass.

The survival rates of species grown in trench and half-moon structures were significantly higher than the pitting (control), spot hoeing, and mowing suggesting that water conservation structures are very helpful to enhance the survival rate of planted seedlings in arid and semiarid agroecological zones. The higher survival rate of tree species planted in water conservation structures might be related to the higher efficiency of the structures in capturing rainwater during the rainy season, enhancing water infiltration, conservation, and allowing greater water availability during the dry season to ensure dry season tree seedling survival [36–38]. Successful tree seedling survival depends on the soil condition and stored soil moisture available to ensure tree seedling survival into the next growing season [36]. The moisture-conserving structures are reported to act as a supplemental moisture and soil nutrients for vegetation growth and survival [39]. Half-moon and trench have been recognized by various authors as a technique that promotes water conservation, especially in arid and semiarid zones [37, 40, 41]. This is because the moisture harvesting structures improve moisture in the root zone of tree species [42].

The height and RCD growth of species varied significantly among species and structures at $P < 0.05$. Based on the findings of this study, individuals of *Cordia africana* have a very good local performance while Acacia species have a suboptimal growth performance. The species difference in growth may be due to the difference in the growth strategy and genetic superiority of the tree species for the growth [43–45]. *Cordia africana* is a reasonably fast growing tree species compared to *Combretum molle* and *Acacia tortilis* which are categorized as slow growing tree species [46]. According to Reubens et al. [32], *Cordia africana* is one of the top three priority species selected as the indigenous, naturally growing species adapted to harsh conditions, often with a sociocultural importance, high protection, and reclamation value, and an excellent agroforestry potential. Since *Cordia africana* is selected by the local people for a number of its socioeconomic value and has performed well in growth and survival when it is combined with moisture conservation structure, the use of the species for rehabilitation of degraded lands in arid and semiarid conditions will contribute to successful rehabilitation schemes [47].

The current study showed that the height and RCD growth of the four studied species was significantly higher in trench and half-moon moisture conservation structures than the other structures indicating that moisture-conserving structures contributed for higher growth increment and are the main factors controlling the performance of tree growth. Various studies in different dry land areas of Ethiopia have showed a similar result where the height and diameter growth of all planted tree species were best under moisture conservation structures than that of tree seedlings planted in normal pits [48–52]. A similar study in the interior dry land of the Maule Region, Chile, by Ovalle et al. [53] reported a significant effect of moisture-conserving structures on plant height, crown diameter, and trunk diameter. Moisture-conserving structures are also reported to facilitate the regeneration of woody plants in the degraded area [54].

The commonly observed drought stress in arid and semiarid areas decreases the growth and development of planted tree species by reducing the photosynthetic rate [55].

Such stress can be overcome by constructing moisture-conserving structures that enhances the growth increment in semiarid climates [56, 57]. The main role of soil moisture conservation structures are reducing runoff and improve the infiltration of rainwater during the rainy season. The infiltrated rainwater will be available for plants during the dry period, which vigorously enhances plant growth and increases plant biomass compared with that of trees planted without moisture harvesting structures, that is, normal pits [58, 59].

5. Conclusion and Recommendation

Survival and growth rates are important factors in selecting the best tree species and moisture conservation structures for restoration activities in degraded arid and semiarid areas. The performance of tree species varied in height, root collar diameter, and survival rate. Better survival rate was observed for the two *Acacia* species, *A. goetzei* and *A. tortilis*. A significant height and RCD performance was observed for *Cordia african*. An optimal growth performance was observed for both *Acacia* species. *Combretum molle* showed the least in growth performance while modest in survival rate.

Half-moon and trench moisture-conserving structures showed a great potential in providing suitable conditions for successful tree establishment and tree growth by promoting the highest water content in the soil profile. Almost all of the four tested tree species exhibited a significantly higher survival rate and growth performance when established with the two moisture conservation structures. Therefore, to restore degraded lands and to support the ongoing land rehabilitation programmes in arid and semiarid areas, we recommend the two *Acacia* species and *Cordia africana* in combination with the moisture conservation structures than the conventional method of tree planting. Authors would also like to recommend additional studies regarding the effect of moisture-conserving structures on water and soil nutrient dynamics. It would be wise to conduct a further study using a range of species with socioeconomic and ecological importance to get more alternative suitable species for successful rehabilitation of degraded lands.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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