



Original Paper

Assessment of the current status of area enclosures and their livelihood contribution in Wag-Lasta areas, north-eastern Ethiopia

Yekoye Alene^{*1}, Abebe Shumie¹, Birhan Worie¹, Haymanot Lamesgin, Menale Wondie³, Beyene Belay⁴, Silesh Asmare¹, Girma Nigusie¹, Adino Ebabu¹, Mubarek Eshetie²

1) Amhara Agricultural Research Institute, Sekota Dryland Agricultural Research Center, Forestry Research Directorate, P.O.Box 62, Sekota, Ethiopia

2) Amhara Agricultural Research Institute, Gondar Agricultural Research Center, P.O.Box 1337, Gondar, Ethiopia

3) Amhara Agricultural Research Institute, Bahir Dar, Ethiopia

4) Bahir Dar University, Collage of Agriculture, and P.O.Box 79, Bahir Dar, Ethiopia

*) Corresponding Author: yakoyea@gmail.com

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Abstract—Several studies have shown that keeping areas free from animal contact can not only restore degraded areas but also improve benefits to local communities. This survey aimed to identify the changes brought in the area enclosures after enclosure, the benefits they are giving to the users, and the current constraints of area enclosures in the Wag-Lasta area. A simple random sampling method was used to select respondents. A total of 180 respondents, from users of the area enclosure, participated. The data were analyzed by descriptive statistics using the SPSS tool version 26. According to the result, the majority of the respondents (74.4%) said that area enclosures were effective in the rehabilitation of degraded lands, and confirmed that they were beneficial for soil erosion control, the development of water sources, the conservation of natural resources (soil, water, trees, and shrubs), and the regeneration of trees and shrubs. The results also showed that the local community got different benefits from area enclosures, like animal fodder (53.3%), bee pollen sources (23.3%), and reducing soil erosion (23.3%). The local community also gained, on average, 4102.3 ETB and 1018.18 ETB per annum from grass and fuelwood selling, respectively, from area enclosures. Despite all these benefits, respondents explained that area enclosures were under critical problem due to free grazing (49.4%); flooding (28.9%); and illegal cuttings (21.6%). Hence, to minimize the existing constraints and improve the sustainability of benefits from area enclosure, it is important to diversify benefits, create awareness, and introduce new technologies related to sources of better fuelwood and animal fodder, as well as strengthen local communities.

Keywords—area enclosure, Community, constraints, socio-economic benefits

I. INTRODUCTION

Direct or indirect human-induced activities characterize land degradation as a descending trend in the land's state [1]. It is a well-known problem that affects billions of people's livelihoods globally [2] and comprises the loss of biological and water-related goods [3]. In Ethiopia, land degradation upsets all provinces of the socioeconomic and political lives of the people [4]. Because agriculture is the main economic determinant for

the majority of Ethiopian people, land degradation became a serious problem for agricultural production [5, 6]. This land degradation leads to soil erosion, biodiversity loss, loss of ecosystem services, and climate change [7]. The main reason for land degradation is deforestation, and it's a historic problem in Ethiopia, mainly in the central and northern highlands [8]. So, letting local communities be involved in everything from the beginning to the end of the rehabilitation work helps them feel more connected to shared property [9]. Ethiopia has started employing area enclosures to restore degraded forests [8, 10]; to boost agricultural output besides restoring degraded areas [11]; to provide socio-economic benefits to the livelihoods of the community [12, 13, 14]. Area enclosures that designed to restore degraded lands become the best method to conserve forests in the globe (Fikirte et al. 2019). Besides, area enclosures provide chances not only restoring the degraded areas relative to the original one in maximum, and conserve the forests from loss, but also ensures the benefits gained from the forests such as provision of animal fodder, raw materials for local communities use, medicine for people and animals, and other environmental, socioeconomic, and aesthetic values. Area enclosures in degraded areas are cost-effective and convenient for restoring and managing those areas [15, 16]. Assessing the rehabilitation status of area enclosures through formal and informal surveys is important to identify the gaps, determine the success of area enclosures, and then put solutions for constraints to ensure the success of area enclosures and sustain the benefits from them. Therefore, the survey was conducted to assess: (a) the current status of area enclosures; (b) the benefits from area enclosures for the local community; and (c) the constraints that influence the effectiveness of area enclosures.

II. MATERIALS AND METHODS

A. Description of the study area

The survey was carried out in Waghimra and North Wollo Zones in three agro-ecologies, namely lowland, mid-altitude, and highland, in the Amhara region (Figure 1). It is situated at

12°15'North latitude and 39°17'34" East longitude. Waghimra is an administrative zone in eastern Amhara, and 540 km from the regional state capital, Bahir Dar. Lasta district in North Wollo

zone was also one of the surveyed areas to represent the highland agroecology that is located geographically at 1235'31" N latitude and 3904'30" E longitude (Figure 1 and Table I).

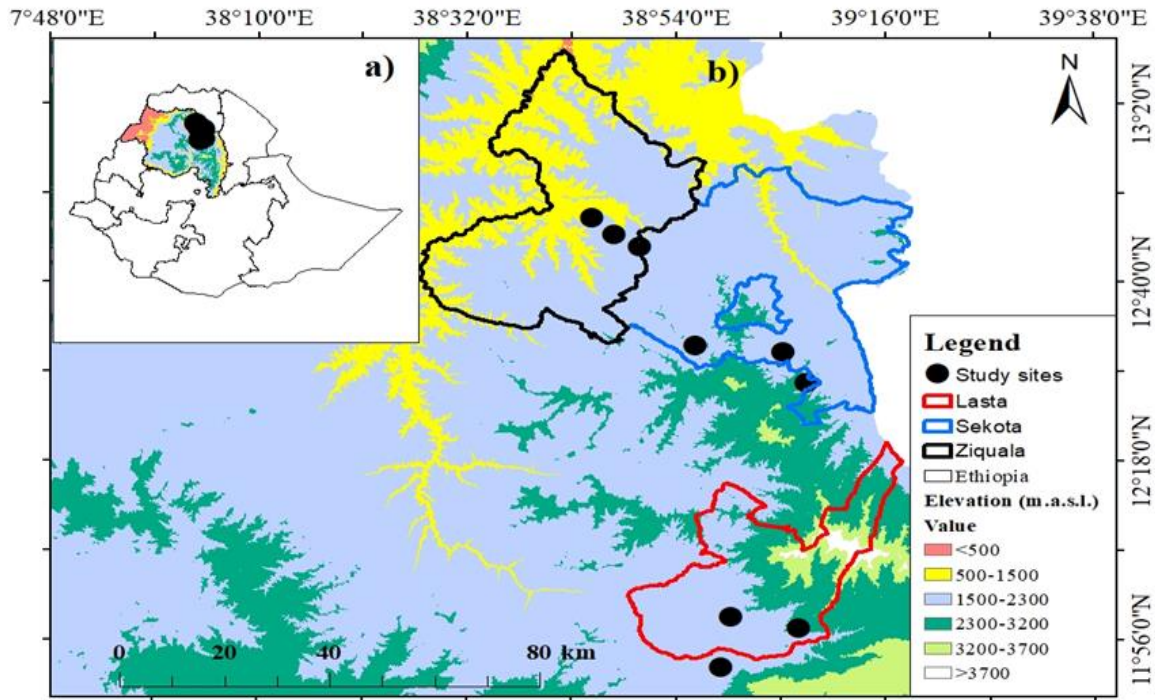


Fig. 1. Map of the study area

TABLE I. CHARACTERISTICS OF THE STUDY AREA

Attributes	Highland	Mid-altitude	Lowland area
Altitude (m.a.sl.)	2129 to 3600	1340 to 2200	500 to 1300
Rainfall (mm)	500 to 1000	350 to 700	250 to 750
Temperature (°C)	24.5	16 to 27	23 to 43
Soil type	Eutric Cambisols (51%)	Umbric Leptosols (52%)	Eutric Leptosols (29%)
Agro-ecology	Dega (52.7%)	Woyna-dega (65%)	Dry kolla
Topography		Chain of mountains, hills and cliffs	Chain of mountains, hills and cliffs
Vegetation		Bushy woodlands and forest only around churches	

Source: [17]

B. Sampling procedure and data collection

A reconnaissance survey was conducted to get an overview of the area and specify study sites. Three districts in different agro-ecological zones were selected purposively. The districts were Ziquala (lowland), Sekota Zuria (mid-altitude), and Lasta (highland). The criteria for selection of area enclosures were the presence of area enclosure interventions and accessibility. In each agroecology, three area enclosures were selected. The questionnaire survey was used to collect data on the current status of area enclosures, benefits gained from area enclosures for the local community, and constraints that influence their

effectiveness. Respondents were selected by simple random sampling from users of area enclosures. The proportion of the respondents was 10% of the total users of the area enclosures. Based on this, 60 respondents were interviewed in each agroecology. A total of 180 respondents were interviewed for this assessment.

C. Data analysis

In order to make the analysis easier, the data were divided into various strata. First, variables were identified which are the best indicators for the sustainability of area enclosure. An analysis of selected socioeconomic characteristics related to area enclosure practices provided a basis for evaluation of the system. The questions and questionnaires were coded to fit the statistical package. Chi-square test was used to examine the data using the SPSS tool version 26.

III. RESULT AND DISCUSSION

A. Demographic characteristics of the respondents

From the total number of respondents (180), the majority (72.8%) was males, and the remaining were females (27.2%). Besides, 74.4% (n = 134) were married, while 8.9% (n = 16) were single. The highest number of respondents (55%, n = 99) was in the 36–50 age category. In the case of educational status, only 58% (n = 105) of respondents were well-educated. Depending on their farmland size, half of the respondents owned 0.25–1 ha of land, followed by 1.1–2.5 ha (47.8%) of

respondents. Only 2% of the respondents have farmland sizes greater than 2.5ha (Table II).

TABLE II. SOCIOECONOMIC CHARACTERISTICS AND LAND HOLDING SIZE OF THE RESPONDENTS

Sex of respondent	Frequency	%	Maternal status	Frequency	%
Male	131	72.8	Single	16	8.9
Female	49	27.2	Married	134	74.4
			Divorced	30	16.7
Respondent age			Educational status		
20-35	60	33.3	Read and write	70	38.9
36-50	99	55	Literate	35	19.4
>50	21	11.7	Illiterate	75	41.7
Categories	Farmland size				
	0.25-1 ha	1.1-1.75 ha	1.76-2.5 ha	> 2.5 ha	Frequency
Lowland	28	25	7	0	60
Mid-altitude	27	27	4	2	60
Highland	35	11	12	2	60
Total	90	63	23	4	180

Based on the data obtained from this survey, the livestock owned by respondents has varied across agroecologies. It increased from highland (Lasta district) (1292) to lowland (Ziquala district) (2253) agroecology (Table III). The

livestock and distribution affect the area enclosures mainly for browsers. The browsers (goats) were higher (1801) in the lowland agroecology compared to mid-altitude (1118) and highland (248) agroecology.

TABLE III. LIVESTOCK DISTRIBUTION ACROSS AGRO-ECOLOGIES

Agro-ecology		Goat	Sheep	Cow	Ox	Calf	Equine	Total
Highland	Max	23	14	4	4	3	3	
	Min	0	0	1	0	0	0	
	Total	248	572	147	137	99	89	1292
	Ave.	4	9	2	2	2	1	
Mid-altitude	Max	48	14	4	3	2	2	
	Min	0	0	0	0	0	0	
	Total	1118	277	101	117	49	49	1711
	Ave.	18	4	2	2	1	1	
Lowland	Max	63	8	4	3	3	2	
	Min	5	0	0	0	0	0	
	Total	1801	94	125	105	64	64	2253
	Ave.	28	1	2	2	1	1	

Source: survey data

B. Current status of area enclosures and its effectiveness in restoring degraded areas

There was a significant difference and association ($\chi^2 = 12.32, p = 0.0021$) of local community response to whether the current status of area enclosures was effective between agroecology. The majority of respondents (74.4%) confirmed that area enclosures were effective in rehabilitating degraded areas, eliminating gullies, with the advantages of grass significantly impacting their attitudes and participation (Table IV). This was supported by [18], who reported that the majority of respondents agreed about area enclosures in rehabilitating degraded areas; increment of above-ground woody species composition; and greater plant species diversity in area enclosures compared to adjacent bare land. In contrast, 25% of the respondents reported that area enclosures did not effectively rehabilitate degraded lands, mainly 41% in the lowland, and 18.3% in mid-altitude agroecology. This could be the issue of the elders, as they had seen the area before and after degradation, and the current intervention could not bring the changes easily after enclosed

TABLE IV. EFFECTIVENESS OF AREA ENCLOSURE IN REHABILITATION OF DEGRADED LANDS ACROSS AGRO-ECOLOGIES

Agro-ecology	Yes	No	Total	Chi-square (χ^2)	Sig.
Lowland	35	25	60		
Mid-altitude	49	11	60	(12.32, df=2)	0.0021
Highland	50	10	60		
Total	134	46	180		

C. Involvement of the local community in the management of area enclosures

There was a significant difference and association ($\chi^2 = 18.8014, p = 0.001$) of local community about tree species types planted by the local community across agroecologies. All respondents replied that local communities involved in planting of different tree species not only in area enclosures but also on their farmlands, in addition to assistance from physical structures and managing and taking care of the newly regenerated tree species on their farms. This might decrease the

burden on area enclosures for fuelwood supply a little bit. Around 55% of respondents confirmed that the local community was involved in planting of exotic tree species, followed by indigenous tree planting (24%), and both indigenous and exotic tree planting (20%). Across agroecology, 65% of the

respondents in the lowland and 63% in the mid-altitude replied that the local community was experienced in planting of exotic tree species, whereas 41% of respondents replied local community evolved in planting of indigenous tree species in highland agroecology (Table V).

TABLE V. TYPES OF TREE SPECIES PLANTED IN AREA ENCLOSURES AND AROUND HOMESTEADS

Agro-ecology	Indigenous tree species	Exotic tree species	Indigenous and exotic tree species	Frequency	Chi-square (χ^2)	Sig.
Lowland	12	39	9	60		
Mid-altitude	7	38	15	60	(18.80, df = 2)	0.0009
Highland	25	22	13	60		
Total	44	99	37	180		

D. Observed changes in area enclosures

There were significant differences in the current status of area enclosures that were observed by respondents across agroecologies ($\chi^2 = 69.04$, $p = 0.000$). All respondents confirmed their observations about changes in degraded lands after area enclosures formed (Table VI). Mainly, more than 51% of the respondents agreed that area enclosures were successful in the rehabilitation of degraded land, conservation of trees and water, and control of soil from erosion. Moreover, such biophysical changes were observed in the mid-altitude (>73%), in the lowland (>40%) and in the highland agroecology (>38%). This

indicated that area enclosures play a role in the rehabilitation of biophysical changes, besides the tangible benefits of area enclosures for the local community; they could give their testimony from their observation. The result was supported by [18] and [9] indicated significant role in increment of above ground woody species abundance in area enclosures, and emphasizing their crucial role in maintaining biological diversity; increased vegetation coverage, regeneration of trees and grasses, woodland conservation [12, 15]; conserving woody species with higher numbers found in area enclosures compared to adjacent open grazing lands [19, 14, 20].

TABLE VI. OBSERVED CHANGES IN AREA ENCLOSURES

Agro-ecology	Rehabilitation of degraded land	Conservation of soil, water, trees and shrubs	Water source development	Soil erosion control	All	Total	Chi-square (χ^2)	Sig.
Lowland	2	10	22	1	25	60		
Mid-altitude	1	3	4	8	44	60	(69.0446, df = 2)	0
Highland	19	11	5	2	23	60		
Total	22	24	31	11	92	180		

E. Perceptions of the local community on the benefits of area enclosures

There was a highly significant difference and associations ($\chi^2 = 47.022$, $p = 0.000$) in local community response, whether area enclosures provided benefits for the local community across agroecology. The majority of respondents (75.5%) indicated that the local community perceived benefits from area enclosures. Moreover, among the respondents, many of them replied that area enclosures provide benefits for the local community (>78% in lowland, 75% in highland, and 73.3% in mid-altitude agroecologies) (Table VII). In contrast, 24% of the respondents disagreed on the benefits of area enclosures. This might be due to either the local community with a higher number of animals wanting pastures for their animals, the local community remaining close to the site, which is what they want, or even if the area is enclosed, there were those who thought that only the nearby community members could benefit unlawfully.

TABLE VII. RESPONDENTS' RESPONSE ON WHETHER THEY BENEFITED OR NOT FROM AREA ENCLOSURES

Agro-ecology	No	Yes	Total	Chi-square (χ^2)	Sig.
Lowland	13	47	60		
Mid-altitude	16	44	60	(47.022, df = 2)	0

Highland	15	45	60		
Total	44	136	180		

F. Benefits gained from area enclosures for the local community

There was a significant difference and associations ($\chi^2 = 19.19$, $P = 0.0007$) between agroecology and the perceived benefits that the local community gained from area enclosures. Local communities in all agroecologies have benefited from area enclosures. More than 75% of the respondents agreed that area enclosures provided benefits (source of animal fodder, bee forage source, and soil erosion control) for the local community (Table VIII). Specifically, the majority of respondents in the mid-altitude (65%) and highland (64%) agroecology identified animal fodder as the key benefit of the local community obtained from area enclosures, whereas this was reported by only 29.7% respondents in the lowland agroecology (Table VIII). In contrast, about 40% of the respondents in the lowland agroecology mentioned that the area enclosures served as the main source of bee forage for beekeepers, a benefit much less recognized in highland agroecology (17%) and the mid-altitude (9%). Regarding soil erosion control, 29.8% of the respondents in the lowland, 25% in the midland, and 17% in the highland acknowledged this benefit, showing relatively balanced but slightly varied recognition in agroecologies. In general, bee

forage source and soil erosion control covered about 47% of the benefit, whereas animal fodder covered more than 52% perceived benefits from area enclosures (Table VIII). The result was supported by [18] that economic benefits are derived from rehabilitated areas. In addition, other scholars confirmed that

provision of animal fodder, fuelwood source, and non-timber forest products from area enclosures [12]; perceive grasses for cattle and fuel wood after enclosures [13]; and contribution of area enclosures in socioeconomic benefits [14].

TABLE VIII. BENEFITS GAINED FOR THE LOCAL COMMUNITY FROM AREA ENCLOSURES

Agro-ecology	Source of animal fodder	Source of bee forage for bee keepers	Soil erosion control	Frequency	Chi-square (χ^2)	Sig.
Lowland	14	19	14	47		
Mid-altitude	29	4	11	44	19.19, df = 2	0.0007
Highland	29	8	8	45		
Total	72	31	33	136		

Moreover, respondents replied that the household share of the local community from grass and fuel wood becomes additional annual income. On average, 0.33 tone (Std. = 0.04 tone) of grass and 0.76 tone (Std. = 0.15 tone) of fuelwood had been obtained from area enclosures annually (Table IX). Based on this, the local community got an average of 4102.3 ETB (Std. = 460.7 ETB) from selling grass and 1018.18 ETB (Std. = 203.86 ETB) from fuelwood selling at market price annually.

TABLE IX. AMOUNT OF GRASS AND FUELWOOD OBTAINED FROM AREA ENCLOSURES, AND ANNUAL MARKET PRICE

Items	Total	Mean	Std.	Min	Max	Range
Amount of grass obtained (tone)	59.4	.33	.04	.3	.4	.1
Fuelwood amount obtained from area enclosure (tone)	136.8	.76	.15	.6	.9	.3
Income from selling grass (ETB)	738,414	4102.3	460.7	3500	5000	1500
Income from fuelwood sold (ETB)	183,272.4	1018.18	203.86	800	1200	400

G. Local community's perception of area enclosures futurity

The result revealed that there was high significant difference and association ($\chi^2 = 31.16$, $p = 0.0000$) between agroecology and the local community's opinion on area enclosures. From the respondents, the majority of them (>59%) have explained local community worry about the area enclosures futurity (Table X). Definitely, 85% of respondents in the lowland agroecology clarified their worry about the future of area enclosures. In contrast, a higher number of respondents (65%) confirmed that they did not worry about the area enclosures futurity in the highland agroecology. This might be due to the existence of a

higher number of livestock including browsers (Table III), erratic rainfall distribution that undesirably affect crop production, and having small land size in the lowland agroecology (Table II), whereas in the highland agroecology there occurred minimum number of livestock and more experienced in cut and carry system to feed their animals from their farmland. In general, decreasing of crop productivity due to soil fertility loss and the occurrence of erratic rainfall distribution that adversely affect crop production, which in turn leads to dependence more or less on animal raising, the number of livestock and land size, and the number of landless and unemployed youth could affect the sustainability of area enclosures.

TABLE X. RESPONDENTS WORRY ABOUT FUTURITY OF AREA ENCLOSURES

Agro-ecology	Yes	No	Total	Chi-square (χ^2)	Sig.
Lowland	51	9	60		
Mid-altitude	35	25	60	(31.16, df = 2)	0
Highland	21	39	60		
Total	107	73	180		

H. Constraints of area enclosures

There was no significant difference or association ($\chi^2 = 4.3336$, $p = 0.363$) between agroecologies and constraints observed in area enclosures (Table XI). This means the issue of free grazing, illegal cutting, and flooding were widespread across all agroecologies. Fire, animal grazing, and unlawful cutting were the issues facing area enclosures, as suggested by [21], which support this finding. Although there was no significant difference statistically among constraints faced in area enclosures across agroecologies and within constraints, the frequently reported issue was free grazing (>49%), followed by flooding (>28%) and illegal cutting (>21%). There was also a significant issue reported by [12] significant issue for area enclosures was free grazing. Regardless of statistical values, the respondents agreed that the main constraint of area enclosures was free grazing (60%) in the highland, illegal cutting (25%) in the mid-altitude, and flooding (33%) in the mid-altitude agroecology (Table XI). In general, the problems pointed out by respondents suggest that free grazing, illegal cutting, and flooding were serious problems in all agroecologies.

TABLE XI. COMMON PROBLEMS IN AREA CLOSURES (CONSTRAINTS)

Agro-ecology	Free grazing	Illegal cutting	Flooding	Frequency	Chi-square (χ^2)	Sig.
Lowland	28	14	18	60		

Mid-altitude	25	15	20	60	(4.3336, df =2)	0.363
Highland	36	10	14	60		
Total	89	39	52	180		

IV. CONCLUSION AND RECOMMENDATION

Area enclosures were effective in rehabilitating degraded lands by controlling soil erosion, regenerating trees and shrubs, and developing water sources. Moreover, animal fodder, bee forage, and fuelwood were benefits obtained from area enclosures for the local community. Conversely, free grazing, illegal cutting, and flooding were constraints of area enclosures that hindered their success. Therefore, to tackle the constraints and ensure the existence of area enclosures, the local community, government, and NGOs should collaborate to address the challenges of area enclosures practice, create awareness for the local community, and promote the formation of strong local bylaws with their implementation. Besides the long term economic and environmental benefits, maximize and diversify short term benefits from area enclosures for local communities to ensure the success of area enclosures. The local community should address constraints of area enclosures, mainly free grazing, illegal cutting, and flooding, immediately. Researchers should focus on innovating new technologies to solve the shortage of animal fodder, fuel wood shortage, and flood control mechanisms and introduce these technologies to the local community.

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