Condition of communal grasslands in Abergelle and Menz areas for action research on management and restoration

RESEARCH PROGRAM ON
Livestock

CGIAR

65

Condition of communal grasslands in Abergelle and Menz areas for action research on management and restoration

Jason Sircely and Bedasa Eba

International Livestock Research Institute

December 2020

Contents

Tables

Figures

Executive summary

Action research trials are a powerful approach for identifying grassland management and restoration approaches that can succeed in the challenging contexts of communal grazing lands in the Ethiopian highlands. To provide a baseline for action research trials on grassland management and restoration in highland communal grasslands, assessments were conducted in eight communal grasslands used for grazing, with four sites in the Menz area of Amhara Region and four sites in the Abergelle area along the boundary of Amhara and Tigray regions. The two sites varied dramatically in terms of grassland condition, with semi-arid grasslands in Abergelle less productive than humid grasslands in Menz due to differences in land potential primarily on account of elevation and associated climate. In Abergelle, degradation may involve declines in cover of perennial grasses and woody plants, and increases in bare soil, although these differences appear to largely reflect background variation in land potential. In Menz, the only apparent degradation was a gradient in woody cover indicative of woody invasion of these humid grasslands. Among the two experimental groups of plots, grassland condition indicators that did not differ statistically and showed relevance to degradation and livestock production systems consisted of bare soil cover in Abergelle and plant base cover and woody plant cover in Menz. The experimental design is robust and action research trials managed by community institutions responsible for overseeing management of these communal grasslands will provide a strong basis for assessing options for improving grassland productivity and reversing degradation.

Introduction

Grasslands cover large areas of the Ethiopian highlands and play important roles in the livelihoods of farmers by providing a significant proportion of livestock feed in many areas, and in the delivery of ecosystem services such as hydrological regulation. The improvement of management in communal grazing lands through collective community action can improve the sustainability of resource management (Gebremedhin et al. 2004) and help to alleviate feed shortages (Hassen et al. 2010).

Degradation of highland grasslands is common but not ubiquitous, and degradation is always relative to land potential in terms of soils and climate (Herrick et al. 2019). Action research trials are a powerful approach for identifying grassland management and restoration approaches that can succeed in the challenging contexts of communal grazing lands (Sircely 2019a, 2019b, 2019c). This report details the condition of communal grasslands in the Abergelle and Menz areas of the Ethiopian highlands, toward the design and implementation of community-managed action research trials testing restoration and management options to identify those most effective and feasible for restoring, improving productivity, or thwarting degradation threats in highland communal grasslands.

The precise objectives of this report are to (i) assess and summarize grassland condition in the Abergelle and Menz sites; (ii) assess and summarize condition among grasslands within sites; (iii) test for differences among experimental groups within grasslands to determine the validity of these groups for accurately discriminating changes in condition in response to action research treatments; and (iv) identify appropriate and relevant indicators of grassland condition to enable assessments of action research trials that are scientifically valid, and relevant to communities benefitting from the research.

Methodology

The two sites focused on here are the Abergelle and Menz areas in the Ethiopian highlands. Spanning the boundary of Amhara and Tigray national regional states, Abergelle is semi-arid, and the grasslands assessed here ranged in elevation from 1,280 metres above sea level (masl) in Tigray to 1,500–1,700 masl in Amhara (Figure 1). Menz is in a humid area of Amhara, and the grasslands assessed here ranged in elevation from 2,800–3,400 masl (Figure 2). Abergelle is known for its indigenous Abergelle breed of goats, and Menz is known for its indigenous breed of Menz sheep, both breeds that constitute significant indigenous biological resources of Ethiopia.

Between November 2019 and January 2020, focus group discussions were held with members of communities in Menz and Abergelle that reside near and regularly use the grasslands monitored here. Those communities who expressed an open willingness to host action research trials on how to improve their grasslands suggested general portions of their grasslands for monitoring. The community members joined the researchers in setting up plots in the field, which were arranged in two sets—one set of three plots for restoration or management treatments, and one set of three plots to serve as controls (Figures 1 and 2). Land PKS plots (Riginos et al. 2011) were used to conduct baseline monitoring. Statistical analyses were performed by univariate analysis of variance (ANOVA) using untransformed data.

Figure 1. Landscape location and monitoring plot locations for communal grasslands in Abergelle

Figure 2. Landscape locations and monitoring plot locations for communal grasslands in Menz
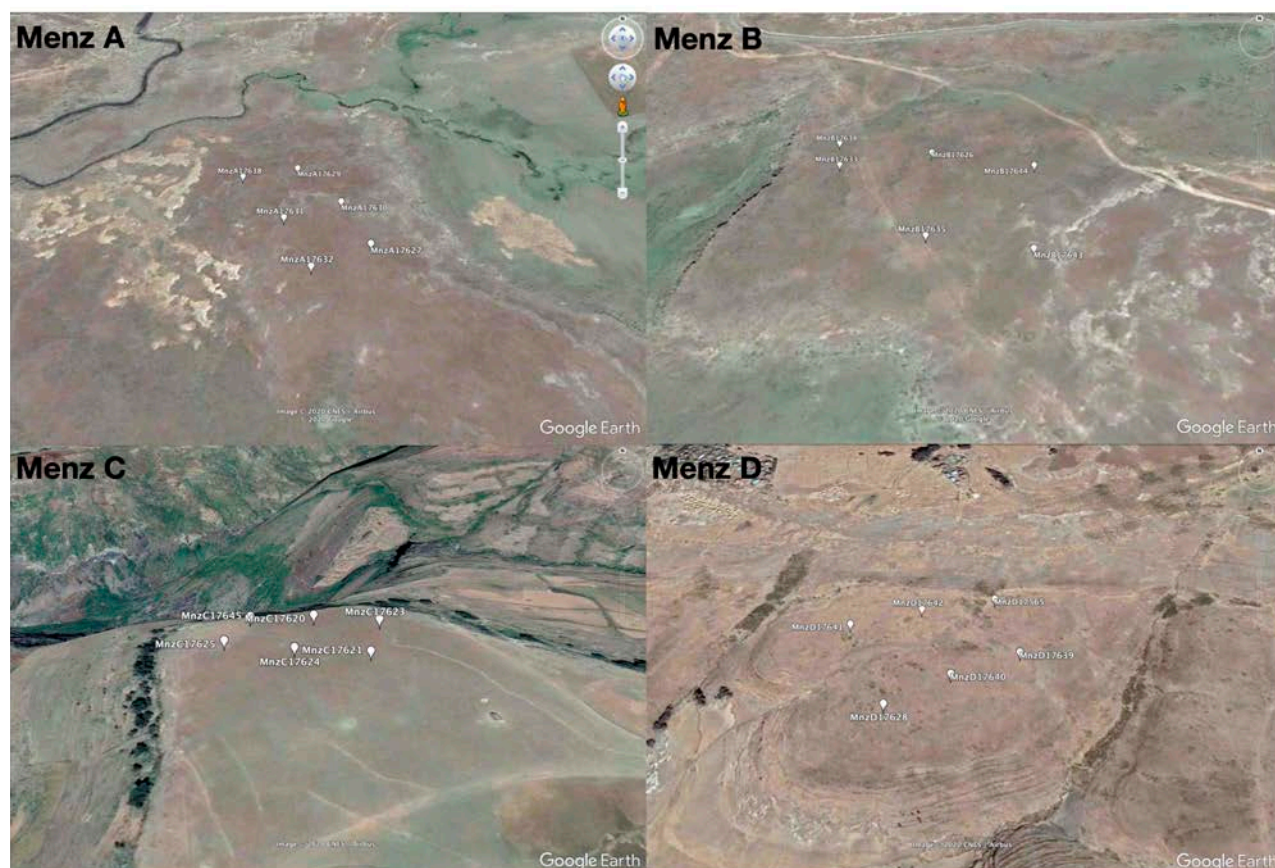
Results and discussion

Grassland condition assessment among sites

Compared to humid grasslands in Menz, semi-arid grasslands in Abergelle had much higher bare soil cover, much lower cover of plant bases, much lower perennial grass cover, and much lower woody plant cover (Table 1, Figures 3 and Figure 4). Differences in cover of plant bases was almost entirely attributable to differences in perennial grass cover, as opposed to cover of annual grasses, forbs, or woody plants including trees, shrubs, and sub-shrubs. All of these differences in grassland condition indicators were highly significant statistically (Table 1) and demonstrate the fundamental differences in grassland ecology in the two sites. The humid grasslands of Menz with nearly complete perennial grass cover contrasted strongly with semi-arid Abergelle, where bare soil was the largest proportion of fractional spatial cover at nearly 40% cover on average (38.5%).

Grassland condition assessment within sites

Variation in grassland condition indicators was much greater in Abergelle than in Menz (Figure 4). In Abergelle, the greatest source of variation in grassland condition was from differences in bare soil cover, ranging from 5% at minimum up to 64% at maximum. Otherwise, most sites in Abergelle were similar in most indicators, with the exception of 'Abergelle B' grassland, which had higher cover of woody plants and especially perennial grasses than the other Abergelle grasslands. These observations suggest that loss of perennial grasses and woody plants resulting in bare soil are linked degradation threats. However, it is not entirely clear to what degree these site differences reflect degradation over and above intrinsic variation in land potential—for example, bare soil cover was strongly and significantly negatively correlated with rock cover (Pearson's r = –4.55 [95% CI –0.725, –0.063], df = 22, P = 0.025) and likely soil depth as well. This trend suggests that differences in condition among grasslands in Abergelle may primarily reflect differences in land potential, and perhaps degradation secondarily.

Variation in grassland condition indicators was much lower in Menz, where most sites had high cover of perennial grasses, leading to high cover of plant bases given the species composition of perennial grasses. The greatest source of variation in grassland condition in Menz was from differences in cover of woody plants, most of which are unpalatable, not useful for any purpose, and furthermore indicative of woody encroachment degradation of grasslands. The wide range in woody cover from 7% at minimum up to 61% at maximum may therefore represent a degradation gradient. Woody encroachment is the main degradation threat in the Menz grasslands in this study.

Regional differences in Abergelle were observed with grasslands in Amhara Region in better condition than those in Tigray Region (Table 2 and Figure 5) in terms of bare soil cover and perennial grass cover, the latter also leading to differences in cover of plant bases. Most likely, these differences primarily issue from the higher elevation of grasslands in Amhara (1,500–1,700 masl) than in Tigray (1,280 masl) with consequently lower aridity and greater land potential on the Amhara side of Abergelle, resulting in greater productivity of perennial grasses most particularly. However, it is possible that these differences may indicate degradation to some degree over and above effects of land potential. Any differences in management and subsequent degradation are likely primarily attributable to the effectiveness of community

management at the level of individual grasslands and are almost certainly not related to any regional differences in culture, management, or regional policies. These differences do, however, indicate that management strategies will need to differ between the two sides of Abergelle to be effective.

Table 1. Differences in grassland condition indicators between Menz and Abergelle sites

Response variable (units)	Model parameter	df	Sum of squares	Mean square	F	P
Bare soil (% cover)	Site	1	14,560.33	14,560.33	84.37	< 0.0001
	Residual	46	7,938.92	172.59		
Plant bases (% cover)	Site	1	44,652.00	44,652.00	358.59	< 0.0001
	Residual	46	5,728.00	124.52		
Perennial grass (% cover)	Site	1	59,291.02	59,291.02	457.01	< 0.0001
	Residual	46	5,967.96	129.74		
Woody plants (% cover)	Site	1	8,190.19	8,190.19	56.62	< 0.0001
	Residual	46	6,654.29	144.66		

Figure 3. Differences between sites: Menz and Abergelle communal grasslands
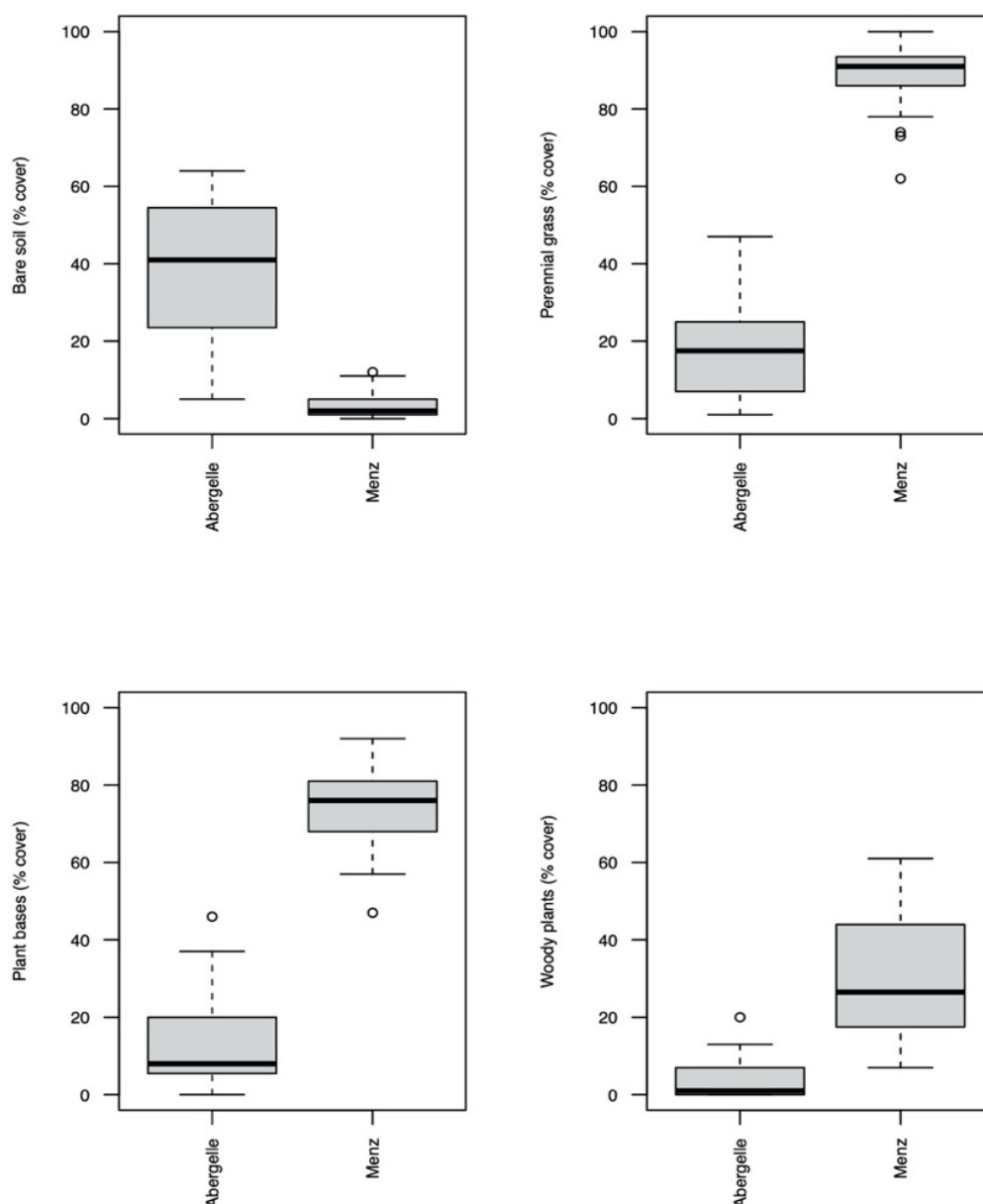
Figure 4. Variation in indicators of grassland condition among and within communal grasslands monitored in Menz and Abergelle
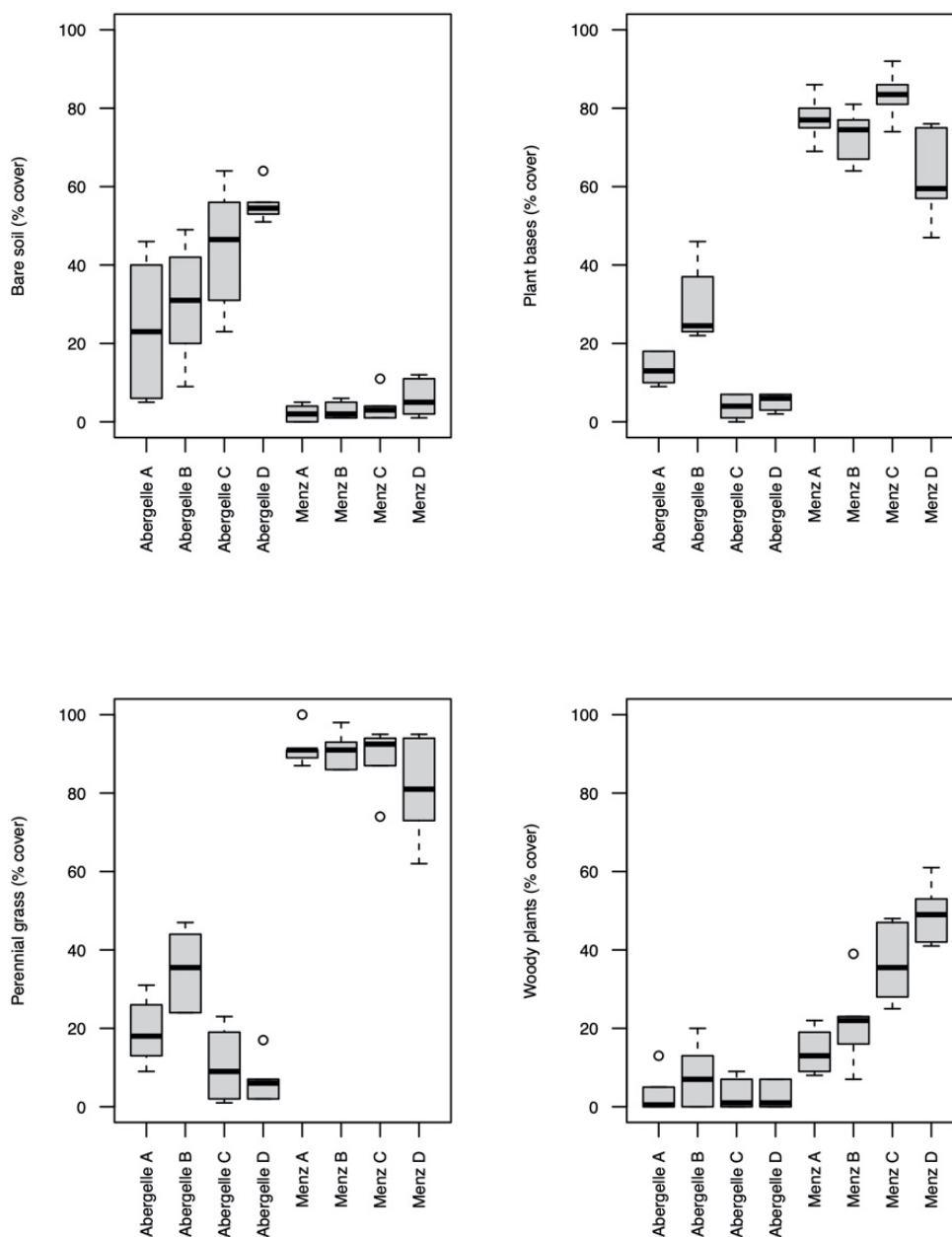
Table 2. Abergelle site: differences in condition between grasslands in Amhara Region and Tigray Region

Response variable (units)	Model parameter	df	Sum of s quares	Mean square	F	P
Bare soil (% cover)	Region	1	3,151.04	3,151.04	15.35	< 0.0001
	Residual	22	4,516.92	205.31		
Plant bases (% cover)	Region	1	1,734.00	1,734.00	26.98	< 0.0001
	Residual	22	1,414.00	64.27		
Perennial grass (% cover)	Region	1	2,053.50	2,053.50	20.88	< 0.001
	Residual	22	2,163.83	98.36		
Woody plants (% cover)	Region	1	42.67	42.67	1.41	0.248
	Residual	22	666.67	30.30		

Figure 5. Abergelle site: differences in condition between grasslands in Amhara Region and Tigray Region
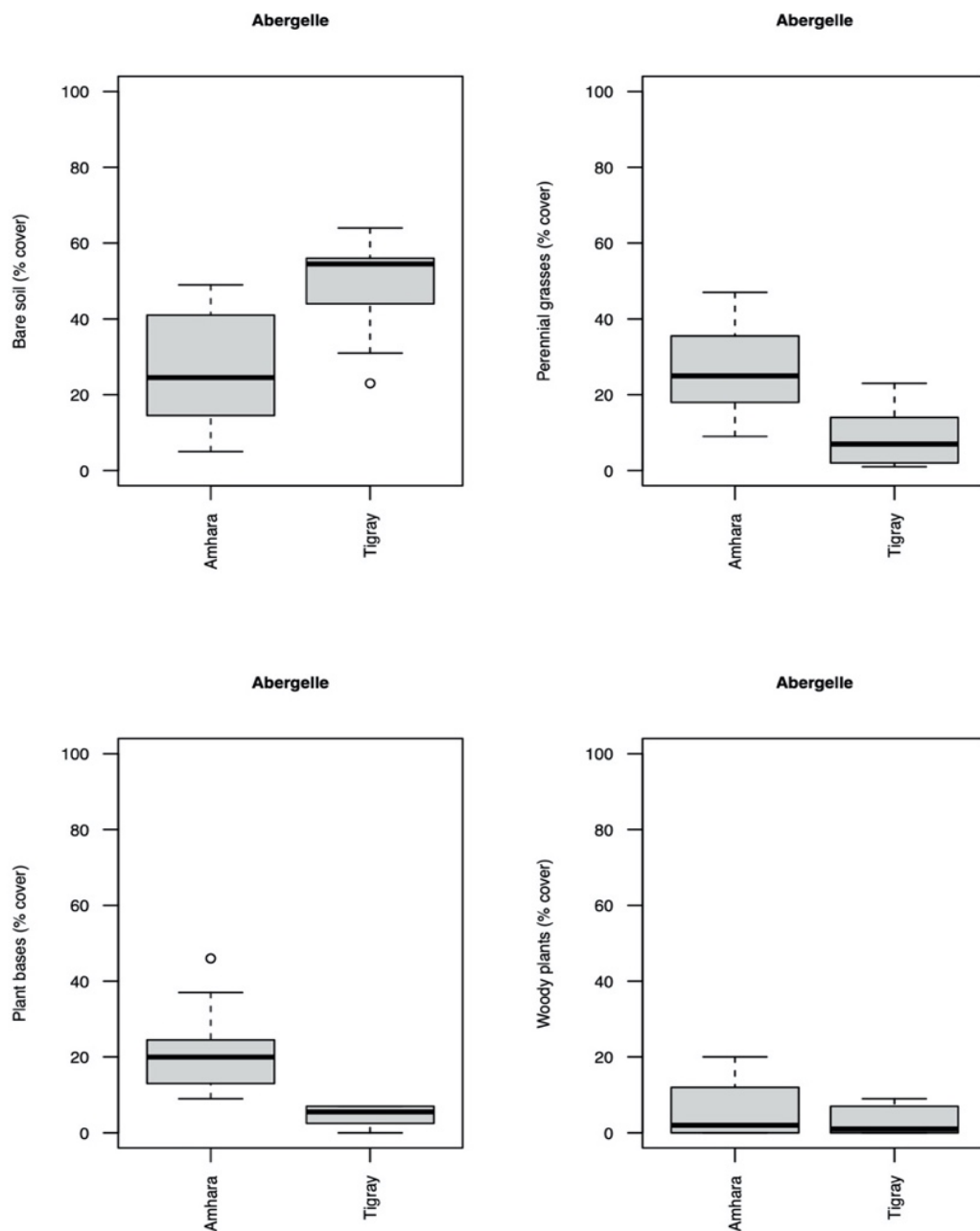
Assessment of experimental groups within grasslands

In Abergelle, no differences were observed among monitoring plots in experimental groups A and B, in terms of any of the four indicators assessed—cover of bare soil, plant bases, perennial grasses and woody plants (Table 3 and Figure 6). The current groupings of monitoring plots into groups A and B therefore create a robust experimental baseline for action research trials managed community institutions responsible for these communal grasslands in Abergelle.

In Menz, no differences were observed among monitoring plots in experimental groups A and B in terms of cover of plant bases or woody plant cover (Table 4 and Figure 7), although bare soil cover and perennial grass cover differed significantly but only modestly. The current groupings of monitoring plots into groups A and B can serve as a robust experimental baseline for action research trials in Menz, although selection of appropriate indicators of grassland condition will be a significant decision.

Identification of grassland condition indicators

In Abergelle, because no differences were observed among the two experimental groups of plots, all four indicators assessed (cover of bare soil, plant bases, perennial grasses, and woody plants) are potentially valid monitoring variables. However, because Abergelle production systems comprise a mix of cattle, sheep and the Abergelle breed of goats, the most useful indicator of grassland condition is likely to be bare soil cover. Since goats typically browse on woody shrubs and trees but also graze on grasses at times and consume forbs as well, while cattle and sheep focus on perennial grasses, virtually all plant growth forms are likely to be useful. All of these forms of vegetation provide useful ecosystem services as well, including infiltration of rainfall, erosion control and soil carbon storage. Since woody cover is currently low (mean 4.16%) woody encroachment appears unlikely to immediately threaten the grass feed supply for sheep and cattle.

In Menz, cover of bare soil and perennial grasses differed significantly though modestly among experimental groups A and B, but more importantly the high perennial grass cover and low bare soil cover leave little room for improvement in terms of these indicators. As such, there is a need for more sensitive indicators that ideally do not differ between the two experimental groups of monitoring plots. For both of these reasons, the best indicators of grassland condition in Menz are the cover of plant bases, an increase in which would indicate improvements in grass vigour and erosion control, and woody cover, a decrease in which would indicate success in controlling the apparent threat of woody encroachment degradation.

Final selection of grassland condition indicators requires forthcoming community validation of indicators. Because virtually all plant growth forms are likely to be useful as livestock feed in Abergelle, woody plant cover expansion in Abergelle would be a positive development for browsing of Abergelle goats, and since woody cover is currently low (mean 4.16%) woody encroachment appears unlikely to negatively impact perennial grass forage for cattle and sheep. In contrast, woody cover expansion in Menz is unquestionably a negative effect on grassland condition, indicating encroachment of unpalatable woody species into grassy vegetation useful for grazing cattle and Menz sheep. On the other hand, planting of some trees and shrubs that are useful or have conservation value would benefit grasslands in Menz, but tree-planting is difficult to conduct in grazing systems except if portions are placed into grazing exclosure.

Table 3. Differences in grassland condition between experimental groups A and B in Abergelle communal grasslands

Response variable (units)	Model parameter	df	Sum of squares	Mean square	F	P
Bare soil (% cover)	Experimental group	1	260.04	260.04	0.77	0.389
	Residual	22	7,407.92	336.72		
Plant bases (% cover)	Experimental group	1	24.00	24.00	0.17	0.685
	Residual	22	3,124.00	142.00		
Perennial grass (% cover)	Experimental group	1	37.50	37.50	0.20	0.661
	Residual	22	4,179.83	189.99		
Woody plants (% cover)	Experimental group	1	0.17	0.17	0.01	0.943
	Residual	22	709.17	32.23		

Table 4. Differences in grassland condition between experimental groups A and B in Menz communal grasslands

Response variable (units)	Model parameter	df	Sum of squares	Mean square	F	P
Bare soil (% cover)	Experimental group	1	77.04	77.04	8.74	0.007
	Residual	22	193.92	8.81		
Plant bases (% cover)	Experimental group	1	228.17	228.17	2.13	0.158
	Residual	22	2,351.83	106.90		
Perennial grass (% cover)	Experimental group	1	315.38	315.38	4.83	0.039
	Residual	22	1,435.25	65.24		
Woody plants (% cover)	Experimental group	1	12.04	12.04	0.04	0.835
	Residual	22	5,932.92	269.68		

Figure 6. Differences in grassland condition between experimental groups A and B in Abergelle communal grasslands
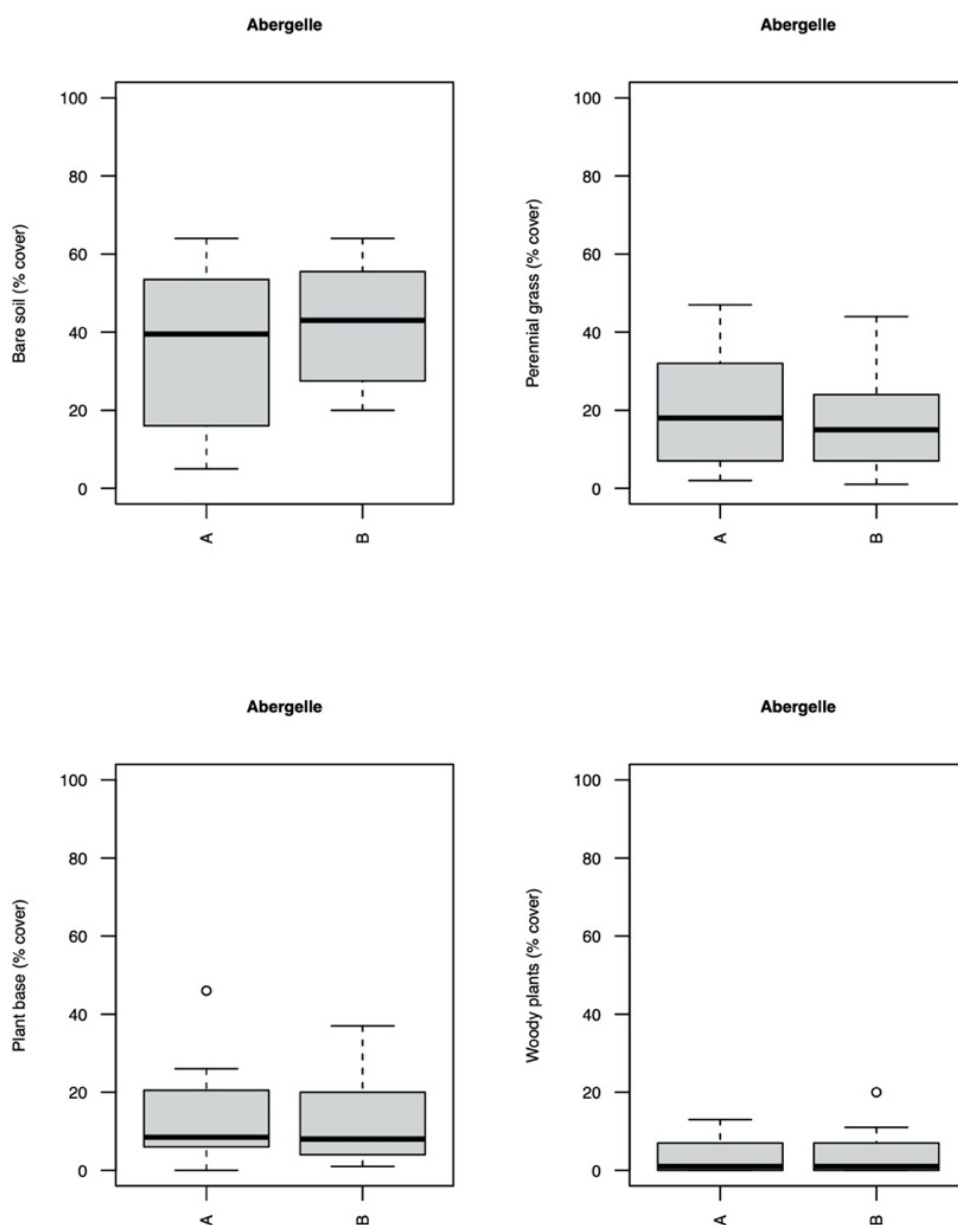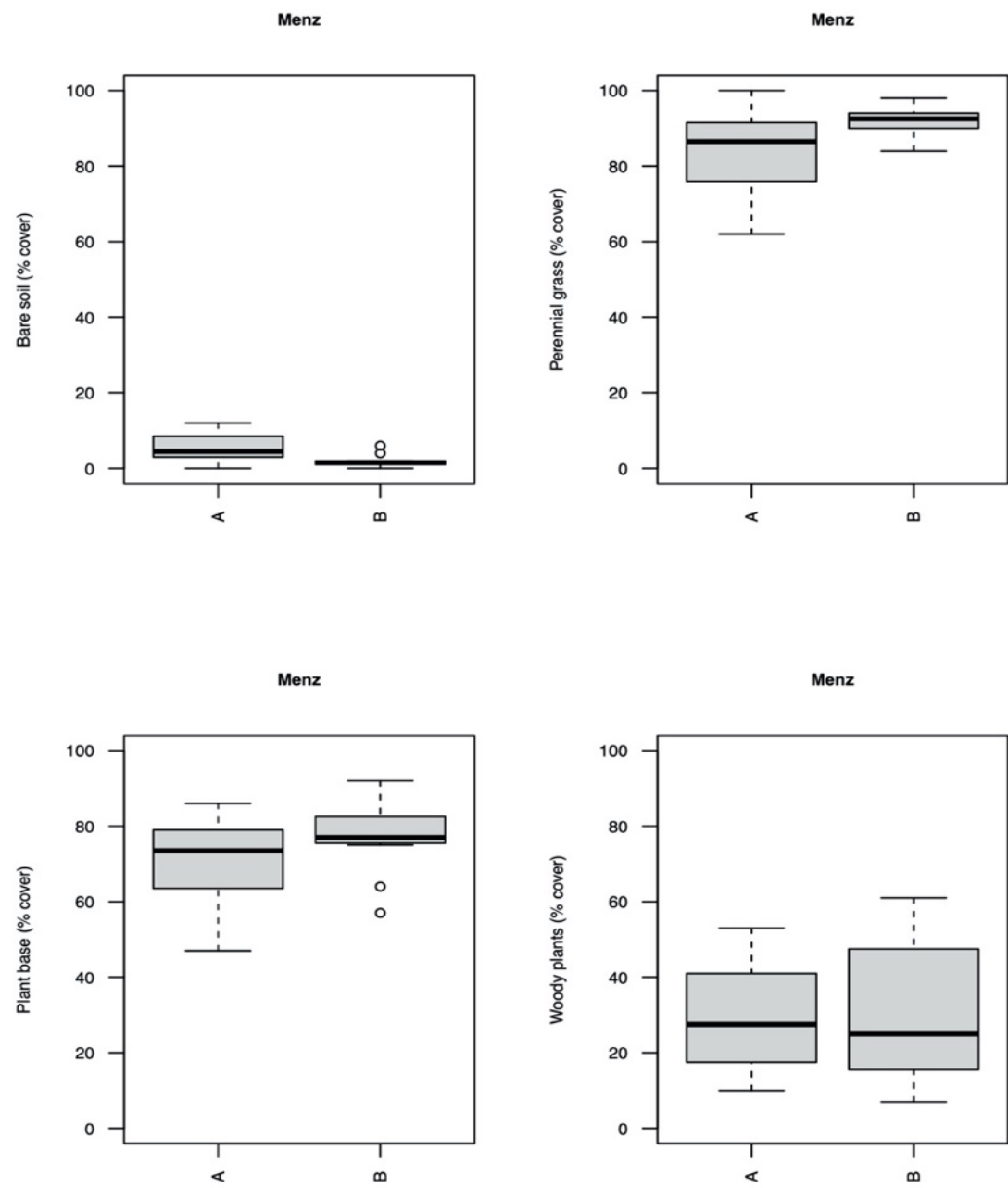
Figure 7. Differences in grassland condition between experimental groups A and B in Menz communal grasslands

Conclusions

Grassland condition in terms of multiple indicators varied substantially among sites. These fundamental differences in grassland ecology in the two sites clearly demonstrate the need for fundamentally different management strategies, restoration approaches and indicators of management and restoration success. Within the Abergelle site grassland condition varied substantially, while within the Menz site condition varied little with the exception of an apparent degradation gradient due to woody encroachment into grasslands likely on account of heavy grazing use. Most variation within the Abergelle site was the result of differences in perennial grass cover, leading to greater or lesser cover of bare soil and plant bases. These differences may reflect land potential more than degradation, yet they remain likely to affect the suitability of pasture for cattle and sheep but might not affect suitability for the Abergelle breed of goats. The only dramatic variation within the Menz site was in terms of cover of woody plants, which is indicative of encroachment of unpalatable woody species into grasslands currently in good condition and productive for grazing of cattle and the Menz breed of sheep.

The differences in woody cover among sites are unsurprising and indicative of humid grasslands such as those in Menz being more vulnerable to woody encroachment than grasslands in drylands such as Abergelle. The presence of more browsers, especially Abergelle goats, is likely to contribute to keeping woody plants in check. In contrast, encroachment of woody vegetation is the pre-eminent degradation threat to grasslands in Menz. These differences strongly highlight the context-specificity of grassland management in accordance with differences in land potential (soils and climate) versus degradation (Herrick et al. 2019)such as in the definition of future land degradation neutrality, can add significant cost and uncertainty to land management projects that require some knowledge of the current status of the land relative to its potential. This paper (1, as well as livestock species composition as related to local livelihoods.

Experimental groups did not show any differences preventing their use in assessing the results of action research trials using 50% of monitoring plots as treatment and 50% of monitoring plots. The most effective grassland condition indicator identified for Abergelle appears to be bare soil cover, while the most effective grassland condition indicators identified for Menz appear to be perennial grass cover and woody plant cover, the latter indicating woody encroachment on grassland vegetation, a form of land degradation. Final selection of grassland condition indicators to be applied in systematic assessment requires forthcoming community validation of indicators. With this information in hand, an efficient assessment framework for community-managed action research trials is in place.

References

Gebremedhin, B., Pender, J. and Tesfay, G. 2004. Collective action for grazing land management in crop–livestock mixed systems in the highlands of northern Ethiopia. *Agricultural Systems* 82: 273–290.

Hassen, A., Ebro, A., Kurtu, M. and Treydte, A.C. 2010. Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. *Livestock Research for Rural Development* 22:229.

Herrick, J.E., Shaver, P., Pyke, D.A., Pellant, M., Toledo, D. and Lepak. N. 2019. A strategy for defining the reference for land health and degradation assessments. *Ecological Indicators* 97(June 2018): 225–230.

Riginos, C., Herrick, J.E., Sundaresan, S.R., Farley, C. and Belnap. J. 2011. A simple graphical approach to quantitative monitoring of rangelands. *Rangelands* 33(4): 6–13.

Sircely, J. 2019a. *Summary of research results: Exclosure productivity improvement Amhara Bureau of Agriculture, Amhara Ethiopia*. Nairobi, Kenya. ILRI.

Sircely, J. 2019b. *Summary of research results: Short-resting and reseeding Shompole and Olkiramatian Group ranches, Kajiado.* Nairobi, Kenya. ILRI

Sircely, J. 2019c. *Summary of research results: Short-resting and reseeding Burder community-based natural resource management committee, Burder Ward, Wajir.* Nairobi, Kenya. ILRI.