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Sustainable Rangeland Management: How Grazing Management and Woody Cover can Alter Herbaceous Diversity, Forage Quantity, and Carbon Stocks in Semi-Arid Rangelands of Ethiopia

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Abstract

Semi-arid savannah rangelands are currently under threat by overgrazing, which can lead to dense woody cover in the absence of fire and often results in the suppression of herbaceous plants. On the other hand, woodland expansion might result in a large increase in Carbon (C) storage in the grassland ecosystem, an important aspect for climate change mitigation potentials. Particularly the influence of grazing intensities on the belowground herbaceous root biomass, where large amounts of C can be stored, has poorly understood. We compared the effect of livestock enclosure under varying woody cover in pastoral grazing systems of southern Ethiopia. Caged plots and transects were established to assess species composition, dry matter and above-and below-ground C stocks of herbaceous plants, as well as total ecosystem C under the different treatments. Herbaceous above-and belowground dry matter yield and overall ecosystem C storage was declined with increasing woody cover. Grass dry matter yield was significantly higher in enclosure compared to open grazing lands but was dependent on woody plant density and cover. Herbaceous species composition did not significantly vary across grazing management while root biomass and total soil organic C positively responded to grazing exclusion. Older age of enclosure did not pronounce differences in herbaceous species composition, above- and belowground dry matter yield, which highlights the importance of rotational grazing practices. We conclude that high woody cover suppresses herbaceous cover and could aggravate soil erosion, less stabilise soil organic carbon (SOC) or increases its loss, and hence climate change mitigation strategy through soil C sequestration need to focus on improving the condition of herbaceous cover through implementation of better woody management, improved grazing and livestock management systems in this semi-arid rangelands. While enclosures represent important management tools, rotational grazing should be fostered to restore herbaceous vegetation and its C stocks.

Keywords: Borana rangelands, bush encroachment, carbon sequestration, carbon stock, enclosure, grazing management, herbage yield, land cover changes, savannah, species richness