Tracking restoration of tropical degraded grasslands in the highlands of Kenya

Summary. This project is testing in degraded grasslands in Kenya the short-term effectiveness of restoration approaches based on the combined addition of soil inoculum, including the native microbial community, and seeds from local non-degraded grasslands and common practices such as tillage ad manure application. We assess how these approaches, combined with the cessation of livestock grazing, affect recovery processes in degraded grasslands. A grazing exclosure was installed at the campus of the Kabianga University in Kenya in April 2022, when restoration treatments were laid out and baseline soil samples taken and analysed for key soil physical, chemical and biological properties. In November 2022, fresh soil samples were taken to track short-term changes in the soil. In addition, we assessed the plant community species composition, and measured *in situ* soil respiration rates.

Aim: To test experimentally the short-term (3 years) effectiveness of different restoration approaches for degraded grasslands in Kenya.

Hypothesis: Native plant species and local land management practices can be used to restore soil functions and to kick-start grassland restoration processes.

Experimental design. The treatments tested in a 2x2x2 factorial design are tillage (T), the addition of native soil inoculum (S) and manure (M) application. **Tillage (T)** was applied using a hand hoe to a depth of 5 cm to break the superficial crust and to improve soil infiltration (Fig. 1).

Figure 1. *Use of a "jembe" or hand hoe to break the sealed soil surface in a semi-arid region of Kenya. This method has been recommended to restore degraded grassland in Kenya. Source Kinyua et al., (2010).*

Soil inoculum (S) is proposed as a tool to restore disturbed ecosystems and to steer plant community development (Wubs et al., 2016). For this treatment, topsoil (0-5 cm) was collected from a nearby non-degraded grassland. The soil was sieved through a 1 cm mesh to remove stones and roots and the inoculum was added and mixed with the top 5-cm of the soil of the at a rate of 800 g m^{-2}. The **Manure (M)** treatment consisted of farmyard manure applied once at the beginning of the experiment at a rate of 500 g m^{-2}, at a recommended rate of manure as fertiliser in Kenya (Lekasi et al., 2001).

Table 1. Combinations of treatments from the full factorial design

Treatment	Tillage (T)	Soil inoculum (S)	Manure (M)	ID
1	0	0	0	Control (C)
2	1	0	0	M
3	0	1	0	S
4	0	0	1	T
5	1	1	0	MS
6	1	0	1	MT
7	0	1	1	ST
8	1	1	1	MST

Treatments were applied using a full factorial design (2x2x2) with 4 replicates resulting in 32 experimental plots (Table 1). Plots were laid using completely randomised blocks. Plot size was 4x4 m (16 m^2) with 2 m separation between plots and blocks. Total experiment size about 50x50 m.

Measurements

Baseline soil sampling was conducted in April 2022 to assess soil physical, chemical and biological properties. Vegetation recovery is assessed regularly (every 6-12 months) using high-resolution photographs, biomass and species community assessment. Species composition was assessed in November 2022 when soil sampling was repeated, and soil respiration measurements conducted.

References

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Lekasi, J. K. et al. 2001. *Manure management in the Kenya highlands: Practices and potential*. Henry Doubleday Research Association.

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