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Preserving and enhancing soil health in the rangelands of Uganda

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Abstract

Rangelands in Uganda covers an area of 84.000Km² which is about 44% of the country's land mass. Commonly known as the Cattle Corridor, it stretches from the south through the central region to the northeastern part of Uganda and supports pastoral and agropastoral communities.

Food insecurity in Uganda has been considered an outcome of low agricultural productivity which is attributed to the gradual decline in soil fertility originating primarily from anthropogenic causes including continuous tillage and mono-cropping as well as reduced agricultural inputs.

In our study, we highlight 2 smart agricultural technologies as alternative solutions to low soil fertility:

Organic fertilizers tend to be costly to farmers without integrated agricultural systems but some of their benefits include: preservation of soil by minimizing negative effects on the environment, exhibiting stability and resilience to a changing climate, having a beneficial effect of increasing organic matter and soil fauna and improving soil quality.

Vermicomposting is a technology that utilizes different species of earthworms coupled with microorganisms to mechanically digest the organic matter thereby enhancing mineralization. However, there is a need to apply the organic waste as the raw material to be digested; therefore, interplay of organic waste and the vermicomposting organisms is needed to achieve the mineralization.

Introduction

Rangelands in Uganda covers an area of 84.000Km² which is about 44% of the country's land mass. Commonly known as the Cattle Corridor, they stretch from the south through the central region to the northeastern part of Uganda and support pastoral and agropastoral communities.

Food insecurity in Uganda has been considered an outcome of low agricultural productivity which is attributed to the gradual decline in soil fertility originating primarily from anthropogenic causes including continuous tillage and mono-cropping as well as reduced agricultural inputs.

The growing population has exerted pressure on rangelands due to more demand for goods and services.

The use of rangelands is intensifying, resulting in extensive rangeland degradation and desertification. The land use shift from the original tropical rainforests to savannahs and other non-agricultural activities (e.g. construction, charcoal burning, bricklaying and animal grazing) has significantly contributed to the degradation of soil. Loss of soil fertility has been manifested through loss of organic matter mainly caused by farmers removing the post-harvest biomass leaving the soil unreplenished and with a negative nitrogen balance.

It is no longer possible to apply the old soil management practices of bush fallowing and shifting cultivation that would restore fertility to the damaged soils.

To assess rangeland condition, a methodology often referred to as Rangeland Health Assessment can be performed. This provides tools that help land users interpret the landscape and react in time before land degradation becomes irreversible. Rangeland health assessment is about evaluating ecosystem processes using indirect methods to determine whether an ecosystem is at risk or healthy under the current management scheme. Constructing a rangeland health methodology requires understanding of ecosystem processes and how they are expressed in the environment.

Rangeland health is defined as the degree to which the integrity of the soil, vegetation, water and air, as well as the ecological processes of the rangeland ecosystem, are balanced and sustained. Integrity in this case refers to “maintenance of the functional attributes characteristic of a locale, including normal variability” It has replaced the terms ‘range condition’ and ‘ecological status’

Rangeland Soils:

Rangeland soils are often characterized by low fertility, poor drainage, and rough topography.

Specific things to consider with rangeland soils:

Soil erosion

Soil erosion can cause the loss of nutrients, organic matter, and fine-size soil particles, which can decline soil fertility.

Disturbance

Some disturbance can help maintain soil health and biological diversity however, too much can be detrimental and lead to permanent ecological changes.

Livestock grazing

Livestock grazing is the most common economic use of rangelands, but may degrade rangeland health.

Rangeland degradation

Rangelands are threatened by a variety of natural and anthropogenic causes, including climate change, drought, aridity, and desertification.

Methods

Nakasongola District was selected as the study area because of its specific location in the center of the cattle corridor. The District covers an area of 4,909 km² and is located between latitudes 0 0 57' 44.89" and 1 0 40' 42.76" North and longitudes 31 0 58' 03.77" and 32 0 48' 00.29" East (Figure 1). Earlier studies (Nakasongola 2011) on the soils and land use in Uganda classified the soils of Nakasongola district in the driest part of Buganda Province. These rangelands were identified as a ‘hot spot’ with severe land degradation, pasture and water scarcity that were translating into high livestock mortality and poverty. The District has hence received national attention to help solve the environmental problems and save dependent communities

Nakasongola District is classified under the banana-millet-cotton farming system (MAAIF, 1995). Because of the less stable rainfall, there is a great reliance on annual food crops basically millet, sorghum, groundnuts, cassava, pigeon peas and maize, with cotton as a major cash crop and livestock production dominating in the drier areas of the District.

Key methods to improve soil health include: Implementing Rotational grazing practices, managing livestock stocking rates, planting diverse native plant species, use of cover crops, minimizing tillage, monitoring nutrient levels and use of fertiliser and controlling erosion through strategic vegetation placement.

We implemented all these methods on farms in the Nakasongola District of the Ugandan Rangelands and observed the effects over a period of time.



Figure 1. Uganda showing the location of Nakasongola district

Results

Rotational grazing

Moving livestock between different pastures regularly prevents overgrazing and allows vegetation to recover, ensuring even manure distribution. For example; regenerative grazing in Nakasongola district is crucial for restoring degraded rangelands and improving livestock management, particularly in the face of climate change and land degradation. By focusing on soil health and pasture productivity, it can enhance livelihoods and reduce the risk of overgrazing and its consequences.

Adaptive stocking rates:

Adjusting the number of livestock based on available forage prevent overgrazing and maintains healthy plant communities. In Uganda, studies have shown that carrying capacity can vary significantly, with the lowest carrying capacity occurring during the long dry season (June to August) and the highest during the short rain season (September to November).

For Ankole region, pastoral systems in southwestern Uganda, a stocking rate of 1.41 ha/TLU is considered sustainable

Plant diversity

Introducing a variety of native plant species with different root depths to enhance soil structure, nutrient cycling, and resilience to drought. Examples of plants include; Pongamia (*Millettia pinnata*) and Croton nuts (*Croton megalocarpus*)

Cover cropping

Planting temporary cover crops during fallow periods to protect the soil from erosion, add organic matter, and improve soil structure.

Minimal tillage

Reducing soil disturbance through minimal or no tillage practices to preserve soil structure and microbial activity.

Nutrient management

Regularly monitoring soil nutrient levels and applying necessary fertilizers strategically to avoid excesses and maintain soil balance.

Erosion control:

Implementing practices like contour planting, grassed waterways, and windbreaks to minimize soil loss from wind and water erosion.

Monitoring and assessment:

Regularly monitoring soil health indicators like organic matter content, microbial activity, and soil structure to evaluate the effectiveness of management practices

Conclusion

The benefits of improved soil health in rangelands include:

Increased forage production and quality, enhanced water infiltration and retention, improved biodiversity and ecosystem services, greater resilience to drought and extreme weather events, and reduced soil erosion.

The encroachment of grasslands by bare and woody vegetation has led to a decline in pasture biomass yield and therefore has strong implications on the sustainability of pastoral livelihoods in the semi-arid rangelands of Nakasongola. The low pasture biomass in woody understory implies that most native pasture species in the rangelands of Nakasongola are not shade tolerant and therefore increased woody encroachment will most likely wipe out indigenous nutritive pastures in the rangeland. Organic matter, nitrogen, calcium and magnesium are the most critical nutrients limiting pasture biomass. Rangeland management strategies for improving soil quality and pasture production should therefore be strongly focused at increasing the levels of these nutrients.

There is a need for intensification and transformation of cropping systems from low input to high input agriculture so as to reduce opening up of new land every season in search for fertile soils. Opening new lands for cultivation is among the most insidious practices devastating the sustainability of rangeland ecosystems.

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