Junior Scientists Tandems
Final Report

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Brief introduction

In mid-April 2025, I embarked on a research stay at the International Livestock Research Institute (ILRI) in Nairobi, supported by the ATSAF- Career Exploration Scholarship. My research focused on testing plant functional groups (legumes and grasses) to help kick-start grassland soil restoration. I also aimed to build research networks and foster collaboration with local institutions and stakeholders in the field of grassland restoration. This six-month research stay at ILRI provided me with invaluable opportunities, from conducting independent research to engaging with local scientists and stakeholders.

First, I met with scientists and the team leader of Mazingira at ILRI, where I introduced myself and my research objectives, and expressed my appreciation for being hosted at their institution. We discussed shared research interests, methodologies, and potential areas for collaboration. The scientists at ILRI provided valuable insights into local ecological challenges that are highly relevant to my work on grassland restoration and offered suggestions for refining my research approach to better suit the local context.

After discussing the details of my research work with my supervisor at ILRI, the next step was traveling to the research site in Nyando, Western Kenya, to collect soil samples and plant species seeds for a greenhouse experiment. With help from the Mazingira team, we transported samples from Nyando to ILRI-Nairobi, where we set up the greenhouse experiment. Western Kenya is quite far from Nairobi, and one might ask, "Why didn't you conduct the experiment in Nyando? Why transport the samples such a long distance?" That would have been easier, but there were no facilities, including greenhouse infrastructure, in the study area, which necessitated transporting the samples to ILRI-Nairobi.

This research stay at ILRI provided me with valuable skills and experiences. During sampling campaigns, I had the opportunity to speak with local stakeholders, including village managers and farmers, to gain their perspectives on the challenges of grassland soil degradation. Working in the laboratory and analyzing data in the Mazingira Lab also significantly enhanced my skills, which will be essential for my future research work.

Research focus

My research work in Kenya aimed at restoring degraded grasslands to maintain and sustain ecosystem services and improve the livelihoods of local communities whose survival entirely depends on these resources. Tropical grasslands are among the most degraded biomes due to anthropogenic activities. Despite their massive importance in mitigating climate change, regulating water resources, maintaining soil quality through nutrient cycling, and providing forage for livestock production, an integral part of local farmers' livelihoods, tropical grasslands have received little attention, and there is limited knowledge and understanding of how to manage grassland ecosystems to sustain and maintain the ecosystem services they provide.

Grassland ecosystem research has received less recognition compared to other land uses because grasslands are often perceived as suppressed forests resulting from disturbance. This is why forests are typically considered carbon sinks and indicators of biodiversity, and why carbon payment schemes usually focus on forests and trees, promoting afforestation and reforestation. In Africa, for example, an approximately 1 million km² of grassland biomes are targeted for tree planting under the United Nations Decade on Ecosystem Restoration plan by 2030 (Dudley et al., 2020). However, the reality is that grasslands can provide similar ecosystem services as other land uses. For instance, some literature indicates that grassland soils store up to 343 Gt C, which is far greater than the amount stored in forests. Studies even show that species diversity declines as tree coverage increases at the expense of grasslands. Planting trees in grasslands for restoration represents irreversible action that overlooks the crucial belowground carbon storage in old-growth grasslands (Buisson et al., 2022). Furthermore, trees require long-term investment to grow before providing intended ecosystem services, whereas grass species can establish within a few years and provide services in a much shorter period. Moreover, livestock production is the main livelihood activity in Africa, particularly in Western Kenya, and without proper management of grassland resources, the primary source of livestock feed, it would be difficult to alleviate poverty and improve the livelihoods of local farmers.

Therefore, it is equally important to give grasslands similar recognition for their contribution to ecosystem services without diminishing the importance of forest and other land use conservation. Grasslands have been severely degraded in Africa, particularly in Kenya, due to overgrazing coupled with climate change. One strategy for restoring degraded soils is through the reintroduction of native plant species. Therefore, my work focuses on testing plant functional groups (legumes and grasses) to identify suitable plant species that can help restore degraded land while also contributing to climate change mitigation and providing forage for sustainable livestock production.

Experimental design and research progress

In this experiment, I used soil collected from Western Kenya, selecting two contrasting soil conditions, degraded and non-degraded, for comparison. This approach allowed me to evaluate how different soil health statuses influence plant establishment and growth. The degraded soil represented typical conditions found in overgrazed areas, while the non-degraded soil served as a reference for healthier ecosystem functioning.

I selected two plant functional groups for the study: legumes and grasses. I'd chosen legumes for their nitrogen-fixing capabilities, which can enhance soil fertility, and grasses for their rapid establishment and ability to stabilize soil structure. The experimental setup followed a randomized complete block design with a full factorial arrangement, including single functional groups and all possible combinations. This design yielded eight treatments in total: legumes alone, grasses alone, legumes combined with grasses, and an unplanted control. With six replications per treatment, the total number of mesocosm pots was 96 (2 soil conditions × 8 treatments × 6 replications). The experiment was conducted in a greenhouse setting using 10-liter pots, which provided controlled conditions while allowing sufficient root development.

Including the experimental setup, which involved sample collection, soil processing, and preparation that took nearly two months, the entire experiment lasted six months. I monitored the experiment closely throughout this period. Watering was done daily for the first three weeks until the plants were successfully established, then reduced to three times weekly thereafter to maintain optimal soil moisture. To understand microbial activity and soil dynamics, I measured soil gas fluxes (CO_2) twice a week using a LICOR.

After four months of growth, we harvested the plants to measure aboveground biomass and collected root samples for trait analysis. Simultaneously, we collected soil samples from each pot for analysis of biochemical soil properties. The analysis of several soil parameters, including enzyme activities (such as β-glucosidase, N-acetyl-glucosaminidase, and phosphatase) and mineral nitrogen concentrations, is currently underway at ILRI's Mazingira laboratory. Root trait measurements, including root length density, specific root length, and root biomass allocation, are also being conducted at the Mazingira lab. Additionally, soil samples are being processed and prepared for transport to my home university, where I will analyze their chemical properties (such as pH, organic carbon, and nutrient content). These analyses will help determine which plant functional groups are most effective for restoring degraded grassland soils.

Some pictures taken during sample collection and pot experiment in the greenhouse (soil processing, plant growth stage and flux measurement): Image © 2025, Habtamu Sibilu

Challenges during the research work

During my research work, I encountered a few challenges that required flexibility and problem-solving. One of the primary challenges was the unavailability of seeds for local grass species. I had initially planned to collect seeds for legumes, grasses, and forbs directly from the field, but it was difficult to find mature seeds for all the considered plant species, particularly forbs. The timing of seed collection did not align well with the seed maturation period for many species, and some plants had already dispersed their seeds before we could harvest them. After consulting with my supervisors, we made some adjustments to the experimental design and ultimately focused on legumes and grasses, which were more readily available and still allowed us to test our core hypotheses about plant functional group effects on soil restoration.

Another challenge related custom-made chambers for soil flux measurement. Initially, there was difficulty in standardizing the soil flux measurement protocol, particularly considering the number of pots we had, the limited space in the greenhouse, and the varying stages of plant growth. The chambers needed to accommodate different plant heights as they grew while maintaining airtight seals for accurate gas measurements. My immediate supervisor at ILRI and senior lab members provided valuable guidance on how to approach this challenge. Together, we built proper chambers that ensured consistency in measurements while being practical for use in the greenhouse setting.

On a deeply personal note, I must mention that I suffered a profound loss during this period with the passing of my supervisor, Professor Mariana Rufino, after her courageous battle with cancer for almost a year. Professor Mariana was extraordinarily supportive, not only as a supervisor but as someone who treated her students like family. She was deeply passionate about science and dedicated to mentoring the next generation of researchers. Although losing her was one of the most difficult moments of my life and for all her students and everyone whose life she touched, I am determined to carry on her legacy. I hope to honor her memory by embodying the same supportive and compassionate approach she showed us, by pursuing excellence in research, and by making her proud through my continued work in grassland restoration and sustainable agriculture.

Conclusion

This six-month research stay at ILRI has deepened my experience both professionally and personally. I acquired deeper understanding of grassland restoration ecology with practical skills in experimental design, greenhouse management, laboratory analysis, and stakeholder engagement. Beyond the technical knowledge, I have gained invaluable insights into the complex socio-ecological challenges facing grassland ecosystems in East Africa and the urgent need for evidence-based restoration strategies that balance environmental conservation with local livelihoods. The collaborative relationships I built with scientists, local communities, and stakeholders have broadened my perspective on how research can be translated into meaningful impact on the ground. As I continue analyzing the data at my university, I am hopeful that the results will provide practical guidance for selecting appropriate plant species combinations for restoration efforts in Western Kenya and similar tropical grassland ecosystems.

Acknowledgment

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