Brief

CGIAR Initiative on Livestock and Climate

Restoration of grazing lands by One CGIAR researchers and partners

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COVER PHOTO:
ICARDA, ILRI, and Direction Générale des Forêts (DGF) of Tunisia review production of Hedysarum coronarium in a seasonal grazing exclosure Sbaihia, Zaghouan, in the agrosilvopastoral area of northern Tunisia. Photo credit: J. Sircely/ILRI.

Background

Tunisia

The Tataouine, Kebili and Medenine Governorates in southern Tunisia have a temperate desert climate, with annual rainfall of 100-200 mm/yr at ~100 m elevation, and livelihoods depend on livestock fed on forage from communal rangelands and purchased feeds. The restoration approach used was short-duration, high-stocking-rate opportunistic grazing.

Zaghouan Governorate is in the agrosilvopastoral region of northern Tunisia with annual rainfall of 400 mm/yr at ~200 m elevation, and where agriculture depends on olives and small ruminants on private croplands and state-owned rangelands, including Sbaihia. The restoration approach used was silvopastoral enriched seasonal exclosure.

Climate change, increasing livestock densities, complex land tenure systems, and rangeland fragmentation are key factors contributing to rangeland degradation. The dismantling of Tunisia's traditional grazing practices, Gdel, has further exacerbated the problem.

East Africa (Ethiopia, Kenya, Tanzania)

The rangelands of southern Ethiopia (Borana Zone in Oromia Region, southern Somali Region) and northern Kenya (here Baringo, Isiolo, and Marsabit Counties) vary from tropical semi-arid savanna rangelands (350-700 mm/yr at 300-1,700 m elevation), to hot tropical arid desert and semi-desert rangelands (100-350 mm/yr at 200-600 m elevation). Bi-modal annual rainfall is divided among two rainy and two dry seasons each year.

The rangelands of northern Tanzania (here, Kiteto District) have a tropical semi-arid savanna climate, with rainfall of approximately 700 mm/yr annually, at approximately 1,300 m elevation in Kiteto. The uni-modal rainfall in the area means that all rainfall comes in one season, with a single dry season in the remainder of the year.

The restoration approach used was short-resting of 1-6 months, usually in combination with control of problematic and/or invasive plant species.

These rangelands are communal, use and management of which is overseen by local or traditional rangeland management institutions. Livelihoods focus on extensive household milk production, with occasional sales of live animals and products. Farming of annual crops is higher in semi-arid rangelands, especially in uni-modal areas of Tanzania, while arid zones have little farming. Rangeland degradation in East Africa is primarily the result of droughts caused by climate change, weak communal land tenure security, weak local institutional oversight leading to disorganized and heavy grazing, and rangeland fragmentation.

Colombia

The Orinoquia region of Colombia has a tropical humid forest climate, receiving annual rainfall of 2,000-3,000 mm/yr, at 100-200 m elevation. Hacienda San José in Vichada is a private ranch in the Orinoquia managed for beef production, with rainfall of ~2,500 mm/yr at ~100 m elevation. The restoration approach used was rotational grazing with managed spontaneous tree regeneration.

Degraded landscapes in the Orinoquia need effective solutions to minimize the impacts of overgrazing and restore cover of native forest trees, leading to the development of monitoring methods using remote sensing and artificial intelligence (AI) that can track tree cover, aboveground biomass, and soil carbon over private ranches such as Hacienda San José at 9,000 ha.

Restoration techniques and results

Short-duration, high-stocking-rate opportunistic grazing

In short-duration, high-stocking-rate opportunistic grazing, high intensity grazing pressure is created by allowing large numbers of livestock to enter and graze areas being rested under the Gdel 3-year resting areas (historically, Gdel resting was between a few weeks and 1-2 years). Livestock can only enter these areas after the national Office of Livestock and Pastures (OEP) decides with pastoralists in common agreement with all stakeholders to open the rested areas, when highly favorable rainfall create large surpluses of forage that will go to waste and lead to disagreement between local administrations and agro-pastoralists. Further, under longer resting periods in drylands, there is a risk of rangeland condition and productivity failing to achieve peak potential (1), indicating the importance of grazing as a natural and effective management tool in these dry rangeland ecosystems. The key to this approach is time—grazing is in good seasons of surplus, for a short period of time. Short grazing periods prevent heavy grazing from damaging the ecosystem; in fact, brief heavy grazing can be highly beneficial to rangelands (2). To summarize, once areas being rested for three years under Gdel register adequate rainfall amount and distribution, grazing is allowed in the target range site regardless of the planned Gdel resting duration, for as long as the forage lasts, usually 1-3 weeks.

Planted Hedysarum coronarium in a seasonal grazing exclosure Sbaihia, Zaghouan, in the agrosilvopastoral area of northern Tunisia. Photo credit: J. Sircely/ILRI.

The beneficial impacts of this restoration and management practice can be summarized as follows, compared to rested and ungrazed areas nearby, 1-2 years after the grazing event: (i) total plant cover improved by over 200%; (ii) plant diversity increased more than 150% (Simpson index); rangeland productivity improved by over 250%; the total area of 19,000 ha of rested sites subjected to opportunistic grazing produced nearly 4 million feed units in a favorable year, roughly equivalent to 4,000 tons of barley grain. The approach was considered highly acceptable by pastoralist communities, with this flexible management providing social and economic benefits through building trust and cooperation and savings on animal feeds. The area covered by the new OEP approach is now estimated at >100,000 ha (PRODESUD and PODEFIL IFAD projects), benefiting 9,800 households total (~49,000 beneficiaries).

Short-duration, high-stocking-rate opportunistic grazing is useful where long rest (e.g., Gdel) is in place through practice or policy, and may lead to waste of useful grass, stirring resentment among agro-pastoralists, and not achieving peak rangeland condition. This new, flexible approach based on local knowledge, with local government engagement and the approval of the OEP, put rural pastoral communities and their local institutions (Groups for Agricultural Development, GDAs) at the center of all interventions. In doing so, opportunistic grazing contributed to (i) building national capacities in all dimensions, (ii) piloting, demonstrating, and scaling up innovative technologies and practices including indigenous traditional systems such as Gdel and adapting it to current social, economic and cultural contexts; (iii) generating and disseminating new data, information, and knowledge; and (iv) accelerating action on the ground building communities of practices that sharing experiences, best practices and lessons and demand-driven partnerships that benefit Tunisia. Across all of Tunisia, this approach could be expanded to benefit about 2.5 million hectares of communal and private rangelands.

Silvopastoral enriched seasonal exclosure

In Sbaihia, Zaghouan, in the agrosilvopastoral area of northern Tunisia, an exclosure was created using an integrated package of restoration practices including reseeding with sulla (Hedysarum coronarium), a highly productive, tall-statured native herbaceous perennial forage legume, planting of nutritious fodder trees and shrubs (e.g., carob tree, medic shrub), along with soil and water conservation structures, such as gabions and trenches for water harvesting. Planting of forbs (sulla), shrubs, and trees, and silvopastoral management, were used to maximize the potential of water harvested and to protect the highly vulnerable hillside soils from erosion. The Sbaihia exclosure is closed seasonally to allow growth of vegetation during the winter Mediterranean growing season, and opened for fee-based grazing according to the number of sheep or goats and allowed carrying capacity according to agreement of the local administration on behalf of the Tunisia forestry directorate (Direction Générale des Forêts, DGF).

The integrated silvopastoral package improved soil fertility, reduced soil erosion, increased water availability, and improved forage availability, thereby increasing livestock production. Following successful sulla establishment, biomass exceeded controls by up to tenfold, and the cost of feeding dropped by nearly 1/3. The use of sulla as a honey bee forage allowed local communities to adopt beekeeping and diversify incomes. The silvopastoral approach adopted by ICARDA and DGF was applied in a degraded state-owned area that covers about 4,700 ha and supports 70 households dependent on small ruminants and olive farming, for whom the exclosure provides 60% of livestock feed.

This silvopastoral technique is appropriate for agrosilvopastoral areas in North Africa and beyond, such as in the semi-arid, temperate climate (~400 mm/yr rainfall) of Sbaihia. The restoration accomplished in Sbaihia relies on a sound participatory approach with full cooperation from the local population, who contributed to major decisions such as the species to plant, site management once planted, and the restoration timeline. The participation of both young people and women helped harness innovative capacities for long-term climate change adaptation and mitigation while also increasing agricultural production. The creation of Groups for Agricultural Development (GDAs) as local community institutions guarantees community engagement and ensures sustainable management of silvopastoral resources. Sulla has been scaled out in other Governates in Tunisia, and has been adopted by more than 100 households in Siliana.

Short-resting (+ other techniques usually)

Short-resting of rangelands is an approach in which rangelands are rested for short periods of time, usually during the early portion of the growing season, for as little as two weeks (3), to as much as six months in higher-rainfall savannas (4). Short rest can be used in "rotational resting" (5), where degraded portions of a rangeland are rested in succession over multiple growing seasons, eventually restoring the entire rangeland. Short-resting of 1–6 months is a component of all 14 restoration packages rolled out recently in East Africa (6–8), and in one case short-resting was conducted without any other technique, in Balesa, Marsabit, Kenya.

Fenceline photos outside and inside a restoration area treated with short-resting and removal of the invasive Acacia reficiens by simple cutting, Paka Hill community rangeland, Baringo County, Kenya. Photo credit: J. Sircely/ILRI.

Fenceline photos outside and inside a restoration area treated with short-resting and removal of the invasive Acacia reficiens by simple cutting, Paka Hill community rangeland, Baringo County, Kenya. Photo credit: J. Sircely/ILRI.

Resting for even short periods visibly enhanced rangeland pasture cover, indicating restoration of rangeland condition both ecologically and in terms of pastoralists' forage availability in most monitoring locations. Short rest has been shown to provide modest benefits in terms of forage availability, with roughly 10% additional dry season pasture cover persistent beyond one month of grazing (9) from one month of rest in arid rangelands, or two months in semi-arid rangelands in East Africa. Costs of short-resting are mostly transaction costs, as 'social fencing' through bylaws replaces physical fencing. Short rest carries low opportunity costs and risk, and helps prevent encroachment of problematic vegetation compared to longer rest. Benefits to local rangeland management and restoration capacity were significant, with uptake of short-resting documented in the management plans for all 14 of the focal rangeland institutions. Beyond the 84 ha recently restored through short rest, planned restoration should restore an additional 200 ha annually over coming years in these 14 communities.

Short-resting is especially useful in moderately degraded areas that do not require heavy and costly investment into intensive restoration, and in tropical and arid rangelands where rapid growth follows precipitation. It is flexible, inexpensive, simple, and is easily fitted into local and traditional knowledge and systems as similar approaches are sometimes used by pastoralists, e.g. as in Malkagalla, Isiolo, Kenya, where the grazing committee has used short-resting for some time in specific, important pastures close to settlements and water points. Communities can reduce costs and risks by limiting the length of resting time and/or the size of resting areas, enabling short-resting to be easily and flexibly fitted into the restoration plans of local institutions. The scaling potential for short-resting is enormous, comprising most of the rangelands that cover a majority of the land area of Ethiopia, Kenya, and Tanzania, among other regions globally.

Control of encroacher/increaser/toxic/invasive species + Short-resting

Limiting encroachment of woody and other undesirable rangeland vegetation, including species that can be toxic to livestock, is an important management objective in most rangelands. Control of problematic rangeland vegetation includes thinning of woody encroacher species, or unpalatable "increaser" species that increase under heavy grazing (10, 11), and/or species toxic to livestock. Control of problematic species ranges from complete removal, to thinning of overgrown beneficial species, to pruning of lower branches. By allowing sunlight needed by grasses beneath, woody thinning can greatly improve grass cover and production (12). Similarly, slowing the spread of invasive species is important to protect the health and productivity of many rangelands. By definition, invasive species fundamentally change ecosystem structure and function, in rangelands typically deteriorating livestock-based livelihoods. Invasives are best controlled through preventative early action to halt incipient invasions, maintaining native vegetation and limiting bare soil to slow down invasion, and surveillance and reporting (13).

Control of invasives and problematic vegetation requires resting, and is conducted in the dry season (except species needing moist soil for up-rooting). Of the 14 restoration packages at present in East Africa (6–8), 9 packages included control of problematic vegetation, and 3 included removal of toxic species—such as Euclea divinorum in Arda Olla, Dukusu, and Wayama-Bede rangelands (known locally as mi'essa or gadala). These packages included short-resting of one month in arid zones, and two months in most semi-arid rangelands, excepting six months of resting in Kiteto District in Tanzania given its higher rainfall and unimodal pattern of rainfall. In current restoration packages, the primary woody encroacher species removed included: (1) in the Ethiopia rangelands, Acacia mellifera, A. senegal, Commiphora tenuis, C. africana, and Solanum spp. ('sodom apple' species complex); (2) in Irong Hills in Baringo, Acalypha fruticosa and mixed Acacia spp.; (3) in Gafarsa in Isiolo, Salvadora persica and mixed Acacia spp.; and (4) in the Tanzania rangelands, Acacia drepanolobium, mixed Acacia spp., and Dichrostachys cinerea. Of the 14 packages, 3 included invasive species control. The invasive species removed were Prosopis juliflora in Malkagalla and North Horr (with one month rest), and the native invader Acacia reficiens in Paka Hills (two months rest).

Early-action invasive species control, and thinning of encroaching woody species enhanced rangeland condition, both ecologically and as seen by pastoralists. Short-resting with removal of problematic and invasive species benefitted forage availability, likely by releasing grasses from competition, while removing toxic species had clear benefits to livestock keepers. More importantly for invasives, their removal protects against further invasion and degradation in the restoration vicinity, and beyond. Removal requires significant manual labor (or machinery/fuel), and removal always carry a risk of re-encroachment, due to long resting periods or if management does not change post-restoration. Control of problematic and

invasive species includes transaction costs, from 'social fencing' and organizing contributions of labor and other inputs, while brief resting (e.g., 4 months over year 1) will have low opportunity costs. Local capacity benefits from these restoration packages included better planning and targeting of labor for invasive and problematic vegetation control, better understanding of the unique threat of invasives and control techniques, with documented uptake in most of the focal rangeland institutions' management plans. In addition to the 72 ha restored recently through control of problematic and invasive species, planned restoration should yield an additional 180 ha restored annually in these 12 communities over the next few years.

Control of encroachment is most useful in areas infested by problematic species, yet likely to be recoverable, where risking costly investment (14) is not necessary. Invasive control is most appropriate where an invasive species has more recently begun to invade specific areas critical for pastoralists, because smaller individual invasives are more likely controllable than are large, mature ones. Woody thinning, invasive control, and similar techniques can be planned under the restoration plans of local institutions, with sufficient provision of labor, and post-restoration resting and use. The scaling potential for these techniques is large, including many of the rangelands across East Africa faced by woody encroachment (mostly semi-arid) and invasive species (semi-arid and arid).

Caption: Livestock exiting a grazing area with scattered chaparro trees (Curatella americana), and in the background a row of teak trees (Tectona grandis) planted as a windbreak. Photo credit: Tropical Forages Program ABC.

Rotational grazing + spontaneous tree regeneration

In Colombia, at Hacienda San José in Vichada, rotational grazing is being implemented as a practical approach to restore degraded pastures, positioning the estate as a case study for sustainable land management. By moving livestock across paddocks in a planned manner, vegetation recovery is supported, overgrazing is avoided, and soil health is improved through increased root biomass, organic matter, and microbial activity while reducing compaction and erosion. Spontaneous tree regeneration is incorporated into this system through fencing, adjusted stocking rates, and leaving ungrazed zones around seedlings, creating conditions for seedling establishment, growth, and regeneration of formerly high forest cover.

This approach has also contributed to better vegetation cover, greater biodiversity, and control of invasive species, showing how forage grasses can be managed effectively. These efforts support biodiversity, regulate microclimates, and provide ecosystem services such as carbon storage and nutrient cycling, in the case of Hacienda San José over approximately 9,000 ha.

The work at the hacienda serves as an example for wider adoption of these methods in Colombia and similar regions, especially humid tropical and temperate zones with annual rainfall over 1,000 mm/yr at 0-1,000 m elevation in the tropics, for example (Hacienda San José receives ~2,500 mm/yr at ~100 m a.s.l.). This work has attracted interest from the elsewhere in Colombia, which aim to replicate the model for regional climate adaptation. Additionally, private sector actors, such as retailers, along with conflict-affected communities, are utilizing these examples to advance deforestation-free certification schemes, fostering greater sustainability across supply chains.

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