



## Comprehensive strategies for sustainable rangeland ecosystem restoration

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### Abstract

The development of a resilient and sustainable pastoral landscape is crucial for reversing degradation and ensuring long-term ecological health. Historically, unsustainable practices and climate change have severely degraded these landscapes. The context for restoration involves complex socio-economic, cultural, and ecological factors, necessitating a holistic approach. Key risks and drivers of change include climate variability, land tenure conflicts, and socio-economic pressures on land use. This paper presents comprehensive strategies for sustainable rangeland restoration, drawing on over two decades of experience in arid rangeland restoration and supported by relevant existing literature. Effective planning requires a deep understanding of socio-cultural dynamics, land tenure, and rights to access, rather than focusing solely on biophysical and technical aspects. Identifying target groups that are homogenous and less prone to conflict is essential to initiate restoration efforts effectively. Setting clear restoration priorities and targets, determining appropriate interventions, and understanding the specific uses of restored areas are critical components of the planning process. The basic steps for restoring a degraded ecosystem include agreeing on a common goal, establishing robust governance structures, and devising effective strategies. Removing sources of degradation or conflict is fundamental, followed by physical and biological restoration efforts. Patience is vital, as ecological restoration is a time-consuming process. Success factors include multi-stakeholder engagement, leveraging institutional collaborations to enhance resource utilization and efficiency, securing long-term investments and commitments, and supportive national and local policies. Utilizing local practices and knowledge, along with community empowerment, ensures ownership and sustainability of the restoration process. In summary, intervention strategies for restoring degraded pastoral landscapes are site-specific, requiring tailored approaches rather than a one-size-fits-all solution. Restoration efforts must be coupled with effective management to be successful, and inappropriate policies can exacerbate damage. Developing national institutions' capacity through new tools, monitoring, and grazing management is essential for sustained restoration and rehabilitation efforts.

## **Introduction**

The degradation of pastoral landscapes, particularly in arid regions, is a pressing environmental concern that threatens ecological stability and the livelihoods of pastoral communities. Unsustainable land use practices, exacerbated by climate change, have contributed to the widespread decline of these landscapes, leading to reduced productivity and biodiversity (Zhang et al. 2023). In fact, restoring degraded pastoral landscapes requires a multifaceted / holistic approach that integrates ecological, socio-economic, and cultural practices of the communities involved. As such, the restoration process must be rooted in a thorough understanding of local contexts, which includes identifying key risks such as climate variability, socio-economic pressures, and land-use conflicts (Semplici and Campbell 2023; Birhanu et al. 2024).

In addition to understanding these contextual factors, the success of restoration efforts hinges on planning that prioritizes stakeholder engagement, governance, and long-term sustainability (Gann et al. 2019). It is crucial to set clear restoration goals, determine appropriate strategies, and ensure the involvement of all relevant stakeholders. A collaborative and inclusive approach, leveraging local knowledge and institutional support, can help guide efforts and ensure that the restoration process is both effective and sustainable (Slayi et al. 2024).

This paper presents practical approaches for reestablishing ecological health in pastoral landscapes, drawing on two decades of experience in arid rangeland ecosystems. By examining key drivers of change and the essential elements of successful restoration. Through a synthesis of literature and case studies, critical factors that contribute to successful restoration and rehabilitation will be highlighted, with a focus on ensuring the long-term viability of both ecosystems and the communities that depend on them.

## **Participatory methodologies and approaches**

The International Center for Agricultural Research in the Dry Areas (ICARDA) and in collaboration with the International Union for Conservation of Nature (IUCN) have developed a toolkit (Fig.1) which advocates for holistic approach for addressing the socioecological aspects leading to more resilient pastoral systems (Louhaichi et al. 2022). The key elements of the approach are listed below:

***Set up the governance structure and build partnerships:*** This process begins with understanding the socio-cultural context, land tenure systems, and rights to access. Targeting relatively homogenous groups with minimal conflicts can further support restoration efforts (Naylor et al. 2012) Collaborative partnerships among stakeholders foster shared responsibility, optimize resource allocation, and drive innovative solutions to complex challenges

***Identify the root causes of degradation:*** Conducting a thorough site evaluation is essential to uncover the underlying causes of rangeland degradation. These may include factors such as overgrazing, agricultural encroachment, invasion by woody plants, or unsustainable land management practices. Identifying these root causes provides the foundation for developing targeted interventions to restore and sustain the health of the rangeland ecosystem (AbdelRahman, 2023).

***Define the overall goal and specific objectives:*** Restoration goals should be specific, measurable, and time-bound, aiming to improve soil quality, enhance biodiversity, or increase livestock productivity. Prioritization is key, focusing on the most critical areas for restoration based on the severity of degradation and the ecological importance of the site. Setting clear restoration and rehabilitation priorities, along with specific targets, is essential. This includes determining the type of intervention required, where it should take place, how it will be implemented, and what intended use, ensuring that the approach is tailored to local needs and conditions (Holl and Aide 2011).

***Planning and Design:*** Engaging local communities and stakeholders in the planning process is crucial, incorporating traditional land-use knowledge to inform decisions. Restoration strategies should be tailored to local

conditions, including species selection, grazing management, and erosion control measures. Additionally, it is important to plan for future climate variability to ensure that restoration efforts are resilient in the long term.

**Set up robust monitoring protocols:** Establishing comprehensive monitoring protocols is crucial for understanding and managing rangeland health effectively. Begin by assessing the current condition of the rangeland to create a reliable baseline for future comparisons. This involves examining key indicators such as soil health, vegetation cover, biodiversity, and erosion levels. Regularly updating this data provides valuable insights to inform adaptive management strategies, enabling timely responses to emerging challenges and supporting the long-term sustainability and productivity of rangeland ecosystems (Eyre et al. 2011).

**Use site specific tools and procedures:** Two rules to keep in mind 1) No "one-size-fits-all" approach exists, and (2) it is crucial to fix the physical structure (e.g., erosion) before addressing the biota. For arid ecosystems, water-harvesting techniques such as building check dams or contour lines are essential for retaining moisture and improving the hydrological balance. Vegetation management involves reintroducing native plants and grasses suited to local conditions to stabilize the soil and boost biodiversity. Therefore, before planting the right species in the right place, it is essential to conduct a thorough needs assessment, drawing on indigenous knowledge. The selection process should involve local communities to ensure the choices align with local contexts. Prioritize multi-purpose plant species based on both socio-economic and environmental criteria, with a preference for indigenous and well-adapted species. It is also crucial to select species that require minimal care and protection, reducing demands on capital and labor. Emphasizing social fencing over physical fencing can further enhance sustainability and community ownership (Brancalion and Holl 2020).

**Grazing management:** Grazing is a critical factor in any restoration. Whether the restoration technique used (i.e.: reseeding, planting shrubs and trees), grazing remains essential. For instance, long term protection (no grazing) can lead to the collapse of the entire ecosystem. Therefore, careful consideration must be given to the timing, intensity, and duration of grazing. Recently, there has been increased emphasis on regenerative grazing, which prevents overgrazing and promotes vegetation recovery (Bartley et al. 2023).

The SRM toolkit has been successfully adopted by the HERD project, funded by GEF, in West Asia. More recently, it was applied to a silvopastoral site in semi-arid Tunisia, which was recognized last year as one of the 12 selected success stories worldwide at the FAO Global Conference on Sustainable Livestock Transformation.

### **Conclusions/Implications**

This paper presented comprehensive strategies for sustainable rangeland ecosystem restoration. In summary the key elements to keep in mind include: 1) engaging multiple stakeholders and fostering institutional collaborations to leverage resources, share knowledge, and enhance efficiency; 2) securing long-term investments from financing agencies alongside sustained commitments from key actors; 3) establishing favorable and supportive national and local policy frameworks; 4) integrating local practices and traditional knowledge into implementation strategies; and 5) empowering communities to take ownership of the restoration process.

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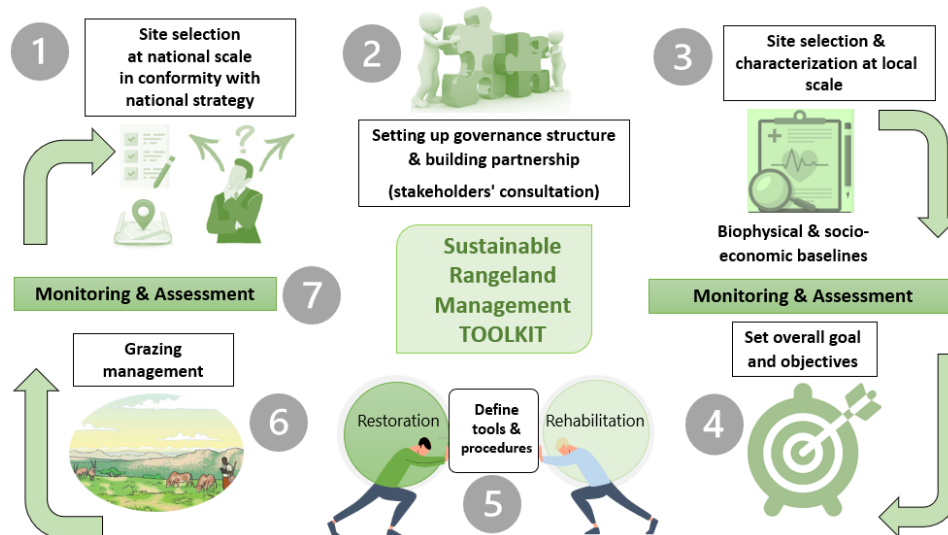


Fig 1. Comprehensive Sustainable Rangeland Management (SRM) Toolkit: A Step-by-Step Process for Developing Resilient Pastoral Systems

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