ECONOMICS OF LAND DEGRADATION INITIATIVE

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

CGIAR

The Business Case for Investment in Rangeland Restoration

Imprint

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Acknowledgements
This paper has been financially supported by the Protecting Climate, Biodiversity and Land through Sustainable Livestock Systems (LIVESys) Programme implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (German federal enterprise for international cooperation), commissioned by the German Federal Ministry for Economic Coorperation and Development (BMZ). It has been made possible by the cooperation and the authors drawing from their expertise with the International Livestock Research Institute (ILRI) and the Global Environment Facility-funded project STELARR (Sustainable Investments for Large-Scale Rangeland Restoration) implemented by the International Union for Conservation (IUCN) and executed by ILRI, supported by other CGIAR centres (ICARDA, Alliance of Bioversity and CIAT, and CIFOR-ICRAF), the Sustainable Fibre Alliance and GMV Solutions. We express our gratitude to the reviewers of this report for their time and valuable advice: Charles Karangwa (IUCN), Natasha Kirit Maru (International Land Coalition), Leonie Meier (WWF), Andrew Seidl (Colorado State University), Lindsay Stringer (University of York), and Richard Thomas (Independent Scientist).

The content and the positions expressed are those of the authors and do not necessarily reflect the perspectives of those who provided input nor of the organizations to which they are affiliated.

Visual concept and layout
now [nau], communicative & visual design, Frankfurt/Main

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Suggested citation
Davies, J., Nyamtseren, M., Wane, A., Hientz, L. (2025). The Business Case for Investment in Rangeland Restoration

Available from www.eld-initiative.org

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Bonn, October 2025

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Executive Summary

> Rangelands occupy 54 % of the global terrestrial surface and they are used by around 500 million pastoralists.

They provide globally important ecosystem services, including food production, climate regulation, water regulation, and biodiversity habitat.

Between one quarter and one third of rangelands are estimated to be affected by land degradation, contributing to poverty, biodiversity loss, and greenhouse gas emissions. Demand for investment in rangeland restoration is increasing due to growing awareness of the multiple values of rangelands, growing concern over rangeland degradation and associated poverty and vulnerability, and emerging recognition of rangelands under international agreements.

As rangeland restoration builds momentum, countries and their development partners are recognising the need to transition from projects to national programmes and policies and eventually to long-term private investment to restore and sustainably manage rangelands. Evidence suggests that rangelands restoration will pay for itself, with estimated returns of USD4-USD35 for each USD invested. However, global figures vary greatly and may not provide adequate confidence for investment at a local level.

Strengthening the Case for Investing in Rangeland Restoration

The lack of certainty over the investment case for rangelands comes from significant gaps in understanding both the costs and the benefits of rangeland restoration. Costs are highly variable because the nature of rangeland degradation is highly variable and there are no one-size-fits-all solutions. On the contrary, there is a great difference in the cost of passive solutions, such as herd management, that work on a large scale in areas of comparatively low degradation and the cost of active solutions like earth soil and water structures that are needed for advanced and severe rangeland degradation. Restoration costs are influenced by the type and extent of restoration, the geographic and economic context, and the scale of restoration projects.

The benefits of rangeland restoration are often inadequately measured, with a tendency to measure one or two values and to overlook and therefore undervalue most benefits. Healthy rangelands produce a wide range of livestock and non-livestock products together with several other eco-system services. The key to balanced rangeland management and to cost effective restoration approaches is to invest in and thereby incentivize several of these benefit streams. This requires innovative approaches to investment in which ecosystem services are bundled or stacked, and through which the investments of more than one business may be aggregated. Businesses may need to invest in unfamiliar areas, such as capacity building and institutional development, to generate returns from rangeland restoration via a range of value chains.

Mobilizing sustainable, equitable investments in rangeland restoration requires governments to strengthen the enabling environment in several ways:

1. Strengthen land use planning and tenure security
2. Target restoration measures to local degradation
3. Provide economic incentives
4. Build local awareness, capacity and governance structures
5. Develop market infrastructure
6. Promote individual value chains that support rangeland restoration
7. Develop innovative financing partner ships and approaches
8. Implement appropriate safeguards
9. Implement effective monitoring and verification systems.

Improving Cost-Benefit Analysis of Rangeland Restoration

The lack of robust estimation of restoration needs and costs and the likely benefits that can be generated is deterring businesses from investing in rangeland restoration. Deeper insights are also needed into risk factors, including climate variability, market volatility and tenure insecurity, and into inequalities in rangeland societies that should influence restoration strategies and investment approaches. Further insight is needed into the ultimate beneficiaries of rangeland restoration to disaggregate benefits that accrue directly to herders and benefits that are enjoyed by wider society, domestically or internationally.

Valuation of rangeland restoration faces several challenges:

- Quantifying human development outcomes associated with rangeland restoration, including peace and security, and maintenance of cultural heritage.
- Measuring the costs and benefits of strengthening communal governance for sustainable rangeland management.
- Quantifying, or otherwise representing, market and non-market values, and identifying motives for investing in both.

Recommendations

Sustainable rangeland management and rangeland restoration offer substantial returns across ecological, social, and economic dimensions. Realizing these benefits depends on the coordinated efforts of investors, governments, policymakers, pastoralist communities, and development partners. Suitable investment can be enabled by more effective governance, inclusive participation, and innovative financing solutions, as outlined in the following recommendations.

1. Investment strategies for rangeland restoration should adhere to the LDN response hierarchy of “avoid-reduce-restore”. Greater emphasis should be paid to avoidance of rangeland degradation, particularly through low-cost and large-scale community-based approaches that emphasise community rights and governance as the foundation for sustainable herd management.
2. Private investors in rangeland restoration should develop strategies that add value to the multiple goods and services of rangelands including livestock and non-livestock values. They should invest in enabling communities to manage rangelands sustainably and they may benefit from developing partnership with co-investors.

3. Public decision-makers should continue to elevate the importance of rangeland restoration as a sustainable development priority, contributing to peace and security, poverty reduction and economic growth, mitigation and adaptation to climate change, and to land degradation neutrality and conservation of biodiversity.

4. Policy makers should enable investment in sustainable rangeland management by pastoralist communities, through measures to strengthen landtenure and local institutions and improve market access for multiple rangeland values. Policies should include context-appropriate economic incentives for sustainable rangeland management, safeguards for the rights of rangeland communities, and measures for monitoring restoration outcomes.

5. Pastoralists and pastoralist organisations are recommended to promote the many values of pastoralism and rangelands in dialogue with government and businesses, including the role of pastoralists as custodians of nature and culture.

6. Development partners, including development banks, international organisations, and nongovernmental organisations, should strengthen the role of pastoralists in implementing sustainable rangeland management and restoration and should work towards long-term investment strategies and partnerships from an early stage of project development.

7. Researchers should strengthen analysis of the economic roles, responsibilities, opportunities and threats of different sectors and actors and strengthen awareness of the risks of rangeland investments entrenching inequalities in rangelands. They should improve methodologies for more consistent and effective economic analysis of rangeland restoration and strengthen advice on innovative ways public and private partners can invest in equitable rangeland restoration.

1. Introduction

Rangelands are vast places of inspiration and beauty that cover more than half of the Earth's land area. They include savannahs, steppe, prairie, pampas, mountain pastures and many other iconic habitats that are used for management of both grazing livestock and wildlife and are integral to the natural and cultural heritage of many countries. They are rich in biodiversity, home to many endemic species, and famous for their great wildlife migrations. They are a rich store of carbon and play a valuable role in the global carbon cycle and in regulating climate. Rangelands are also notable for their cultural diversity and are home to a myriad of pastoralist cultures, known as herders, nomads, shepherds, ranchers and many other names in many different languages. The rangelands are simultaneously the foundation of pastoralist livelihoods and the provider of global environmental benefits, such as climate regulation, water supply, and wildlife habitat.

Pastoralists – the custodians of the rangelands – have developed livelihoods and rangeland management systems based on herd mobility that are pivotal for their resilience. Pastoralism has proven to be a highly adaptive livelihood but has come under heavy pressure in recent decades due to loss of natural resources, undermining of customary governance, insecurity, and failure to provide public services. As a result, they are among the poorest and most marginalized communities in most countries and fall behind their compatriots in development. Pastoralists are explicitly recognized in the 2030 Agenda as peoples who should benefit from achievement of the Sustainable Development Goals (UNEP 2019; UNCCD 2024). The global importance of rangelands, and the vital role of pastoralists in managing them, will be celebrated in 2026 during the UN-designated International Year of Rangelands and Pastoralists.

> The United Nations Convention to Combat Desertification (UNCCD) has a strong mandate for sustainable land management and restoration of the rangelands

due to their overwhelming dominance of the drylands and due to the reported levels of rangeland degradation in many countries. In 2024, Parties to the UNCCD adopted a resolution on rangelands and pastoralists[1], and called on the UNCCD to develop a Rangeland Flagship Initiative, which will boost investment to achieve Land Degradation Neutrality (LDN) by conserving, sustainably managing and restoring rangelands. The Global Land Outlook Thematic Report on Rangelands reports that rangelands are threatened by land use change (e.g. crop cultivation, afforestation, and mining) and mismanagement (e.g. grazing mismanagement, fragmentation of landscapes, reallocation of water resources, and pollution) (UNCCD 2024). FAO has estimated that 13 % of grasslands and 15 % of shrublands were degrad-

1 UNCCD Decision COP16/L15 on Rangelands and Pastoralists

ed in 2015 while 34 % of grassland and 41% of shrubland were in a deteriorated state. Only 54 % of grassland and 44 % of shrubland were found to be in a stable condition (FAO 2022). Such a high estimate demands scrutiny, since different types of degradation require different response measures with radically different costs and benefits.

> An estimated 500 million people rely on rangelands directly for their livelihoods and up to 2 billion rely on rangeland commodities and ecosystem services.

The risk of rangeland degradation contributing to poverty, food insecurity, drought risk, instability, and conflict is therefore taken seriously by many governments. Furthermore, when degradation contributes to loss of biodiversity and carbon stocks, disruption of water supplies, elevated drought risks, and sand and dust storms, the impacts are felt beyond national borders and become a matter of international concern (UNEP 2019).

Public and private investment in rangeland restoration is low compared to forest ecosystems and is constrained by several factors, including low regard for rangeland values, poor understanding of sustainable rangeland management, poor relationships between investors and pastoralist communities, weak resource tenure, and distrust of pastoralist knowledge and governance. Investment in rangeland restoration is further constrained by poor understanding of the cost of rangeland degradation, low appreciation of the benefits of restoration, and challenges in measuring progress. Investors also frequently face challenges in responding to the economic behaviour of pastoralists and their adaptation to the uncertainties of rangelands (Gichuki et al. 2019).

Some investments in rangelands during 1970s and 1980s perceived communal land management and herd mobility as irrational practices and strove to eliminate them through land privatisation and sedentarization. These investments contributed to harmful outcomes by undermining pastoralist risk management strategies and alienating land and water resources, leading to food insecurity, impoverishment, and conflict (Niamir-Fuller 1999; Davies et al. 2010). These failures led to several decades of low investment, referred to by some authors as a period of “benign neglect” (UNEP 2019). The extent to which pastoralist communities have fallen behind their compatriots on human development indicators (literacy, health, productivity) highlights that this neglect has been far from benign (McGahey et al. 2014).

> Rangeland restoration can make a significant contribution to sustainable development,

including synergy between the 3 Rio Conventions, reducing poverty, improving food security, and increasing drought resilience. Recent reports have called for sustainable development in rangelands that recognizes the management strategies of pastoralists and respects their rights (UNCCD 2024; UNEP 2019). The United Nations has designated 2026 as the International Year of Rangelands and Pastoralists (IYRP), creating renewed demand to invest in restoration and sustainable development in the rangelands.

> Scaling up rangeland investments equitably and safely requires greater clarity over the costs and benefits of different rangeland restoration approaches, who benefits from restoration, and how those benefits translate into credible economic and financial returns on investment.

It requires improved assessment of social and environmental outcomes, including livelihood resilience, food and income security, and biodiversity conservation. It also raises questions over the nature of investments and how to differentiate investments in people, practices and value chains, which focus on development of land users, from investments in land, which may not always benefit land users.

The purpose of this discussion paper is to help catalyse investment in rangelands, by strengthening justification for the public and private sectors and providing policy makers with guidance on enabling and encouraging investors to invest in equitable rangeland restoration and sustainable management. The discussion paper provides an overview of the current state of knowledge and identifies questions and knowledge gaps that need to be addressed to advance the aims of the UNCCD Rangeland Flagship Initiative and other rangeland investments. The discussion paper is global and inclusive in its scope, attempting to encompass all regions and all types of rangelands. We refer to rangeland managers as pastoralists for convenience but recognise that these communities go by a wide variety of names and use a diverse range of management systems, including nomadism, transhumance, and sedentary ranching. The discussion paper will be particularly relevant for developing and transition economies that represent most rangeland Parties to the UNCCD and who are attempting to unlock rangeland investment.

2. The Importance of Rangelands

Rangeland restoration is attracting growing international and national interest due to improved understanding of the value of rangeland ecosystems and the cost of rangeland degradation and its associated social challenges. Rangelands cover an estimated 54 % of the terrestrial area and are found in 142 countries (ILRI et al. 2021). **Eighty countries that have acknowledged to be 'affected by desertification' have more than 100,000 km^2 of rangeland[2] .** Half of these are in Africa, 18 are in Asia, 14 in Latin America, 7 are in Europe and Central Asia and 1 is in Oceania.

Although rangelands are globally distributed, they are more widespread in less economically developed countries, and many rangeland regions face challenges in meeting the Sustainable Development Goals. Rangeland degradation contributes to food insecurity, poverty, conflict, and other sustainable challenges. Conversely, prevention of rangeland degradation together with rangeland restoration can contribute to attainment of several sustainable development goals (Table 1).

TABLE 1 Investing in rangeland restoration aligns with multiple SDGs (UNCCD 2024)

SDG 1: No Poverty	By improving land productivity and creating income opportunities for rural communities, rangeland restoration helps reduce poverty and enhance economic stability
SDG 2: Zero Hunger	Restored rangelands lead to better livestock production, ensuring food security and improving the nutrition of local communities
SDG 6: Clean Water and Sanitation	Healthy rangelands improve water retention and filtration, supporting clean water access and reducing water scarcity risks and drought impacts
SDG 8: Decent Work and Economic Growth	Investment in sustainable land management creates jobs through rangeland production and value chains and supports economic resilience in rural regions.
SDG 12: Responsible Consumption and Production	Sustainable livestock production reduces environmental harm, promotes biodiversity, and underpins ethical sourcing of meat, milk and fibre
SDG 13: Climate Action	Rangelands contribute to mitigating climate change through carbon sequestration and reducing greenhouse gas emissions and underpin climate resilient livelihoods
SDG 15: Life on Land	Restoring and sustainably managing rangelands enhances biodiversity, combats desertification and prevents land degradation, ensuring ecosystem balance and resilience

2 Affected countries are those which report to be affected by Desertification, Land Degradation and Drought under the UNCCD. Estimates of land area are derived from FAOSTAT data (retrieved December 2024)

Land degradation is currently drawing attention due to increased awareness of its cost, which has been estimated at USD 300 billion globally per year. **The cost of inaction on land degradation greatly exceeds the cost of action**, while the benefits of investing in actions to address land degradation (i.e. sustainable land management) have been estimated to exceed their costs by at least two times and possibly as much as five times over a 30-year planning horizon globally (Nkonya et al. 2016).

The UNCCD recommends prioritizing actions to avoid rangeland degradation for optimal outcomes. Sustainable rangeland management practices that avoid or reduce degradation should be considered first and should be coupled with efforts to reverse degradation through restoration or rehabilitation of degraded land. Avoiding rangeland degradation can be achieved through proactive measures to prevent advsere changes in land quality of non-degradaded land and confer resilience via appropriate regulation, planning, and management practices (Cowie et al. 2018).

The cost of rangeland degradation can be high, manifesting in reduced food production, increased drought risk, disrupted water supplies, loss of biodiversity, emission of greenhouse gasses, and more. Ecosystem degradation in Central Asia during the period of 2001 – 2020, for example, incurred an estimated USD 12.5 billion of losses, half of which was due to grassland[3] degradation. These losses came from a combination of land use change, reduced land productivity, and loss of vegetation cover, which contributed to soil degradation, carbon emissions, loss of biodiversity, reduced livestock productivity and other costs (Mirzabaev and Akramkhanov 2025).

Rangeland restoration and sustainable rangeland management can make a significant contribution to stimulating rural economic development, although many of the values of rangelands go unmeasured and unrewarded, and as a consequence are often underdeveloped (Davies et al. 2010). They produce animal protein that is vital for food security in many developing countries (Sloat et al. 2025). Rangelands have been estimated to contribute up to 80 % of agricultural GDP in some countries (Davies and Hatfield 2007). Comparison of data from ten countries has shown that extensive pastoral systems in Africa, based on multiple species, multiple products, and communal, mobile herding could be between 2 and 10 times more productive than intensive ranching systems in industrialised countries, although more up-to-date analysis is required to corroborate such studies (Scoones 1995).

Pastoral systems have a unique richness of economic values, but many countries lack basic data on rangeland livestock production and fail to disaggregate their pastoralist livestock sector from other forms of livestock production. Measuring the value of the pastoralist economy is made more challenging by the high degree of pastoralist subsistence, which creates a challenge for livestock development strategies and for responding to pastoralist marketing behaviours (Catley et al. 2016). Pastoralism in most countries is characterised by a diversity of livestock species, each producing a variety of goods: for example, one study found pastoralists in Argentina, Senegal and Mongolia all keep cattle, camelids, sheep, goats and equids, averaging between 20 and 33 livestock units. These animals produce milk, fibre, meat, and hides and some additionally provide transport, creating a substantial portfolio of goods with different values and opportunities for marketing, exchange, and subsistence (Wane et al. 2020).

3 Grasslands are a sub-set of rangelands (accounting for more than $^2/_3$ of the total). Considerable research focuses on grasslands rather than rangelands and where we cite such research we use the term grasslands.

Pronounced inequalities have been observed in pastoral and agropastoral systems, reflected in a high Gini index[4], which in Sahelian pastoralist systems between 2017 and 2020 ranged from 0.47 to 0.71 (Wane et al. 2020). This inequality was driven primarily by restricted access to productive assets – such as rangelands, infrastructure, and essential social services. Comparable patterns in the Horn of Africa indicate that constraints on livestock mobility, combined with rising human and livestock densities, intensify pressure on rangelands and accelerate land degradation processes. Addressing these structural inequalities, in alignment with SDG 10, is a prerequisite for sustainable resource governance and enhancing the socio-ecological resilience of pastoral systems (Little 2013).

Although pastoralism compares favourably with more intensive uses of the rangelands, the sector is facing challenges in some developed countries. Alpine regions of Europe have witnessed a decline in the practice of transhumant pastoralism as shepherds have struggled to remain profitable. In Italy, and several other European countries, demand is shifting towards public goods in the form of rangeland biodiversity and pastoralists are increasingly expected to play a role in maintaining cultural and natural heritage (Mazzocchi and Sali 2019). The shift from pure production towards a combination of livestock production and environmental stewardship has profound implications for the future of the rangelands and many examples are emerging –from both developed and developing countries –of pastoralists deriving substantial incomes from rangeland environmental values that incentivise more sustainable land management (Herrera et al. 2014).

2.1 Rangeland Restoration Generates Multiple Benefits for Society

> Rangelands are more than just grazing areas. They are spaces where people, animals, and landscapes influence each other's futures.

These lands have great potential to produce food and income and underpin resilient pastoralist livelihoods while keeping the land healthy. For pastoral families, herds are economic assets, a source of nourishment, and a way to care for the soil, plants, and wildlife sharing these spaces. Rangelands offer much more than milk and meat. They also produce gum Arabic from Senegal and Sudan, fine wool and mohair from South Africa and Lesotho, cashmere from Mongolia, and, in some areas, even oil and minerals. Many rangelands support tourism alongside pastoralism, capitalising on the scenic beauty, wildlife and pastoral culture of rangeland landscapes.

Each of these goods or services is linked to distant, profitable markets and has the potential to bring value back to the land itself. If these markets can be connected back to the landscapes that sustain them, part of that wealth can be used to restore degraded pastures. This would lead to healthier ecosystems, more stable incomes, and a future

4 The Gini coefficient is a measure of inequality among the values of a frequency distribution, such as income levels. A Gini of 0 reflects perfect equality and a Gini of 1 reflects perfect inequality.

where both people and nature can thrive. The challenge is to attract private investment into these lands to fulfil their potential.

Grasslands store approximately 34 % of the world's terrestrial carbon and can make a major contribution to climate change mitigation, but they are poorly reflected in Nationally Determined Commitments under the Paris Climate Agreement. Forests account for about 39 % of terrestrial carbon stocks, but where forests store most carbon aboveground, 90 % of grassland carbon is stored underground where it can be more stable than forest carbon stores and better able to withstand drought and fire. Grassland diversity has been shown to increase the amount of organic carbon stored in roots and soils and grassland conversion could cause up to 4.25 x 10^9 tonnes of emissions globally by 2050 (Sloat et al. 2025). Carbon sequestration can be enhanced in grasslands through grazing management and restoration of degraded grasslands as well as through interventions like sowing favourable forage species and applying fertilizer and irrigation. Ensuring sustainable management that adapts to climate change is key to long term carbon storage (Ghosh and Mahanta, 2014).

> Restoring and sustainably managing rangelands also contributes to conserving biodiversity,

including species and habitat diversity and rangeland ecosystem functions. Grassland, shrubland and savannahs account for approximately one third of Key Biodiversity Areas globally (6.8 million km^2) and have some of the highest species' richness and endemism globally yet only 4.6 % of temperate grasslands are protected (Sloat et al. 2025). Improved grazing management and biodiversity restoration is a low-cost natural climate solution for global grasslands. Global grasslands have potential to sequester 2.3 to 7.3 billion tons of carbon dioxide equivalents per year (CO_2e year–1) through biodiversity restoration, 148 to 699 million tons of CO_2e year–1 through improved grazing management, and 147 megatons of CO_2e year–1 through sown legumes in pasturelands (Bai and Cotrufo 2022).

Rangeland health is vital for regulating water cycles and for storing and supplying green water and the contribution of rangeland degradation to drought risk is gravely underestimated. Degraded rangelands have lower capacity to infiltrate rainwater, to store moisture in soil, and to recharge aquifers, amplifying the severity of drought and allowing drought effects to be felt even in years of good rainfall. Rangeland restoration can therefore reduce the severity and the frequency of drought as well as strengthen drought resilience (Magero et al. 2024). Healthy rangelands also play a role in reducing soil runoff and river sedimentation and reducing the costs of maintaining the quality of drinking water.

2.2 The Urgency of Rangeland Restoration

Sustainable rangeland management is becoming more urgent due to climate change, which is amplifying many of the pre-existing uncertainties and risks of the rangelands. Climate change contributes to rangeland degradation and further increases the risk of drought and other climate stresses besides other consequences of land degradation like sand and dust storms. Airborne dust leads to numerous determinantal effects on human health, economic costs from damage to infrastructure and to communication and transport networks, and several environmental impacts (Opp et al. 2021; Shepherd et al. 2016).

The impact of climate change on rangeland productivity varies by country and even within countries, but some models predict a decrease in mean herbaceous biomass across global rangelands between 2000 and 2050 with increased variability between years and within years. These vegetation trends are potentially harmful for livestock production and are observed in the Sahel, Australia, Mongolia, China, Uzbekistan and Turkmenistan: regions that together support 376 million people and 174 million ruminant Tropical Livestock Units. They also include the most vulnerable rangeland communities, with lowest livestock productivities and economic development levels and highest projected increases in human population (Godde et al. 2020).

Demand for evidence on the costs of rangeland degradation and the benefits of rangeland restoration is growing as countries establish voluntary targets for rangeland restoration under the UNCCD. This raises questions over the nature of rangeland degradation and the most appropriate restoration actions, including low-cost actions that are effective on a large scale. Research highlights the opportunity for sustainably managing rangelands for multiple benefits, including livestock production, biodiversity conservation, climate regulation, water supply, and others. It is the combined value of these benefits that demonstrate why investments in rangeland restoration should be given higher priority for both public and private actors. This raises new challenges over identifying the most suitable investment strategies and partners and understanding the relative importance of public and private investment (Davies et al. 2015).

Rangeland restoration can contribute to many benefits that are hard to quantify, including human development outcomes, peace and security, and maintenance of cultural heritage. Sustainable rangeland management depends on improved natural resource governance, including public planning of rangeland landscapes and territories and community management of communal pastures and other resources. However, measures to strengthen governance can reap benefits far beyond rangeland restoration by creating conditions for sustainable development and economic growth and resilience (Davies et al. 2015).

In many countries, rangeland restoration depends on effective management of communal land and therefore requires solutions to secure the governance of the commons (Ostrom and Cox 2010). The existence of common property regimes in rangelands enables communities to manage the heterogeneity, scale, and seasonal availability and accessibility of resources. Common property regimes are vital for effective movement of herds to access resources, evade seasonal stressors, and promote grassland health (Herrera et al. 2014). Many countries favour agricultural policies and investments for privately and individually titled land, which has driven a bias towards crop cultivation over extensive livestock production. This bias may derive from institutional instability and weak capacity of governments to effectively legislate for communal tenure, but it may also have roots in a distrust of customary governance arrangements or distrust of previous political systems that historically supported communal resource management.

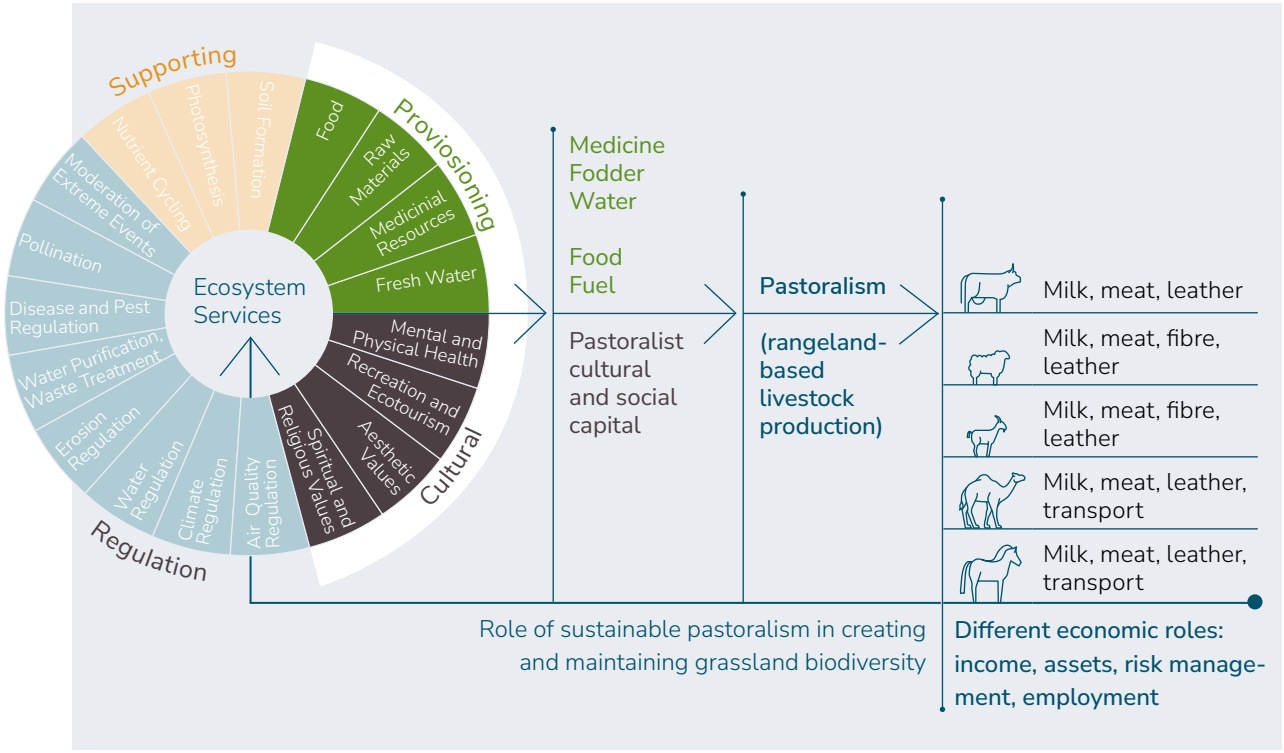
The political case for rangeland restoration is strong and there are increasing signs that this is being recognised by countries. However, governments still struggle to discern good practices and to understand the economic rationale for sustainable rangeland management. As good practices emerge there is urgent need to demonstrate the cost-benefit of each approach in each context and to provide a more rigorous framing to enable investors to answer critical questions in each landscape targeted for restoration.

2.3
The Values of Rangeland Ecosystem Services

A major challenge for rangeland restoration is fully accounting for the wide range of goods and services that are generated. Restored rangelands deliver provisioning ecosystem services such as fodder and water supply, as well as supporting, regulating and cultural services. These ecosystem services sustain pastoral herds which generate additional values including milk, meat, hides, fibre, and transport (► Figure 2)[5]. Cultural services include the conservation of indigenous breeds and the transmission of traditional ecological knowledge. Beyond their ecological functions, livestock serve as key economic assets, providing income, wealth storage, and risk mitigation. This highlights the combined environmental, socio-economic, and cultural significance of pastoralism in sustaining ecosystem service flows, particularly in dryland and marginal environments.

Quantifying ecosystem services is inherently complex because it involves both market and non-market elements. Developing rigorous and widely accepted measurement methods led to t he creation of the TEEB Valuation Database as a collaborative tool to compile economic valuations of nature and related methodologies, including market-based, cost-based, revealed and stated preferences, and benefit transfer methods. Converting natural services into economic terms would enable cost-benefit analyses, cross-regional assessments, and the integration of natural capital into policymaking (Van der Ploeg et al. 2010).

FIGURE 1 Rangeland Values: Proliferation through Pastoralism



5 We do not discuss supporting services in this discussion paper as their value is captured through the other ecosystem functions that they contribute to.

Different landscapes offer different benefits to people and nature. The Central Asian steppe supplies a comparatively higher value of food through grazing and agriculture and helps regulate the climate by storing carbon in its grasslands. However, due to issues with water management and erosion, its biodiversity is considered fragile. The Sahel's dry savanna provides less food and climate regulation per hectare and makes a weaker contribution to water regulation. It has moderate biodiversity but low current investment in recreation and tourism. Conversely, the high-altitude páramo in the Andes produces the least food but excels in climate regulation, thanks to its rich peat soils. It is highly effective at managing water, controls erosion well, and supports a diverse range of life. The páramo ecosystem serves as a vital water source and carbon sink for downstream areas (Van der Ploeg et al. 2010).

The economic contributions of rangelands, natural grasslands, and savannas to the global supply of ecosystem services has been examined in different biomes (Brander et al. 2024). The global assessment of the biome "Rangelands, natural grasslands, and savannas" estimates a total contribution of USD 5,934/ha/year[7], primarily driven by aesthetic information (36 %)[8] and maintenance of soil fertility (24 %), followed by food provision (8 %), climate regulation (7 %), culture, art, and design (5 %), recreation and tourism (4 %), and bequest values[9] (4%) (▶ Table 3).

Aggregating the data in Table 3 by ecosystem service type further highlights the dominance of cultural services, which contribute about USD 3,008 per hectare year (51 %), mainly through aesthetic information. Supporting services contribute USD 1,546 per hectare per year (26 %), notably through the maintenance of soil fertility. Provisioning services rank third with USD 843 per hectare per year, which is primarily delivered through food provision. Regulating services have the lowest aggregate value of USD 537 per hectare per year, mainly related to climate. **These data highlight the importance of public benefits provided by rangelands and underscore the justification for public sector investment alongside private investment.**

TABLE 2 Estimated annual ecosystem service values across selected biomes

Source: (Van der Ploeg et al. 2010)

Region	Food Provision (USD/ha/ year)	Climate Regulation (USD/ha/ year)	Water Regulation	Erosion Control	Recreation and Tourism	Biodiversity Support
Central Asia (Semi-AridSteppe)	$50–100	$20–80	Low	Low	Low	Moderate
Sahel (Dry Savanna)	$30–60	$10–50	Low	Low to Moderate	Low	Moderate
Andes (Alpine Páramo)	$20–50	$50–100	High	Moderate	Moderate	High[6]

6 As an endemic biodiversity hotspot, the Andes hold a correspondingly high value.

7 The original research expresses these data in Int$ and we have used US$ to be consistent throughout the paper, recognising that there may be some minor discrepancy.

8 According to Cooper et al. (2016), aesthetic values can be defined as an appreciation of nature's beauty, judged non-instrumentally, often shared, culturally informed, and linked to moral responsibility.

9 From the perspective of heritage, the idea of protecting environmental resources for future generations is at the heart of what we call bequest value.

TABLE 3 Global Ecosystem Services and Economic Value of Rangelands

Source: (Brander et al. 2024)

Ecosystem services	Value (USD/ha/yr)	Relative value
Aesthetic information	2,114	36%
Inspiration for culture, art and design	284	5%
Opportunities for recreation and tourism	238	4%
Existence, bequest values	225	4%
Information for cognitive development	147	2%
Subtotal cultural services	**3,008**	**51%**
Food	474	8%
Raw materials	191	3%
Water	177	3%
Medicinal resources	1	0%
Subtotal provisioning services	**843**	**14%**
Climate regulation	414	7%
Pollination	58	1%
Regulation of water flows	36	1%
Erosion prevention	26	0%
Air quality regulation	3	0%
Subtotal regulating services	**537**	**9%**
Maintenance of soil fertility	1,429	24%
Maintenance of genetic diversity	117	2%
Subtotal supporting services	**1,546**	**26%**
Sum	**5,934**	**100%**

Rangeland stewardship is vital for maintaining ecosystem services, even in "unmanaged" areas (Society for Range Management Task Force 2023). Resilience relies on three pillars: preventing land conversion, restoring degraded lands, and adaptive management, which guides daily ecological decisions. Effective stewardship depends on governance, policy support, and valuing traditional knowledge, such as mobile pastoralism. Rangelands provide both local and broader societal benefits, such as forage production and reduced downstream flooding and erosion. However, many public goods remain uncompensated, prompting critical questions about who benefits, who bears the costs, and who receives recognition and reward for these ecosystem services.

2.4 Rangeland-Based Livelihoods

The interconnectedness between the livestock economy and rangeland systems is profoundly significant. These vast pasturelands are indispensable, serving as the very foundation for current and future livestock production and family living conditions. Consequently, **rangelands are the basis of the livelihoods of millions of people worldwide.**

Rangeland ecosystem services influence herd composition, production systems, and income from market activities. **While pastoral practices share broad similarities across regions, notable differences emerge, mainly driven by the biophysical traits of rangelands and the level of market integration.** A key indicator of these differences is average herd size, which shows significant disparities even within ecologically similar zones such as the Sahel (Table 4). For example, average herd sizes reach 192 Tropical Livestock Units (TLU) in Chad but are much smaller in Burkina Faso (48 TLU), Mali (61 TLU), Mauritania (54 TLU), and Niger (34 TLU). In contrast, average herd sizes in Mongolia and Argentina are 143 and 172 respectively[10] reflecting different production models ranging from subsistence-based extensive systems (e.g. Chad) to more commercialized and intensive operations (e.g. Argentina).

Differences in household-level economic outcomes further highlight differences between regions. Annual gross income per household in Argentina (USD 20,574) is more than four times higher than in Chad (USD5,454) or Mongolia (USD 4,773), indicating significant variation in productivity and value addition. Production costs also differ greatly, with higher input intensity in Argentina (USD 1,875) compared to Mongolia (USD 283), underscoring differences in technological adoption and system intensification. Beyond forage production, rangelands provide vital ecosystem services such as carbon sequestration, water regulation, and biodiversity conservation.

TABLE 4 Rangeland Realities in the Sahel, Argentina, and Mongolia

Source: Wane et al. (2020), Ndiaye et al. (2025), and Wane et al. (2024)

Country	Average Country Herd (TLU/ LSU)	Average Annual Gross Revenue (USD)	Livestock Revenue Share (%)	Other Monetary Revenue (%)	Self-Consumption Share (%)	Average Annual Prod Cost (USD)	GDP Contribution (Market only) (%)	GDP Contribution (with self-consumption) (%)	Gini Index (%)
Burkina Faso	48	3,040	71	18	11	601	8,6	13,3	>50
Mali	61	3,112	73	15	12	622	10,6	15,2	>50
Mauritania	54	5,518	85	9	6	2,051	5,9	9,2	>50
Niger	34	2,876	85	5	10	593	8,9	13,6	>50
Chad	192	5,454	54	16	30	1,467	11,0	27,0	<50
Mongolia	78	4,773	74	16	10	283	9,6	11,9	>50
Argentina	65	20,574	37	28	35	1,875	0,6	1,4	>50

10 Data for Mongolia and Argentina were reported in Standard Livestock Units (SLU) in the original research. We have converted the data to TLU using a rate of 1 SLU ≈ 2.2 TLU.

However, access to these resources remains highly unequal, as shown by high Gini indices. In this context, inclusive and sustainable rangeland management policies are essential to strengthen the resilience of pastoral systems against environmental, economic, and social challenges.

The interactions between livestock-based human activities and rangeland ecosystems are dynamic and ongoing, characterized by complex trade-offs and hidden synergies in different forms. Livestock management practices significantly impact the ecosystem services provided by rangelands and face multiple threats, including climate change and increased competition for land resources. Well-managed rangelands foster a positive cycle of nutrient recycling, biodiversity conservation, and enhanced ecological and agricultural synergies, thereby strengthening ecosystem resilience and productivity. However, poor management practices, such as overgrazing, improper land use, and inadequate water resource management, can lead to soil degradation, decreased forage availability, and harm to biodiversity. Therefore, **adopting a balance that maintains productive and resilient ecosystems is crucial for ensuring the continued delivery of ecological, economic, and socio-cultural functions associated with rangeland-based systems.**

3. Investment for Rangeland Restoration

3.1 Perceptions and Understanding of Rangeland Values

The multiplicity of rangeland values may be perceived and prioritized differently by different actors, creating potential disagreement over investment pathways. The evidence presented above clearly highlights the economic and environmental values of rangelands, although some actors see trade-off between these values. Rangelands also have significant social and cultural values that are intrinsically important as well as being instrumental for sustainable rangeland management.

Investment in rangeland restoration is constrained by lack of clarity over the diversity and magnitude of rangeland values and challenges in measuring some of those values. Investments are also sometimes constrained by doubt over the roles of pastoralist culture and livestock management in safeguarding ecosystem services and the most appropriate ways of investing in pastoralist peoples as custodians of those services. Failure to quantify the true value of rangelands can lead to an underinvestment in these important ecosystems. Different perceptions of value between pastoralists and rangeland investors may lead to disagreement over investment priorities and a mismatch of expectations.

There is a compelling case for investment in rangelands to achieve combined social, economic and environmental goals. Healthy rangelands are productive landscapes that are an important source of feed for livestock and generate a significant share of the world's food supply (Brander et al. 2024). The animals that graze and browse on these rangelands produce valuable raw materials such as different types of meat, milk and fibre. Furthermore, the rangelands deliver critical ecosystem services such as carbon sequestration and maintaining soil fertility, water regulation and biodiversity conservation (Brander et al. 2024).

The value of rangelands is significant given their vast area, their environmental importance for the environment and the variety of services they provide. Many of these, such as cultural heritage or climate resilience, are public goods that are not easily priced even though they may be of high value (Davies et al. 2015). Investing in rangeland restoration presents a strategic opportunity to achieve multiple global goals at once.

It is only through adequate valuation of rangeland ecosystem services that the full benefit of rangeland restoration can be understood. Failure to value important services is likely to contribute to failure to protect them and pastoralists may be less likely to value ecosystem services that are primarily enjoyed by others (e.g. downstream water supply or climate regulation) unless appropriate incentives are made available. These incentives could be critical for tipping the balance towards more sustainable rangeland management or for absorbing the costs associated with transitioning to more sustainable land management practices.

3.2 Pastoral Production and Relative Notions of Value

Pastoralism as both a production system and a way of life constitutes the primary mode of rangeland use for many communities (including agropastoralists, silvopastoralists and other subcategories). While pastoralism represents the principal means through which ecosystem services are economically exploited in most rangelands, the relative importance of different values displays significant regional differences. These differences are influenced by access to and dependence on markets and by cultural factors. Pastoralists in different countries lie along a gradient of market access, which is particularly influenced by the level of economic development of the country. Livestock play a critical role by converting coarse, low-quality forage, often unsuitable for direct human consumption, into nutrient-dense food products such as milk and meat. Consequently, livestock contributes substantially to food security in these areas and generates added economic value through the provision of marketable goods (Wane et al. 2020).

Beyond their primary production role, livestock serve many important environmental, economic, social, and cultural functions (Box 1). Environmentally, they help preserve biodiversity, manage landscapes, guide territorial planning, and care for natural resources. Economically and socially, they supply marketable livestock products, create jobs, generate income, and support regional links, such as the connection between Sahelian countries and West African coastal states. Culturally, pastoralism helps revive and pass down traditional knowledge and practices. Additionally, it promotes the sustainable use of marginal lands, which are often not suitable for other farming activities, thus providing a security function.

The multifunctionality of livestock, encompassing economic, cultural, agricultural, and nutritional aspects, creates values that vary significantly depending on the context. In Eswatini, for example, the importance of livestock varies by region, gender, and farming systems (► Table 5). For example, the role of rangelands in generating cash income is highest in peri-urban areas but less important in the more remote Middleveld. Men in peri-urban

The Western Kenya Soil Carbon Project (WKCP)

Beyond the extractive vision of livestock production, the sector's role in promoting rangeland health remains largely overlooked. The perception of livestock as merely a greenhouse gas (GHG) emitter reached its peak with the publication of Livestock's Long Shadow, which identified the livestock sector as responsible for 18 % of global GHG emissions measured in CO_2 equivalents. The assertion that livestock plays an even larger role than the transport sector left a lasting impression.

However, such framing underestimates the multiple functions of livestock, particularly in low- and middle-income countries (LMICs), as well as the significant role of grazing and mobility in promoting rangeland health and carbon sequestration and storage. Mobility of herds (domestic or wild) can contribute in multiple ways to rangeland health – through nutrient cycling, vegetation dynamics, seed dispersal, and landscape maintenance – even if these processes can be further optimized in some countries. In most cases, rangeland restoration and sustainable rangeland management requires organised management of herds to ensure sufficient grazing at the right time combined with periodic rest to optimize the benefits of herbivore interactions.

TABLE 5 Perceptions of livestock values in Eswatini's rangelands

Source: (Morton et al. 2025)

Rank	Highveld Peri-Urban		Middleveld		Plateau		Highveld Rural		
	Men	Women	Men	Women	Men	Women	Young Men	Older Men	Women
1	Income	Income	Bridewealth	Ploughing	Income	Assets/ Wealth	Income	Wealth/ Assets	Ploughing
2	Assets	Milk	Ploughing	Manure	Assets/ Wealth	Income	Bridewealth	Income	Manure
3	Cultural Reasons	Meat	Manure	Milk	Meat	Milk	Cultural Reasons	Bridewealth	Income
4	Bridewealth	Ploughing	Rituals and Fines	Income	Milk	Meat	Ploughing	Ploughing	Milk
5	Ploughing	Manure	Milk	Rituals and Fines	Bridewealth	Cultural Reasonsc	Manure	Cultural Reasons	Bridewealth
6	Milk	Assets	Meat	Bridewealth	Manure	Manure	Meat	Milk	Wealth/ Assets
7	Manure	Skins	Income	Assets	Ploughing	Ploughing	Milk	Meat	Cultural Reasons
8	Meat	Cultural Reasons	Assets	Meat	Cultural Reasons	Bridewealth	Wealth/ Assets	Manure	Meat
9	Skins	Bridewealth	Skins	Skins	Skins	Skins	Skins	Skins	Skins

areas also place greater emphasis on security whereas women place greater value on milk, highlighting their role in managing and marketing milk. In most areas men place greater value on generation of bridewealth and providing security, whereas women prioritize using manure for home gardens and directly consuming meat and milk. These differences highlight the diverse and context-dependent values that livestock keepers attribute to cattle.

3.3 The Investment Case for Rangeland Restoration

Rangelands provide a wide portfolio of values, including pastoral products such as meat, milk, fibre that are the backbone of many rural economies. Rangelands also yield wild foods, medicinal plants, honey, gum, and other non-livestock products. Many rangeland regions are rich in biodiversity and possess cultural and natural heritage that attracts tourism, while their climatic features make many rangelands suitable for implementing renewable energy solutions (Davies 2024). These multiple value streams can operate in parallel under sustainable and multi-use management. Restored rangelands can therefore support complementary value chains, strengthening the case for investment.

Recognizing synergies and co-benefits between the different value propositions is key to make a viable case for investing in rangeland restoration. Investors can combine revenue streams to improve returns because rangelands can produce a bundle of ecosystem goods and services. A single restoration initiative might generate income from livestock production, carbon credits from soil carbon sequestration, biodiversity credits or wildlife conservation payments and eco-tourism fees (Brander et al. 2024). Combining these revenue streams can, for example, increase overall returns or brand value and diversify risk. ► Figure 2 illustrates how

multiple values or returns can be realized through livestock and non-livestock products, ecosystem services and supplementary services by investing in rangeland restoration.

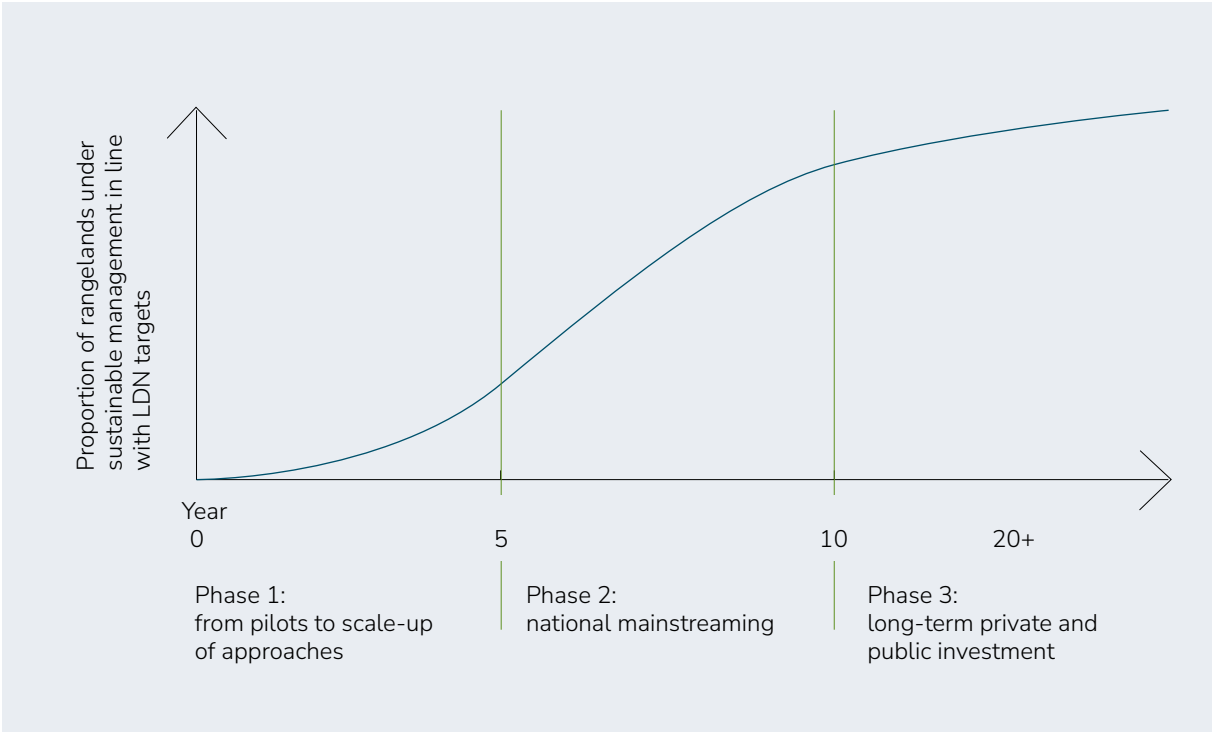
Improved grazing and rangeland rehabilitation can increase yields, which at current market prices could translate into increased revenue for producers. This combined with other revenue streams, such as carbon and biodiversity credit sales, can create an appealing investment case. An example from the South African mohair industry demonstrates the potential of restoration. The Mohair Restoration and Regenerative Land Management Project led by BKB & H&M together with Mohair South Africa (Mohair South Africa 2025) integrated pasture improvement, soil restoration and fibre quality enhancements to secure sufficient fibre supply while improving the livelihoods of mohair farmers. This shows how private sector actors and value chain partners can co-invest in ecological restoration, while improving profitability and supply chain resilience.

FIGURE 2 Making the business case for investing in rangelands (ICIMOD 2024)

Scaling up rangeland restoration and sustainable management requires a long-term plan to move from pilot projects to larger landscape projects to national mainstreaming of approaches. This transition involves phased investment and often starts with donor or publicly funded pilots, moving into blended finance approaches and ultimately engaging private capital to scale the investment, as illustrated in **Figure 3**. At each stage, it is essential to identify the most appropriate types of investment and to develop financing approaches and mechanisms that match the scale, objectives and risk profile of the intervention. Equally important is the need to build on and capitalize the existing investments made by rangeland managers themselves, ensuring that their contributions form a foundation for scaling up and attracting additional capital.

Minimum scale is critical to attract larger investors because restoration generates higher transaction costs at small scales. Implementation at scale helps to reduce cost per hectare and spread fixed cost. Monitoring, reporting and verification (MRV) systems are also essential for performance-based finance, enabling investors to trust reported outcomes and secure payments linked to carbon or biodiversity benefits. To bring the investment case to realization, rangeland restoration initiatives must be built on solid investment models with relatively predictable returns, and long-term investment partners should be involved as early as possible, even in Phase 1 projects (**Figure 3**).

FIGURE 3 Transitioning from rangeland restoration projects to investments



3.4 Who Invests and Why?

Investment in rangeland restoration can come from a diverse range of actors with different motives for investing. Governments invest in rangelands to secure public goods such as food security, economic resilience and reduced disaster risk (UNEP, 2024). The private sector including agribusinesses, carbon developers, fashion brands, and renewable energy companies seeks financial returns and secure value chains (Wane 2023). The Resilient Threads program in Mongolia supported by LVMH (LVMH and Loro Piana 2025) links cashmere production with rangeland restoration and improved herder livelihoods. Pastoralist communities are a kind of co-investor through their labour, knowledge and social capital. Indigenous breeds, locally adapted rangeland management and governance are central to how they invest in rangeland restoration. Recognizing these contributions and priorities of the involved stakeholders is key to designing investment cases (Wane et al. 2020).

Impact investors and the development sector are increasingly interested in nature-positive portfolios that deliver measurable social and environmental outcomes alongside financial returns. Combining types of investment and investor can create robust structures that merge the scale and risk-sharing of public and private capital with community ownership and concessional capital. Despite the interest of these different stakeholders to invest in rangeland restoration, it seems that rangelands receive little funding compared to other ecosystems such as forests and agricultural lands, which dominate current nature-based solution finance flows (Mulder et al. 2021).

3.5 Returns, Risk Mitigation and Value Stacking

> Investors in rangeland restoration can receive both financial and non-financial returns.

Financial returns include higher livestock productivity, income from carbon and biodiversity credits and cost savings from improved land management (Davies 2024). Non-financial returns include job creation, poverty reduction, cultural preservation, biodiversity recovery, water regulation and climate resilience (Brander et al. 2024). Monetizing these non-financial returns may prove challenging, but they may contribute to enhanced resilience and reduced risk, or to enhancing brand value for investors. The mohair example mentioned earlier highlights how value stacking enhances returns: income from sale of fibre is complemented by emerging revenue from carbon and biodiversity credits while restored landscapes have greater land value and lower drought risk.

Investors need greater certainty over the length of time between investment and return on investment, and many existing studies are unclear on this matter. Investors may consider slower returns on investment, if they still offer an acceptable internal rate of return, but may expect greater returns according to the higher levels of risk implicit in slower returns on investment. While some projects may begin delivering rangeland restoration in the first year, it may take longer before these improvements in rangeland production translate into increases along value chains. Other approaches may take longer to deliver rangeland restoration, or may see returns on investment rise incrementally over time, raising questions about internal rates of return discounted over time.

Key risk factors include climate variability, market volatility and tenure insecurity. These can be mitigated by diversifying revenue streams, applying insurance mechanisms such as Index-Based Livestock Insurance (Jensen et al. 2025) securing land tenure, abiding by Free, Prior and Informed Consent or FPIC (IUCN 2022), and implementing robust monitoring, reporting and verification (MRV) systems to provide confidence in reported results. Furthermore, the appropriate methods need to be applied depending on the geographical areas etc. to reduce the of risk of rangeland restoration investment projects.

The credibility of rangeland restoration investments, and the confidence of investors, can be built by aligning projects with established global benchmarks, such as the IUCN Global Standard for Nature-based Solutions (NbS) (IUCN 2020). The NbS Standard ensures biodiversity gains (such as species recovery, soil health, and enhanced ecosystem services), climate benefits (including carbon storage in soils and grasslands and drought resilience), and economic returns (such as livestock value chains, carbon credits and eco-tourism). Rangeland restoration can qualify as an NbS according to the United Nations definition by emphasizing it simultaneous contribution to climate change mitigation and adaptation, biodiversity conservation, and resilient livelihoods. NbS are defined by the UN as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits". These approaches are explicitly designed to safeguard the rights of communities and indigenous peoples (Ministerial Declaration of the United Nations Environment Assembly at Its Fifth Session: Strengthening Actions for Nature to Achieve the Sustainable Development Goals 2021).

3.6 Financing Options and Innovative Approaches

A range of financing mechanisms is emerging that can unlock larger and more sustained investment in rangeland restoration. Climate and nature finance, including carbon credits, biodiversity credits and emerging Land Degradation Neutrality instruments, is becoming increasingly relevant as global markets for environmental services expand (UNEP 2024). These mechanisms channel capital into restoration by monetizing measurable ecological outcomes. Philanthropic organizations and development agencies often provide catalytic capital for pilots or early-stage projects, which can later be scaled through private investment (Davies 2024).

Mainstream investment in primary value chains such as livestock production remains a central pathway for mobilizing finance. These sectors already attract significant capital but are not always linked to positive environmental outcomes. **Investment in sustainable livestock systems, for example through improved rangeland management practices, can align commercial objectives with restoration targets and secure long-term returns for both investors and producers**. Among the expanding suite of private market instruments, green and impact bonds link investor returns to verified environmental and social outcomes, providing a fixed-income vehicle that funds restoration. Debt-for-nature swaps restructure a portion of a country's sovereign debt in exchange for commitments to invest in ecosystem protection and restoration. Value chain finance enables companies to pre-finance restoration activities to secure sustainable supplies and meet sustainability targets, often using forward contracts or offtake agreements. Blended finance combines donor grants, concessional public funds and private capital to reduce risk and improve the risk–return profile for investors (OECD 2024). Index-based insurance pays out based on climate or production indicators, offering a safety net for producers in highly variable environments (Jensen et al. 2025).

Bundling ecosystem services in a restoration initiative can develop multiple revenue streams from different services. This can improve returns and spread risk and therefore make it less risky for investors. For example, one project might integrate livestock productivity gains with carbon credit sales from soil carbon sequestration, biodiversity credits for habitat restoration and lease income from renewable energy installations. In the United States, wind energy on ranch lands generates over USD220 million per year in payments to landowners (American Energy Action 2016). Appropriate restoration approaches are essential to securing these returns. Participatory Rangeland Management (PRM) is one example: a community-led process to improve the governance and management of rangelands, supported by facilitators and technical advisors (Wane 2023).

Matching the restoration approach to the type, size and location of the rangeland helps ensure ecological effectiveness and investor confidence. Clear accounting, robust MRV and legal certainty are necessary to safeguard the credibility of reported results and the security of payments. Practical examples illustrate how these mechanisms work in practice. The Silvopastoral Systems Project in Colombia discussed below shows how farmers can receive payments for tree-based grazing that improves productivity, sequesters carbon and enhances biodiversity (IFPRI 2025). Alongside value chain initiatives such as LVMH's and Loro Piana's Resilient Threads in Mongolia and the Mohair Restoration and Regenerative Land Management Project in South Africa, these cases show that diverse and well-structured financing models can mobilize investment at the scale needed for meaningful rangeland restoration (LVMH and Loro Piana 2025).

4. Costs and Benefits of Rangeland Restoration

The merits of investing in rangeland restoration depend on the costs of action and the benefits that accrue from investment. Historically, the lack of agreement over how to restore rangelands at scale and in a cost-effective manner has been a major impediment to rangeland restoration. The past decade has seen a steady increase in the number of rangeland restoration projects, as illustrated by the case studies in Sections 4.3 – 4.10, but these interventions often lack adequate cost-benefit analysis. Estimates of the cost of rangeland restoration is often misleading, particularly when restoration actions are subsumed within much larger development projects, while measurement of the benefits is usually incomplete.

Estimates of the cost of rangeland restoration vary greatly. A review of the global cost of international commitments on land restoration (Verhoeven et al. 2024) examined 243 restoration projects in all landscapes (i.e. not exclusively rangelands) and found a median cost of USD1691/ha. Among the rangeland restoration examples in the study, silvopasture restoration was found to have the highest implementation cost at USD3012/ha, while passive regeneration and grazing management were among the lowest (USD513/ha and USD631 /ha respectively). Passive solutions include enhancing herd movements to enable natural regeneration of pastures, which can work on a large scale in areas of comparatively low degradation, whereas active solutions like earth soil and water structures are needed for advanced and severe rangeland degradation and are likely to be more costly and more limited in scale.

The study found that the cost of restoration is influenced by several factors including:

1. Type of restoration (i.e. physical infrastructure, such as irrigation or earthworks, is more expensive than passive or assisted regeneration),
2. Geographic and economic context (higher labour and material costs in wealthier countries),
3. Project scale (economies of scale for large projects).

A global review of restoration projects in nine biomes found that grasslands have the highest restoration benefit-cost ratios, ranging from 4:1 to 35:1 and the highest internal rates of return, between 35% and 58% (De Groot et al. 2013). The wide range of cost-benefit estimates reflects significant differences in approaches and contexts. For example, the highest return reflected the low cost of community-based natural regeneration in Jordan's Zarqa catchment and the high value of enhanced hydrological services in an arid landscape that feeds into a major hydro-electric facility (Westerberg and Myint 2014). This underscores the need for improved and context-specific measurement of costs and benefits and deeper insights into the factors that cause such significant variance.

4.1 Differentiating Types of Rangeland Degradation and Restoration

Assessment of rangeland degradation at global and national level is inconsistent and leads to widely divergent estimates of restoration opportunities. This creates a challenge for investors to follow the LDN response hierarchy, which recommends prioritizing avoidance of degradation, followed by actions to reduce and finally to restore degraded lands (Orr et al. 2017). Assessments use different methodologies and include or exclude different ecosystem services. Policy interventions often remain uncoordinated and reactive due to the absence of a standardized typology that distinguishes among degradation forms and their underlying causes. The lack of such differentiation also makes it difficult to quantify the costs of restoration or the returns of investment, which limits the mobilization of investments and public-private financing for sustainable rangeland management.

Rangeland degradation has been defined as a persistent decline in the capacity of rangeland ecosystems to provide their key services, such as biomass production, biodiversity support, and soil and water regulation (Reynolds et al. 2007; Briske et al. 2017). However, state-and-transition models concerning rangeland dynamics indicate that persistence is more indicative of the existing management practices than a permanent state (Briske et al. 2005). Frequently, rangelands transition into alternative states, such as those dominated by woody plants or invasive species, which may be challenging but not impossible to reverse. Consequently, degradation may endure only as long as poor management persists, and recovery can be facilitated through specific interventions. This establishes a basis for a typology that can differentiate degradation pathways and inform more effective restoration and management approaches.

While regional expressions vary, five overarching drivers of rangeland degradation are observed globally, which in many cases may act in concert:

4.1.1 Unsustainable livestock management

Chronic overstocking and loss of mobility concentrate grazing, reduce rest periods and accelerate vegetation loss. In Mongolia, the transition to a market economy in the 1990s led to the privatization of livestock while land remained under state ownership. This created an open-access dynamic where herd sizes tripled – from 23 million in the early 1990s to over 66 million by 2023 – exceeding the country's ecological carrying capacity. The collapse of the traditional otor (seasonal migration) system and increased sedentarization concentrated grazing around water sources and settlements, leaving remote pastures underutilized. In response, policies emphasized destocking and rotational grazing to restore degraded areas. Despite these efforts, an estimated 65 % of Mongolia's rangelands are degraded, and herders report a 26% decline in per-animal income due to reduced pasture quality (Densambuu et al. 2018).

Estimates of land degradation in Mongolia vary greatly: 78.6 % of total land was degraded according to the National Desertification Atlas in 2020 but 13 % was estimated as degraded according to the UNCCD PRAIS reporting system. Estimates vary because different studies interpret degradation in various ways and combine inputs that cannot be compared, such as indicators (like vegetation cover, productivity, and soil), thresholds and baselines/time frames, spatial scales (like plot, pixel, or aimag), and methods (field versus remote sensing). Furthermore, significant yearly climate fluctuations and alternative stable states make it hard to identify and interpret trends. In Mongolia, the lack of consistent ground-truth data, the concentration of grazing near water sources, and other specific contextual factors render the main figures dependent on the method used and not easily comparable.

4.1.2 Land use change and fragmentation

Agricultural frontiers and infrastructure carve rangelands into isolated patches, blocking traditional migration and undermining ecosystem connectivity. Between 2000 and 2015, the Sahel experienced a rapid expansion of rain fed agriculture, with an estimated 12 million ha of natural grasslands and shrublands converted to cereals and oilseeds – representing nearly 10 % of the region's pastoral rangelands (Curtis et al. 2018). This agricultural frontier has sharply reduced contiguous grazing areas, disrupted long standing transhumance corridors, and forced herders to concentrate livestock in smaller enclaves near water points. Field studies in Burkina Faso and Niger document 20 – 40 % declines in pastoral mobility and 30 % increases in localized overgrazing, exacerbating soil compaction and erosion (Herrmann and Tappan 2013). The shift toward cropping not only fragments habitats but also undermines the adaptive capacity of pastoral societies, as farmers and herders increasingly compete for diminishing land and water resources. Fragmentation of rangelands has also been driven by infrastructure development, imposition of administrative and national borders, and by veterinary or wildlife fences (Galvin et al. 2008).

4.1.3 Bush encroachment and alien invasive species

Altered fire regimes and grazing pressures facilitate woody plant proliferation, transforming grasslands into low-forage scrublands. Across the West African Sahel, long term field and remote sensing studies document widespread increase in woody shrub cover at rates of 0.7 – 1.1% yr^{-1}, particularly following reductions in fire frequency and heavy grazing (Eldridge and Soliveres 2015). Applied to the Sahel's ~ 200 million ha of dry savanna, this implies that 14 – 22 million ha of grass dominated rangeland have transitioned toward shrub encroached systems since the 1980s. The IPBES Assessment (Montarella, et al. 2018) identifies bush encroachment as a key degradation form in the Sahel, linking it to declining forage quality, loss of herbaceous biodiversity and altered fire regimes. In southern Niger's Gourma region, transect surveys reveal a 35% decline in perennial grass cover and a 40% rise in Acacia and Combretum shrub density, undermining traditional pastoral grazing patterns and forcing herders to travel farther for forage. This shift not only reduces livestock carrying capacity but also changes soil moisture dynamics, increasing vulnerability to drought and erosion.

4.1.4 Climate variability and change

Dryland regions are warming 1.5 times faster than the global mean and heightened drought frequency, dust storms and compound extreme climate events can tip systems past resilience thresholds. Climate change in China has been observed to cause gradual increases in aridity that have resulted in abrupt decreases in productivity, soil fertility and plant richness in rangelands. Increasing grazing pressure lowered the threshold of ecological change illustrating how ecological thresholds can be amplified by the combination of aridification and grazing pressure (Li et al. 2023).

Climate change has increased the frequency and intensity of "Dzud" events in Mongolia – compound winter–summer extremes characterized by thin, icy snow cover in winter followed by below average precipitation in spring and summer. These compounded stresses prevent pasture recovery and concentrate livestock around scarce forage. Between 2000 and 2020, five major Dzuds each resulted in national herd losses exceeding 20 %, with mortality peaking at over 30 % in the harshest years. Meat, milk and fibre productivity declined among surviving herds. Satellite derived NDVI analyses show that vegetation recovery post Dzud is up to 30 % slower on overgrazed sites compared to rested reference areas (Hilker et al. 2014). The traditional 'otor' migration system – which once spread grazing pressure seasonally – has been

largely abandoned, intensifying livestock concentrations near settlements and water points during Dzud years (Fernandez-Gimenez and Allen-Diaz 1999). Without strategic destocking and the reinstatement of seasonal mobility, Dzud events can push degraded pastures into long term, low productivity states, imperilling both ecosystem resilience and herder livelihoods.

4.1.5 Governance and policy failures

Weak and changing property rights, lack of communal tenure security and sectoral policy biases undermine sustainable management. As in many countries, rangeland degradation in Kyrgyzstan was driven by breakdown in communal herding strategies, reduction in herd mobility, and abandonment of remote pastures. Kyrgyzstan's 2009 Pasture Law enabled the formation of over 200 Community Based Pasture Associations (CPAs) managing some 3 million ha of communal rangelands and representing over 60,000 pastoral households (Kerven et al. 2021). These CPAs establish rotational grazing plans, maintain water infrastructure, and enforce by laws – actions that have reduced localized bare soil patches by 45% and increased perennial grass cover by 25% within five years of establishment (Sayre 2023). By securing seasonal grazing rights and fostering cooperation among herders, pasture associations have reconnected traditional migration routes, alleviating pressure hotspots around settlements and improving overall pasture condition. Their success illustrates how targeted governance reforms can reverse degradation and generate significant ecosystem service benefits at minimal cost.

4.2 Identifying Restoration Approaches According to Type of Degradation

Rangeland degradation can be summarized in four interlinked categories, each with distinct drivers and remedies as shown in **Table 6** (Eldridge and Soliveres 2015; Reynolds et al. 2007; IPCC 2019; D'Odorico et al. 2010). By diagnosing the dominant degradation type in a locale, practitioners can prioritize interventions – for example, fire reintroduction in shrub encroached savannas versus micro catchment works in erosion prone sites (Eldridge and Soliveres 2015).

TABLE 6 Typology of rangeland degradation and restoration

Type	Key Symptoms	Primary Drivers	Restoration Focus
1. Change in vegetation Composition	Productivity decline, species diversity loss, species composition shift	Grazing mismanagement, fire suppression, invasive species	Improved grazing timing, managed rest periods, controlled burns, reseeding
2. Soil Erosion & Fertility	Bare patches, gully formation, nutrient depletion, loss of soil organic carbon	Rainfall impact, trampling, tillage	Mulching, erosion control structures,
3. Land Use Conversion and Fragmentation	Loss of contiguous rangeland, blocked grazing routes	Cropland expansion, mining, infrastructure	Spatial planning, corridors, offsets
4. Climate Amplified Stress	Recurrent forage collapse, desertification hotspots, drought vulnerability	Heatwaves, shifting rainfall, compound extremes	Early warning systems, climate smart grazing, water harvesting, flexible stocking

TABLE 7 Estimated global extent of four rangeland-degradation types

Degradation Type	Area Impacted (Million ha)	% of Global Rangelands	Key Metric	References
1. Change in vegetation Composition	≈ 300	10–15%	0.5–3.3% yr^{-1} woody encroachment	Stevens et al. (2016)
2. Soil Erosion & Fertility	800–1,000	20–25%	4.4 Gt CO_2 eq. yr^{-1} from soil C loss	Montarella et al. (2018)
3. Land Use Conversion and Fragmentation	200 (conversion) + 50–100 (fragmentation)	5–10%	230 M ha cropland expansion (2000–15)	IPCC (2019)
4. Climate Amplified Stress	2,160 (54% pastures degraded)	50–60%	54% of pastures degraded	Vicente-Serano et al. (2024)

Table 7 provides global estimates of the extent of the major types of rangeland degradation, offering the numerical basis for prioritizing global actions and performing improved economic valuation. Further work is required to ascertain realistic costs of appropriate restoration actions for each type of degradation. By linking each type of degradation to both its area and proportion of the global rangeland, economists can create cost–benefit models, direct investment resources, and customize policy tools according to the extent and seriousness of each degradation category.

The following case studies provide examples that illustrate the different types of rangeland degradation presented above, and a range of different restoration responses. They include estimates of implementation cost but several of the examples lack data on the benefit, or provide only partial data, for example related to a narrow sub-set of values. Some case studies provide inspiration that frequently overlooked values (e.g. cultural values) can be quantified to inform decision making. While the case studies are informative, they also underscore the need for more systematic cost-benefit analysis to give confidence to investors.

4.3 Pasture Regeneration in Tajikistan

Rangeland degradation in Khatlon was traced to livestock concentrating near villages rather than overall over-stocking. IFAD supported Pasture Users' Unions (PUUs), rotational plans across multiple grazing units, water infrastructure, and winter fodder to relieve early-season pressure. In Momirak (Muminobod), herd sizes grew ~25% from 2014–2017 under supervised rotations. Using an ex-post quasi-experimental impact assessment covering 82 communities and ~1,500 households, IFAD estimated large productivity gains versus matched non-beneficiaries: cattle average weight +30%, annual milk production +120%, milk productivity +99%, and livestock income +~110% (no effect on total income). Among women-headed households: milk production +19%, livestock sales value +80%, crop income +114%. IFAD does not report per-hectare implementation costs for rotations; however, the completion analysis shows an economic internal rate of return of 24% (ex-post) on a USD 26.16m programme over 4 years, indicating strong net benefits relative to costs (Cavatassi and Mallia 2018).

4.4 Invasive Species Removal in Kenya

The Kalama Community Wildlife Conservancy in Northern Kenya occupies 9,500 ha and is affected by encroachment by invasive Acacia reficiens trees. The community was supported to remove trees and reseed with Cenchrus ciliaris grass on 3,100 ha, allowing resting and reduced grazing pressure to rehabilitate degraded communal grazing land. Acacia reficiens is a native tree that can encroach degraded areas with bare and disturbed soil, creating a closed canopy that inhibits grass growth and hinders animal access, rendering areas inaccessible for grazing and browsing. The topsoil in heavily encroached areas becomes compacted or forms crusts, which hinders infiltration of water and during heavy storms 60 – 80 % of the rainfall is lost as runoff, increasing soil erosion and further degrading the land. Rangeland grass and fodder productivity in these areas are reduced to a fraction of their potential. The cost of regeneration was USD 12,700 for 55 hectares, or approximately USD 230 per hectare (over an unspecified period), which consisted mainly of labour costs (this was considerably below the lowest figure in the global analysis by Verhoeven et al. 2024 cited above). No maintenance costs were incurred, although restored land must continue to be managed through sustainable grazing (Wells 2021).

4.5 Rangeland Rehabilitation in Tunisia

Tunisia faces significant economic and environmental impacts from land degradation, resulting in an annual cost of approximately USD2.83 billion, equivalent to 4.58 % of its GDP. This degradation results in the depletion of key resources, including an annual loss of 1.28 million tons of crops, 9,500 tons of forest biomass, and 3.56 billion cubic meters of water, which accounts for up to 39.51 % of the total supply. Additionally, 658,000 tons of soil are lost, leading to 470,000 tons of CO_2 emissions. Tackling this challenge has been estimated to require a strategic investment of USD 560 million over ten years, aimed at just 12 % of the identified degradation hotspots. This analysis includes all types of land and land use, but the dominant land category in Tunisia is rangeland. This investment is expected to generate USD1.49 billion annually, showing an impressive return of USD 22.39 for every dollar invested. Key restoration strategies include reforestation, rotational grazing, soil conservation, payments for ecosystem services, and community-led governance. By classifying land value into use (direct and indirect) and non-use values, focusing on carbon sink potential, and using both market and non-market valuation methods, the study highlights a cost-effective approach to reversing land degradation while promoting long-term ecological resilience and socioeconomic benefits (Yigezu et al. 2025).

One positive example of rangeland restoration in Tunisia was achieved by reaching agreement between herding communities to suspend grazing for 2 – 3 years to allow pasture to recover. Achieving this community agreement was far more cost effective than installing costly fencing. Herders committed to respect the protection of the site during the fixed period in return for a subsidy of USD70 or barley to compensate for the loss of production during this period. The resting period was adequate to allow recovery even in heavily degraded rangelands, providing a remnant of key range species and a remaining layer of soil were present. Total cost of the approach, including technical support, was estimated at USD61 per ha to initiate and USD70 in annual subsidy (Ben Zaied 2011).

4.6 An Ecosystem Perspective on Climate-Smart Pastoralism in the Sahel

The Sahel's sylvo-pastoral system – a mix of trees, shrubs, and grazing animals – supports millions of people across the region. It provides up to 70% of the milk and over half of the red meat consumed, playing an essential role in food security and rural livelihoods. Despite its significance, this system is often seen as a major contributor to greenhouse gas emissions. However, a detailed year-long study measuring all greenhouse gases – methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O)– along with carbon captured in soils, trees, and shrubs, tells a different story. The system's annual carbon emissions, estimated at 0.71 tons per hectare, are balanced by carbon storage of about 0.75 tons per hectare.

This results in a small net carbon gain of roughly 40 kilograms per hectare per year, meaning the system stores more carbon than it releases. Notably, trees and shrubs account for 68 % of this carbon storage, while soils are the primary source of emissions. By revising methane emission figures for livestock, previous estimates for Sahelian cattle can be reduced by half. Based on these insights, several practical strategies can be developed to reduce emissions further and improve sustainability. These include better management of manure near water sources, using anaerobic digestion to transform waste into biogas and fertilizer, harvesting surplus forage to slow seasonal animal migrations (transhumance), and maintaining herd mobility. Implementing these measures could boost productivity and income for pastoral communities, enhance climate resilience, protect local biodiversity, and create opportunities for carbon financing through programs like the Great Green Wall initiative and the Koronivia Joint Work on Agriculture (Assouma et al. 2019).

4.7 Reviving Al Hima for Rangeland Restoration in Jordan

Rangelands in Jordan's Baadia region are widely affected by land degradation, characterised by reduction in vegetation productivity and species diversity. Land degradation contributes to greenhouse gas emissions, loss of biodiversity, and economic impacts such as reduced livestock production, increase vulnerability to drought, and siltation of reservoirs which reduces hydroelectric capacity. Restoration was achieved by enabling community groups to protect rangelands by establishing al hima, a traditional practice for protecting seasonal grazing areas that is known throughout the Arab region and has analogues in several other regions. The cost of restoration was low and primarily consisted of training and vegetation monitoring by the Ministry of Agriculture and rangeland surveillance by the local community. Implementation of scaling up to the entire catchment was estimated to cost USD 11.8 million[11], while the net present value of benefits of restoration to pastoral communities in the Zarqa River Basin was estimated at USD 9.5 million if they bear the management costs, whereas the benefit to Jordanian society was estimated at USD205 million (at an 8 % discount rate). The greatest benefit would be generated by additional groundwater infiltration (87 %) followed by natural forage production (10 %) and minor benefits from carbon sequestration, avoided reservoir sedimentation, and production of biodiversity with market value, such as medicinal plants. Total benefits were estimated at 18 times greater than implementation costs over a 25-year period (Westerberg and Myint 2014).

11 Converted from Jordanian Dinar at the rate of 1.42:1 according to the exchange rate at the time of study

4.8 Silvo-Pastoral Systems in Colombia

Colombia has 38 million hectares of land under cattle ranching and faces pressure to raise more cattle while reducing its environmental impact. Cattle production has traditionally been developed by replacing native vegetation with monocultures of exotic grasses, which has contributed to soil degradation, loss of biodiversity, and significant greenhouse gas emissions. Silvo-pastoral systems are a more sustainable option where shrubs and trees like Leucaena are integrated with grasses.

Establishing silvo-pastoral systems can cost more than sowing a monoculture; for example, USD 814 per hectare versus USD 647. However, farmers can stock 33 % more animals per hectare and cattle grow faster, resulting in 49 % more beef production per hectare. Maintaining trees on pasture enhances soil health by boosting organic material and nitrogen, retains more water in the soil, and reduces erosion. Tree shade also helps cattle stay cool, improving their health and productivity. Silvo-pastoral systems provide further benefits to climate and nature, for example by creating habitats for pollinators and native species and reducing methane emissions, which has a value of roughly USD 24 per hectare annually.

Despite challenges such as higher initial costs, the need for more technical expertise, and difficulties accessing carbon credit markets, a silvo-pastoral system offers a sustainable, climate-friendly option for ranching in Colombia. It enables farmers to increase income while safeguarding the environment and advancing the country's goals to cut emissions and promote sustainability (Sandoval et al. 2023).

4.9 Land Treatments on Public Lands in the United States

Land treatments in the western United States typically consist of "active" restoration measures, such as contouring for soil stabilization, hand planting of seedlings or thinning and mastication for vegetation disturbance. They are implemented at variable scales, from less than 5ha to thousands of hectares for most treatment types. Treatment costs varied across treatment categories from an average USD 21 per hectare for aerial seeding to an average USD 373 hectare for soil stabilization. Treatment cost generally decreased with increasing treatment size, across all treatments. Costs for prescribed burning and weed control were both estimated as less than USD 20 per hectare, whereas soil stabilization and vegetation disturbance both were estimated at about USD 59 per hectare. The lower cost treatments required less labour, for example spraying herbicide for weed control, aerial reseeding, or prescribed burning (Meldrum et al. 2025).

4.10 Recreational Value of Drovers' Roads in Spain

Livestock routes or drovers' roads, known in Spain as cañadas, have been integral to transhumant pastoralism for decades. After decades of erosion, these routes began to gain protection in Spanish law, specifically Law 3/1995 which declared them as public goods. Implementation of this law led to the revival of the long-distance transhumance in Spain which generated benefits to livestock production and biodiversity (Guaita Pradas and Segura García del Río 2014).

A project was implemented to restore the Cañada Real del Reino de Valencia route for recreational purposes, and a contingent valuation method was

used to establish its economic value as a non-market good. This methodology internalises perceptions of environmental value and conservation of natural resources among other factors. Assuming a useful life of 25 years and a social discount rate of 5 %, the value of the Cañada Real del Reino de Valencia has been estimated at € 442 million, indicating the value which society places on the drovers' road. The research highlights the need for public awareness raising of the environmental benefits of protecting transhumance corridors as both cultural and environmental assets.

4.11 Observations, Data Gaps and Methodological Challenges

The rangeland restoration projects reviewed in this chapter illustrate the emergence of a body of good practice from which cost-benefit analysis can be drawn. Most rangeland restoration projects provide adequate data on the restoration outcomes, usually in terms of biophysical benefits, such as primary productivity, species recovery, and soil condition. However, some projects are vague on the cost of rangeland restoration, possibly because restoration outcomes are a minor component of a bigger project and the specific cost per unit of land restored is obscured by other project costs. Some projects appear to face a challenge of measuring the real costs of passive interventions, which relate primarily to the costs of extension, training, and coordination.

Several projects fail to evaluate the economic benefit of restoration and do not provide evidence of the impact of rangeland restoration outcomes on livelihoods or ecosystem service benefits. Other studies provide estimates for some of the economic benefits, but **there is a tendency to measure only a narrow set of values and therefore to under-value the ecosystem services that have been restored**.

Rangeland restoration projects must urgently provide evidence of the impact on all ecosystem services, as highlighted in ► Figure 1. At a minimum these benefits must be acknowledged in project evaluations and evidence of the economic value should be ascertained where possible.

Evidence supports the observation of Verhoeven et al. (2024) that **restoration costs benefit from an economy of scale**. This may be particularly true of passive restoration efforts that have negligible recurrent costs but have fixed costs associated with capacity building and coordination: costs which would not necessarily increase with scale.

Rangeland restoration costs are greater where more active intervention is required, for example to remove encroaching vegetation. Furthermore, the costs of passive regeneration must be factored into active restoration approaches because they ensure that land is managed sustainably after being restored.

Carbon returns on investment are low in some rangelands, particularly in the driest areas, and may not be attractive to companies that wish to offset large quantities. While carbon sequestration can be increased, for example using irrigation, soil amendments and tree planting, this is not consistent with sustainable rangeland management. However, **degraded rangelands offer the opportunity to sequester modest amounts of carbon over vast areas with high levels of permanence, and numerous co-benefits**, making them attractive if investments are approached appropriately and attached to other value chains. Carbon payments could provide valuable incentives to kick start transition to more sustainable rangeland management, but as with other ecosystems, soil carbon can become saturated and further carbon sequestration may not be feasible without transforming ecosystems.

Further insight is needed into the ultimate beneficiaries of rangeland restoration to disaggregate benefits that accrue directly to herders and benefits that are enjoyed by wider society. Those external benefits should be further disaggregated into domestic benefits, such as water supply, and global benefits such as climate change mitigation.

The societal benefits of rangeland restoration may help in valuing national rangeland restoration programmes and policies, which can deliver impact on a large scale but can be challenging to monitor. It is important to clearly and completely attribute impacts to interventions to avoid the risk of diverting investment to approaches based on their simplicity of measurement rather than their overall effectiveness.

Stronger cost-benefit analysis will help clarify the roles of public and private investors in rangeland restoration. Financial constraints have restricted public spending in rangelands, but governments need to examine the true value of rangeland restoration across multiple societal benefits and reconsider the importance of rangeland investment. Public investments can be made more attractive if they deliver both quantifiable public goods and pave the way for long-term private investment.

Insight is also needed into gender perceptions of ecosystem restoration benefits to herding communities. There is a tendency to focus on the value of rangeland restoration for livestock production and marketing while less attention is paid to other economic values, such as harvested natural products. These different rangeland values may trade off or they may be complementary, but the benefits may accrue to men and women differently and therefore restoration actions and value chain investments should be managed accordingly.

5. Enabling Rangeland Restoration Investment

> Effective policy responses to rangeland degradation must align legal, financial and institutional levers with on the ground realities,

moving beyond isolated interventions and embracing a holistic, typology informed framework. Policy bottlenecks such as insecure tenure, fragmented land use regulations, limited data on rangeland condition and weak cross-sectoral coordination continue to hinder investment. Addressing these barriers and investing in enabling infrastructure such as water, security and market access will increase investor confidence and the viability of long-term restoration efforts.

5.1 Strengthen Land Use Planning and Tenure Security

Secure land tenure and community rights, participatory planning and strong local institutions are vital for equitable restoration outcomes (IUCN 2022). Rangeland restoration usually requires large-scale action by communities, either to implement passive restoration measures or at a minimum to ensure actively regenerated land reverts to long-term sustainable management. Countries should recognize communal grazing territories and formally guarantee pastoralists' rights to seasonal pastures, thereby recreating the incentives for long term stewardship that traditional common property regimes once provided (Ostrom and Cox 2010). By developing legislation to implement public policies on land use planning and embedding rangeland rights in national land use plans, policymakers can prevent the fragmentation and enclosure of rangelands that so often precedes ecological decline.

5.2 Select Restoration Measures According to Improved Degradation Assessment

Investment strategies should be guided by improved diagnosis of restoration requirements in a target landscape, including prioritisation of active or passive solutions with different costs and benefits and involving different stakeholders. Conventional approaches to promoting restoration investment may not succeed in rangelands due to the complexity of rangeland systems and the disconnect between where investment is needed and where and when returns on investment can be derived.

5.3 Provide Economic Incentives

Economic incentives play a vital role and may be the entry point for public-private partnership. Payment for Ecosystem Services schemes and carbon credit mechanisms can channel private investment into sustainable grazing and restoration activities, rewarding herder cooperatives for maintaining soil carbon stocks, protecting water resources and preserving biodiversity (Nkonya et al. 2016). Blended finance models – combining public grants for governance strengthening with performance based payments – have demonstrated benefit–cost ratios of 3 – 5 times in Central Asian pilot programmes, illustrating how smart financing can amplify restoration outcomes (Mirzabaev and Akramkhanov 2025). Tax incentives can also be used to promote rangeland restoration. Mongolia's Corporate Income Tax Law introduces new incentives for private investment in social responsibility initiatives through which companies can invest up to 1% of their taxable income in corporate social responsibility (CSR) activities and receive a tax deduction (Batbold 2025).

5.4 Build Local Capacity and Governance Structures

Building local capacity and governance structures is a low cost, high impact strategy. Enhanced communal herd movement, conflict resolution, and infrastructure maintenance not only improve pasture condition but also foster community cohesion and resilience. Successful examples from East Africa and Mongolia show that when communities have secure rights and the skills to self organize, rangeland health indicators – such as vegetation cover and forage diversity – improve by up to 30% within five years (Sayre 2023).

5.5 Develop Market Infrastructure

Develop markets for a wide range of rangeland goods (of livestock and non-livestock origin) and develop legal frameworks that enable payment for other rangeland services. Investment strategies should anticipate generating a wide range goods and services that create a disconnect between points of investment and returns on investment. Investing in rangeland restoration can generate financial returns, support livelihoods and restore ecosystems. Rangelands are multi-functional assets and combined revenue streams can make these investments attractive. Returns can be competitive especially when supported by blended finance and cost-efficient restoration methods.

5.6 Promote Individual Value Chains that Support Rangeland Restoration

Investors in individual rangeland commodities can drive rangeland restoration, particularly where those commodities have particularly high value. The mohair restoration project in South Africa, co-financed by Mohair South Africa and brand partners, shows how private sector actors can invest in ecological restoration while securing fibre supply and quality. Similarly, LVMH's Resilient Threads program in Mongolia links cashmere production with rangeland restoration and herder livelihoods, demonstrating how corporate sustainability targets can drive substantial on-the-ground investment.

International standards and certifications can provide market access, increase brand reputation and demonstrate credible environmental and social performance. Initiatives such as Oritain's fibre traceability systems show how compliance with the EU Green Claims Directive and the Corporate Sustainability Reporting Directive (CSRD) can be

leveraged to comply with rules and regulations and enhance investor confidence as well as protect brand reputation.

5.7 Develop Innovative Financing Partnerships and Approaches

Successful rangeland restoration initiatives may depend on collaboration between a range of investors, including multiple private companies, communities, the public sector and philanthropic investors. Risks can be managed through diversification, insurance, tenure security and strong verification systems while supportive policies and governance unlock the potential for large-scale investment. Rangeland restoration can contribute to greater resilience and mitigating natural hazards, for example by safeguarding green water resources in drought prone regions. The insurance value of sustainably managed rangelands should therefore be better evaluated to inform insurance products and drought management programmes.

Innovative approaches to financing restoration are being developed and can be adapted and expanded for use in rangelands. Policy makers and project developers should pilot innovative financing approaches, improve monitoring and verification systems to reduce investor uncertainty, and align national policy frameworks with market incentives. By addressing these knowledge and policy gaps, the conditions for private sector investment in rangeland restoration can be significantly strengthened, unlocking greater capital flows and delivering long-term ecological as well as economic benefits.

5.8 Implement Appropriate Safeguards and Standards

Strengthen confidence in rangeland restoration approaches by aligning with established benchmarks and standards, such as the IUCN Global Standard for NbS, demonstrating biodiversity gains, climate benefits, and economic returns.

Achieving equitable outcomes from investments in rangeland restoration also requires the use of appropriate safeguards. Rangeland restoration investments should abide by safeguards, including Free, Prior and Informed Consent (FPIC), benefit-sharing arrangements, and robust MRV systems (UNCCD 2024), to uphold the rights of pastoralists and other rangeland stakeholders, including women and men.

5.9 Implement Effective Monitoring and Verification Systems

Countries should invest in robust monitoring systems for rangelands to support adaptive management and learning, and to enable investors to track performance. Monitoring systems should include suitable indicators for the relevant types of rangeland degradation that are diagnosed. They can be linked to early warning systems to ensure coordinated action during climate hazards (e.g. drought or dzud), linking herd movements or destocking to short term exigencies and to post-emergency rangeland management requirements (IPCC 2019). In this way, adaptive grazing policies, underpinned by real time data, can dynamically balance livestock needs with ecosystem resilience.

6. Recommendations

Sustainable rangeland management and rangeland restoration offer substantial returns across ecological, social, and economic dimensions. Realizing these benefits depends on the coordinated efforts of investors, governments, policymakers, pastoralist communities, and development partners. Suitable investment can be enabled by more effective governance, inclusive participation, and innovative financing solutions, as outlined in the following recommendations.

6.1 Private Rangeland Investors

Private investors should recognise that the cost of avoiding degradation is lower than the cost of restoring degraded land and should consider the LDN response hierarchy of avoid-reduce-restore. Investors should develop strategies that add value to the multiple goods and services of rangelands and develop partnership with co-investors where appropriate. Investments will typically focus on sustainable livestock production and its co-benefits, through rangeland management practices that align with restoration targets, and which secure long-term financial and non-financial returns for both investors and producers. Rangeland restoration often requires investment in enabling local communities to manage rangelands sustainably and to implement their own risk management strategies, and businesses should anticipate returns on investment through a multiplicity of downstream value chains and multiple revenue streams. Investors should explore emerging financing mechanisms that can unlock larger and more sustained investment in rangeland restoration.

6.2 Public Decision Makers

Investments in rangeland restoration offer benefit–cost ratios ranging from 4:1 to 35:1 as well as boosting economic output and employment. Governments should prioritize investment in sustainable rangeland management and restoration to fulfil international commitments to climate, biodiversity, and combat desertification and to achieve their sustainable development goals. Pastoralism compares favourably with more intensive livestock systems in the rangelands and is crucial for maintaining rangeland ecosystem health. At the same time, public demand for environmental goods and services is growing and pastoralists play an important role in maintaining cultural and natural heritage. In most countries, rangeland restoration depends on management of communal land and governments should implement solutions to secure the governance of the commons. Measures to strengthen governance generate benefits that go far beyond rangeland restoration by creating conditions for stability, sustainable development, and economic growth and resilience.

6.3 Policy Makers

Policies should recognise the range of values of rangeland ecosystems and the need to invest in a combination of these to secure the rangelands in the long term, particularly to prioritize avoidance of rangeland restoration in line with the LDN response hierarchy. Effective policy responses to rangeland degradation must align legal, financial and institutional levers with on the ground realities. A supportive enabling environment for rangeland investment should:

- Strengthen land tenure and community rights, participatory planning, and community institutions
- Strengthen local government structures, build local capacity, and implement safeguards
- Recognize rangeland values, align incentives and, and promote innovation in investment
- Ensure rangeland restoration approaches are correctly selected and are effectively monitored
- Develop safeguards and monitoring systems
- Strengthen market access for multiple rangeland values

6.4 Pastoralists and Pastoralist Organisations

Pastoralists and pastoralist organisations are recommended to promote the many values of pastoralism and rangelands in dialogue with government and businesses, including the role of pastoralists as custodians of nature and culture. Pastoralists should engage in dialogue over appropriate investments and should encourage investments that address the different needs and values of different members of society (i.e. different socio-economic groups, different genders). They should be aware of emerging risks and pressures associated with increased investment in rangelands, including market volatility, resource competition, insecurity, and climate change. Pastoralist organizations should place greater emphasis on developing grassroots capacity and leadership.

6.5 Rangeland Restoration and Development Partners

Development partners, including development banks, international organisations, and nongovernmental organisations, should support improved diagnosis of land degradation and selection of cost-effective and equitable restoration options. They should support national mainstreaming of effective practices, including low-cost, herder-centred approaches based on participatory planning, natural resource governance, and herd mobility. Particular attention is needed to addressing underlying development barriers and to building the capacity and leadership of pastoralist communities. Projects should be developed with suitable time-horizons and with clear plans for leveraging successive phases and transitioning from projects to programmes to long-term investment. Projects should also support improved validation of approaches and cost-benefit analysis of good practices, following guidelines outlined in this discussion paper.

6.6 Recommendations for Further Research

This discussion paper provides an overview of the state of knowledge of the costs and benefits of rangeland restoration, the business case for scaling up investments, and the importance of creating enabling conditions for private investment, and has been prepared to inform a more in-depth economic assessment. The following recommendations should be addressed in the subsequent report and will also be relevant to other actors.

Strengthen analysis of the economic roles, responsibilities, opportunities and threats of different sectors and actors.

- Provide clearer differentiation between the roles of public and private investment for rangeland restoration and strengthen analysis of public investment to address underlying poverty and development constraints, including food insecurity and conflict.
- Clarify the role of the public sector in creating enabling conditions for private investment, in-

cluding good governance and security and the connection between resource rights and the ability to convert public to private investment opportunities.

- Develop stronger profiling of categories of investor, differentiating between those seeking to invest in land, those seeking to invest in commodities, and those seeking to invest in people or institutions, and considering how each category delivers sustainability outcomes, and where they will generate returns on investment.
- Place greater emphasis on enabling investment by primary land users (pastoralists) in rangeland restoration and sustainable rangeland management.
- Strengthen understanding of the ultimate beneficiaries of rangeland restoration to disaggregate benefits that accrue directly to rangeland managers from benefits that are enjoyed by wider society, both domestically and internationally.

Improve methodologies for more consistent and effective economic analysis of rangeland restoration.

- Promote a robust analytical framework for cost-benefit analysis of rangeland restoration investments that can be adopted by project developers, including guidance on how to conduct thorough valuation, which costs and values to include in each landscape or location, and how to represent values for which data is unavailable or non-monetary.
- Conduct stronger economic analysis of rangeland restoration opportunities using both economic and financial benefit-cost analyses to make the case for public and private sector investment.
- Demonstrate the importance of measuring returns on investment over specified time periods to provide more realistic estimates of internal rates of return and to identify where different revenue streams (or ecosystem services) generate returns at different rates.

Strengthen awareness of the risks of rangeland investments entrenching inequalities in rangelands.

- Improve awareness of the risks of investment delivering inequitable outcomes and entrenching inequalities, including stronger analysis of gender dimensions of rangeland investment.
- Improve understanding of the risks to marginalized communities from rangeland investment, particularly those not fully integrated in the formal economy.
- Provide evidence of investments that have addressed the specific needs of indigenous peoples (e.g. experiences in access and benefit sharing).
- Examine differences in perception of value between investors and herders and within herding communities (i.e. between men and women) with recommendations on how to adjust investment strategies accordingly.

Strengthen advice on innovative ways public and private partners can invest in equitable rangeland restoration.

- Develop advice on effective business models for scaling from pilots to landscape-level programs, on integrating sustainability standards into primary value chain investments, and on designing financial instruments that meet both investor requirements and community needs.
- Advise on investment innovation in the rapidly evolving field of environmental finance and give guidance on good practices from other sectors (e.g. forest restoration investments), options for blended finance (e.g. to reduce risk, reduce cost of capital, or leverage returns), methodologies for bundling and stacking multiple revenue streams, and the level of detailed required to evaluate restoration returns and risk profiles.
- Explore the use of natural capital accounting to match beneficiaries to finance solutions, particularly for public good provision and potential concessional capital arrangements.

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With financial support from:

Federal Ministry
for Economic Cooperation
and Development

Implemented by

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

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