Ranching Best Management Practices

INTERVENTION CATEGORY: MANAGEMENT

DESCRIPTION

Best Management Practices (BMPs) in ranching often aim to maintain or improve water quality through maintaining and/or improving grazing management practices, range structures (e.g., access roads, water developments, fencing, grade stabilization, etc.), or land treatments (e.g., brush management, range seeding, edge of field treatments, etc.).[1] Related measures include:

- **Grazing management**[2] is the active management of how animals graze on pasture. This may concern the concentration of animals per hectare (intensification) or the system being used to control the timing of grazing, such as through rotational grazing.
- **Silvopasture**[3] typically involves using rotational grazing to combine forestry and grazing of domesticated animals in a mutually beneficial way.
- **Fencing**[2] consists of installing physical barriers to protect water bodies from potential pollutants that may result from livestock accessing them.
- **Brush management**[4] and other forms of land treatment which affect vegetation composition or productivity, such as range seeding and edge of field treatments.

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WATER SECURITY CHALLENGES (WSCs) ADDRESSED

TYPE		IMPACT	MAGNITUTE	DEPTH OF EVIDENCE BASE
Water availability	Groundwater recharge	Increased mean annual groundwater recharge	★★☆	★★☆
	Dry season flows	Maintained dry season flows	★★☆	★★☆
Disaster risk	Flood risk	Reduced peak discharge	★☆☆	★☆☆
Water quality	Erosion and sedimentation	Reduced on-site erosion and sediment yields	★★★	★★☆
	Nutrients and pollutants	Reduced in-stream nutrient and pollutant concentrations	★★★	★★☆

Ranching BMPs typically reduce sediment and nutrient loadings (e.g., phosphorus, nitrogen) and potentially harmful pathogens from livestock waste in order to protect or restore a water body impacted by ranch operations[1]. Introduction of several ranching BMPs for a case in the western U.S. achieved a reduction of 13% for Total Dissolved Solids (TDS).[5]

Brush management can protect soils, control erosion, reduce sediment, improve water quality, and enhance stream flow. The roots of brush species usually extract water from greater depths than grasses, and brush control can reduce the total amount of water used by vegetation. Proven effects of brush removal on different aspects of rangeland hydrology include the amount of rainfall that is intercepted and held by the plant leaves, surface runoff, spring flow, water use by individual plants and plant communities, fluctuation of shallow water tables, and streamflow.[4]

Rotational (grazing only one portion of pasture at a time) allows the rest of the pasture to recover. This practice can help forage plants rebuild and deepen their roots to improve the health and longevity of the soil.[2] By potentially reducing soil compaction, natural water infiltration can be maintained, impacting groundwater recharge and dry season water availability. Buffer strips can be installed to avoid livestock manure from reaching streams.[6] Silvopasture can help protect soil from water runoff, erosion, and nutrient depletion.[7]

OTHER BENEFITS

WHAT?	HOW?
Carbon sequestration	Carbon is stored in the different compartments of silvopasture (soil, grass and tree) enabling design of climate-smart agriculture.[3] Grazing and brush management also helps to maintain soil carbon.
Sustainable livelihoods	Integrating trees, forage, and livestock creates a land management system that reduces economic risk and a relatively constant income from livestock sale and selective sale of trees and timber products.[8]
Climate stabilization	Trees provide shade or wind protection and have a climate-stabilizing effect to reduce heat stress and wind-chill of livestock. The direct cold effect can be reduced by 50% or more and wind velocity reduced by as much as 70%.[8]
Biodiversity	Improved habitat for wildlife.[9]
Aesthetic quality	Silvopastures provide an attractive landscape with an aesthetically pleasing "park-like" setting.[8]

LINKAGES TO CLIMATE CHANGE

Mitigation: Incorporation of trees in ranching practices improves sequestration of carbon (C) in both above ground biomass and in the soil. Benefits from carbon storage in soils are often overlooked but can be significant in improved tree-based practices.[13, 14]

Adaptation: Ranching BMPs can effectively regulate hydrological conditions, which are generally predicted to become more erratic under climate change.[15] Silvopastoral systems provide climate stabilization benefits.[8]

DESIGN-ENABLING CONDITIONS AND TYPICAL CONSTRAINTS

- •When making tree and forage crop selections in silvopasture, potential markets, soil type, climate conditions, and species compatibility need to be considered.[8]
- Silvopastoral systems can require a relatively large land base to sustain timber and livestock production continuity.[8]
- Appropriate grazing systems depend on climate, terrain, tree species, tree age, other vegetation, kind of livestock, labor requirements, and extent of fencing, water supplies, and supplementary equipment.[8]
- Tree pattern is an important factor for silvopasture success. Trees can be evenly distributed over the area to optimize growing space and light for both trees and forage. Alternatively, grouping trees into rows or clusters concentrates their shade and root effects while providing open spaces for pasture production.[8]
- Brush control in upland areas is unlikely to increase significantly water yields if soils and geologic formations are not conducive to increased runoff and/or subsurface flows to streams or to aquifers.[4]
- Policies may need to include financial incentives for land owners to engage in brush control that exceeds their preferred amount.[11]
- Grazing management should carefully arrange periods of grazing and recovery. Enabling conditions regarding recovery processes are plant type, timing in growing season, geomorphic setting, time since a major disturbance (flood or fire).[2]
- Maintenance needs:
  - In brush management, regrowth of brush and herbaceous vegetation should be controlled so that it is less dense and more shallow rooted than the pretreatment vegetation.[4]
  - Livestock grazing should be intensively managed.[8]
  - Fences and any other developed structures need to be maintained.

RELATION TO GREY INFRASTRUCTURE

INFRASTRUCTURE?	SERVICE PROVIDED BY GREY SOLUTIONS	TYPE OF RELATION
Off-stream water development, road and stream-crossing improvements[5]	Short-term water retention	Alternative
Water treatment facilities	Improved water quality	Alternative, Complementary

COMMON RISKS AND TRADE-OFFS

- The greatest risk in range seeding lies in the uncertainties of predicting rainfall and other conditions at planting and during the establishment period.

- Depending on livestock type, age, and tree species present, livestock can damage trees. Both browsing of newly planted seedlings and debarking of well-established trees may occur, compromising their survival and growth[3]
- There can be a risk of limited effectiveness of brush control due to an insufficient understanding of hydrogeology.[10]

MONITORING OPPORTUNITIES

- Downstream impacts of ranching BMPs on streamflow, spring flow and water quality can be measured with various sensors
- Satellite-derived vegetation maps can support monitoring of vegetation status and regrowth.

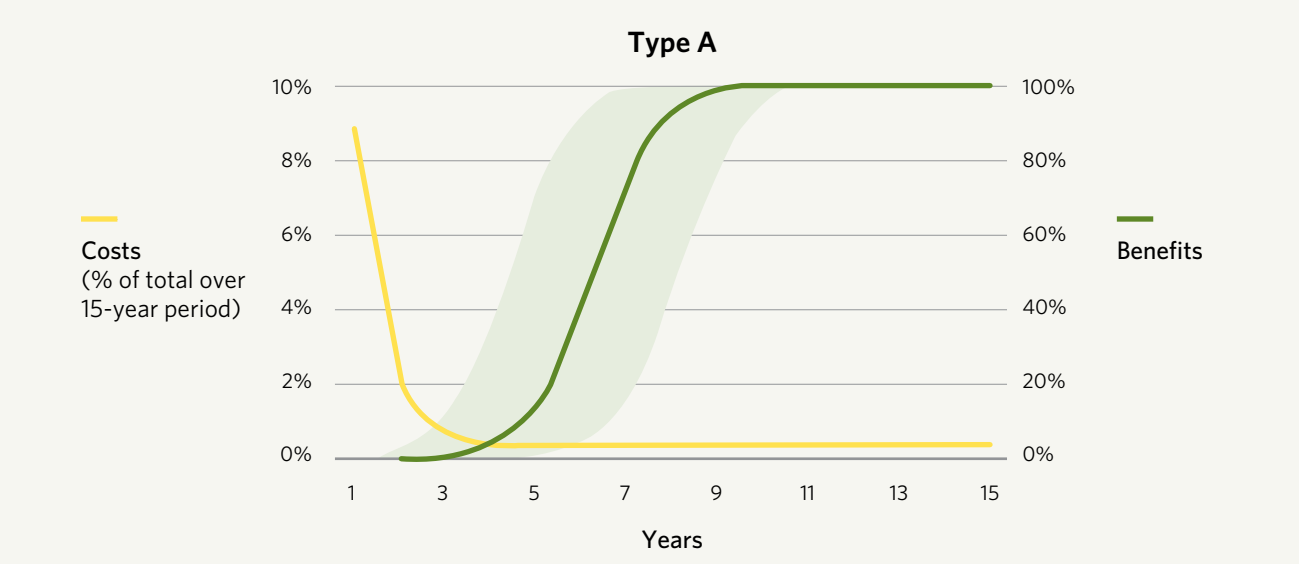
IMPLEMENTATION COSTS AND TIMING OF BENEFITS

Initial establishment costs in silvopasture include site preparation, seedling cost, labor associated with planting, and fencing. Typically, costs for establishing a silvopasture system in an existing pasture in the southeastern U.S., is around $100–150 per acre[12]. Recurring costs include seeds, herbicides, labor, equipment, livestock management, and maintenance of fences and other structures.

Grazing management for specific objectives generally involves input of labor and materials as well as opportunity costs from forgone animal production. Investment in up-front labor and materials for developing infrastructure, such as fenced pastures, can reduce ongoing labor costs. The cost of fence building and maintenance varies by location, soils, terrain, and climate.[2]

In brush management, often removal of 90–95% of the brush species is required. Costs vary significantly with the vegetative type, the density of brush, size of brush, method or methods of brush removal selected, soils, number of acres treated and topography. Thereafter, regular maintenance is required to prevent re-infestation by brush species, at relatively substantial annual cost. A review of different treatment techniques in Texas showed costs of between 10–90 USD/acre, with intervals varying between 5-15 years.[17]

Even when only private economic **benefits** to ranches are considered, introduction of ranching BMPs is often beneficial. A study in northeastern Oregon showed that the effect of a range of BMPs yielded annual net returns to the ranch ranging between $4,500 and $11,000 depending on cattle prices and precipitation levels.[16] In cases where private benefits are insufficient to justify investment, the financial case generally becomes much more favorable when public benefits are considered.[17] Well-managed grazing provides economical control of weeds and brush.[8]



Silvopastoral plot in Colombia (source: CIAT)

EXAMPLES

The literature on case studies describing ranching BMPs is dominated by U.S. systems, particularly those located in the south of the country. However, large-scale livestock ranches are abundant in other parts of the world, notably in South America, where sustainable practices are increasingly being adopted. Below some examples are listed:

Misiones and Corrientes Provinces, Argentina

Brief description: Small-, medium- and large-scale farmers in northeast Argentina's are adopting silvopasture systems to a moderate extent, either through individual decisions, or spurred by extension education and financial subsidy payments. Costs, benefits, and motivations of farmers were evaluated in a study.

Lessons learnt:

- In this setting, farmers appreciated most the microclimate benefits provided for livestock management, followed by the economic benefits.
- Due to relatively limited capital costs, also small-scale farmers continue to adopt to sustainable silvopasture systems.

Missouri, United States

Brief description: Costs and benefits of silvopasture systems were evaluated for three individual farms. Implemented measures include rotational grazing systems, fencing, and (for one site) site clearing and establishment costs. Maintenance and establishment costs are provided per acre for each site.

Lessons learnt:

- Despite the differences between the three sites, similar benefit to cost ratios with magnitude 3–4 are calculated for all sites, showing the profitability of silvopastoral practices to the ranches.
- Included benefits do not involve public benefits and impacts on WSCs, which would like include the benefit to cost ratios considerably.

REFERENCES

1. WWAP/UN-Water. *Nature-Based Solutions for Water. Unesco* (2018).
2. Swanson, S. R., Wyman, S. & Evans, C. Practical Grazing Management to Meet Riparian Objectives. *J. Rangel. Appl.* **2**, 1–28 (2015).
3. Jose, S. & Dollinger, J. Silvopasture: a sustainable livestock production system. *Agrofor. Syst.* **93**, 1–9 (2019).
4. Jones, C. A. & Gregory, L. Effects of Brush Management on Water Resources. (2008).
5. Ellison, C. A., Skinner, Q. D. & Hicks, L. S. Assessment of best-management practice effects on rangeland stream water quality using multivariate statistical techniques. *Rangel. Ecol. Manag.* **62**, 371–386 (2009).
6. Larsen, R. E., Miner, J. R., Buckhouse, J. C. & Moore, J. A. Water-quality benefits of having cattle manure deposited away from streams. *Bioresour. Technol.* **48**, 113–118 (1994).
7. Browder, G., Ozment, S., Bescos, I. R. & Gartner, T. *Integrating Green and Gray: Creating Next Generation Infrastructure.* (2019).
8. Usda-nac, A. N., Klopfenstein, N. B., Carman, R. C. & Clason, T. R. DigitalCommons @ University of Nebraska–Lincoln Silvopasture : An Agroforestry Practice. (1997).
9. Shrestha, R. K. & Alavalapati, J. R. R. Valuing environmental benefits of silvopasture practice: A case study of the Lake Okeechobee watershed in Florida. *Ecol. Econ.* **49**, 349–359 (2004).
10. Archer, D. R., Forsythe, N., Fowler, H. J. & Shah, S. M. Sustainability of water resources management in the Indus Basin under changing climatic and socio economic conditions. Hydrol. *Earth Syst. Sci.* **14**, 1669–1680 (2010).
11. Thurow, T. L., Thurow, A. P. & Garriga, M. D. Policy prospects for brush control to increase off-site water yield. *J. Range Manag.* **53**, 23–31 (2000).
12. USDA-NAC. *Silvopasture: Establishment & management principles for pine forests in the Southeastern United States.* www.unl.edu/nac (2008).
13. Tonucci, R. G., Nair, P. K. R., Nair, V. D., Garcia, R. & Bernardino, F. S. Soil Carbon Storage in Silvopasture and Related Land-Use Systems in the Brazilian Cerrado. *J. Environ. Qual.* **40**, 833–841 (2011).
14. Howlett, D. S., Moreno, G., Mosquera Losada, M. R., Nair, P. K. R. & Nair, V. D. Soil carbon storage as influenced by tree cover in the Dehesa cork oak silvopasture of central-western Spain. *J. Environ. Monit.* **13**, 1897–1904 (2011).
15. Coble, A. P. et al. Influence of forest-to-silvopasture conversion and drought on components of evapotranspiration. *Agric. Ecosyst. Environ.* **295**, 106916 (2020).
16. Stillings, A. M. et al. Economic implications of off-stream water developments to improve riparian grazing. *J. Range Manag.* **56**, 418–424 (2003).
17. Consultants, P. ASSESSMENT OF BRUSH CONTROL Ep. (2000).
18. IUCN. *Nature-based solutions to address global societal challenges. Nature-based solutions to address global societal challenges* (2016). doi:10.2305/iucn.ch.2016.13.en.