PASTORALISM AND RANGELAND MANAGEMENT

Silvopastoral system, Senegal. (Christoph Studer)

In a nutshell

Definition: Pastoralism and rangeland management refer to extensive production of livestock using pastures and browse, and is mainly found in arid and semi-arid areas. In SSA the term 'pastoralism' is usually associated with the use of common property resources subject to some group agreements rather than 'open access'. 'Ranching' on the other hand implies individual, privatised land ownership. Pastoralism is based on open grazing lands, e.g. savannas, grasslands, prairies, steppes, and shrublands, managed through herding. Pastoralists adopt opportunistic land use strategies, that is they follow resources of grazing / browsing and water, destock in times of drought (often *de facto* through livestock mortality rather than stock sales) but have rapid response post-drought restocking strategies (commonly based first on the high reproduction rates amongst indigenous sheep and goats). There are many types and degrees of pastoral mobility, which vary according to environmental conditions or the given household situation. Mobility can be seasonal, regular between two well-defined pasture areas, or following erratic rain. It is rarely the same from one year to another. Movement is not necessarily undertaken only for resource-based reasons; it can be for trade or because of conflict. Pastoral activities have conventionally been considered uneconomic and ecologically destructive. Current thinking increasingly recognises these strategies as economically viable, environmentally sustainable, and compatible with development. The challenge is to adapt traditional pastoralism to today's changing environmental conditions. Establishment of feed banks, improvement of herd composition and health, a more dense distribution of wells, collection and storage of surface water by, for example, 'charco dams', adaptive grazing, land use plans, access to markets, and empowerment are such opportunities.

Applicability: A production system for marginal, dry lands: relatively low inherent productivity due to aridity, altitude, temperature and / or a combination of all factors. Pastoralism is becoming increasingly constrained because of weakening of traditional governance over communal natural resources, restricted mobility, sedentarisation, boundaries and advancing agriculture.

Resilience to climate variability: By definition pastoralism is based on continuous adaptation to highly uncertain environments, especially climate. Traditional pastoralism has / is losing flexibility and options for coping with drought (e.g. loss in mobility due to encroachment of cropping and growing human populations) leading to increased risk.

Main benefits: Mobile herding systems combine economic production in marginalised land and environmental protection (biodiversity) of vulnerable ecosystems, which have been modified over time by pastoralism itself; improved food security and livelihood of marginalised and disadvantaged people. The vast areas of degraded rangeland play a vital role in sequestering carbon. Dry soils are better longer term sinks for C than soils in more humid environments.

Adoption and upscaling: Effective pastoral management of the drylands depends on livestock mobility (access to dry season grazing sites and water points), effective communal tenure and governance systems, and herd adaptation.

Development issues addressed	
Preventing / reversing land degradation	++
Maintaining and improving food security	++
Reducing rural poverty	++
Creating rural employment	+
Supporting gender equity / marginalised groups	+++
Improving crop production	+
Improving fodder production	+++
Improving wood / fibre production	++
Improving non wood forest production	++
Preserving biodiversity	+++
Improving soil resources (OM, nutrients)	++
Improving of water resources	++
Improving water productivity	++
Natural disaster prevention / mitigation	++
Climate change mitigation / adaptation	++

Climate change mitigation	
Potential for C Sequestration (tonnes/ha/year)	0.1 - 0.3*
C Sequestration: above ground	+
C Sequestration: below ground	++

Climate change adaptation	
Resilience to extreme dry conditions	+++
Resilience to variable rainfall	++
Resilience to extreme rain and wind storms	++
Resilience to rising temperatures and evaporation rates	+++
Reducing risk of production failure	++

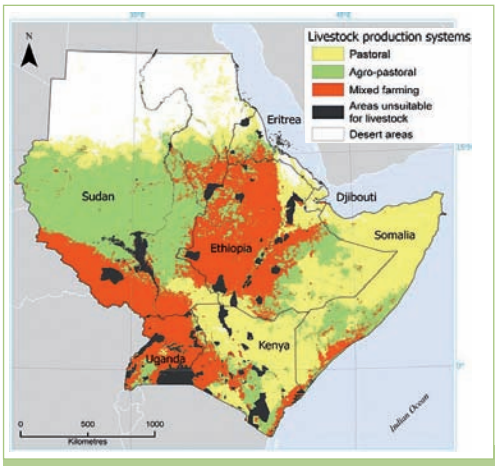
**for proper rangeland management in US$ and for a duration of the first 10-20 years of changed land use management (Schumann et al., 2002 in FAO, 2004).*

Origin and spread

Origin: Pastoralism is one of the most ancient forms of agricultural activity and pastoralists maintain diverse cultures, ecological adaptations, and flexibility in management systems. It evolved in arid and semi-arid regions as a result of increasing population densities and domestication of livestock. Pastoralism made efficient use of the extensive rangelands, and could cope with climate variability - particularly uneven and erratic distribution of rainfall. Between 1960s and 1980s international donors invested heavily in rangeland and livestock projects by introducing 'ranching' models where boundaries were delineated and destocking programmes encouraged or enforced. These misguided efforts to develop livestock systems have contributed to the current vulnerability of many pastoralists.
Mainly applied in: the arid and semi-arid zones extending from Mauritania to the northern parts of Chad, Eritrea, Ethiopia, Kenya, Mali, Niger, Somalia, Sudan, Tanzania and Uganda. Pastoralists who are principally dependent on camels are confined to areas north of the equator. Communities practicing agropastoralism are found throughout: opportunistic cropping (sometimes based on RWH) is common in 'pastoral' areas.
Also applied in: arid zones of Namibia, parts of Botswana and southern Angola.

Principles and types

Traditional pastoral systems utilise, modify and conserve ecosystems by extensive grazing / ranching with rotational grazing and by using a variety of livestock: sheep and cattle, principally as grazers; and goats, donkeys and camels as browsers.
The Fulbe / Fulani herders in Nigeria, for example, faced with rapidly vanishing grass, switched from the Bunaji cattle breed, which depends on grass, to the Sokoto Gudali, which readily browses (FAO, 2001).
Nomadism: Nomads are livestock producers who grow no crops and depend on the sale or exchange of animals and their products to obtain food (e.g. Tuareg and Fulbe). Their movements are opportunistic and follow pasture and water resources in a pattern that varies from year to year according to the availability of resources.
Transhumance is the regular movement of herds between fixed points in order to exploit the seasonal availability of pastures. A feature of transhumance is herd splitting; the herders take most of the animals to search for grazing, but leave the resident community with a core of lactating female cows and / or camels (e.g. Maasai and Fulbe). For the Fulbe it follows a century–old grazing route northward to the borders of the Sahara, and southward to the moist savanna during the wet and the dry seasons, respectively. Available grazing lands are diminishing and movement channels are blocked through land use change, urbanisation, and frontiers. In West Africa, governments have tried to demarcate transhumance corridors and to legislate for trans-boundary mobility.
Agropastoralism describes settled pastoralists, who live in villages and cultivate sufficient areas to feed their families and keep livestock as valued property (herds are usually smaller). Mixing of crops and livestock primarily serves to minimise risk: failed crops provide animal fodder for example.
Mixed systems: Traditionally some systems are mixed where crops and livestock are managed by different communities based on a long standing relationship. After harvest of the crop, pastoralists are allowed to feed their livestock on the residues. However, since keeping livestock has been promoted amongst crop farmers, this practice is diminishing in importance.
Enclosed systems and ranching: Land is individually owned and usually fenced. In the colonial era, livestock ranches were established in Botswana, Kenya, Namibia, Mozambique, South Africa and Zimbabwe and a substantial proportion of these remain today. Animal movement and pressure are adjusted to the available fodder within the ranch by controlled and rotational grazing and well distributed water points thus reducing degradation as much as possible.



Modelled distribution of livestock production systems in Eastern Africa (Source: Cecchi et al, 2010).


Top: Cattle and camels in a pastoral system, Kenya. (Wiliam Critchley)
Middle: Livestock in a pastoral system, Mali. (William Critchley)
Bottom: Livestock ranching close to a water point on a private estate, South Africa. (William Critchley)

Applicability

Land degradation addressed

In the pre-colonial era, pastoralists were limited principally by disease and insecurity. In the twentieth century occupation of land by cultivators (competition for water and land) and the presence of boundaries impeded free movement of livestock which led to overgrazing of vegetation and soil resources. Overgrazing is a function of time (grazing and recovery) and not simply numbers of animals. Most of the environmentally harmful effects of livestock production in dry areas occur around local water points and settlements.

Biological deterioration: Grazing reduces soil cover and changes the composition of the vegetation. Both, heavy and light grazing can reduce the density of palatable perennial species, which are replaced by less palatable ones as their competitive ability declines.

Water degradation: Low and unreliable rainfall, pasture degradation leading to reduced water infiltration and limited permanent sources of surface water can exacerbate competition for water.

Land use

Mainly extensive grazing land: natural, semi-natural grasslands, savannas, shrubland (*brousse*).

Ecological conditions

Marginal lands and challenging climates with heterogeneity and high variability of resources in space and time. Low in *tsetse* infestation.

Climate: pastoralism: in semi-arid zones with <600mm annual rainfall and a growing season of less than 120 days; seasonal mobility: every wet and dry season; agro-(silvo-) pastoralist systems: semi-arid zones with rainfall ranging between 650 - 1,000 mm. Length of growing period: 130–170 days.

Terrain and landscape: no restrictions - whole range from flat to hilly.

Soils: no restrictions; camels, cattle, donkeys, sheep and goats can utilise a broad range of poor quality forage thriving on marginal soils.

Socio-economic conditions

Pastoralists are usually the most politically and economically marginalised, have the least access to resources (land, water, pasture) and basic services such as health and education and suffer from insecurity, conflicts, poverty, environmental degradation and exposure to climatic risks.

Market orientation: Pastoralists sell livestock products (meat and milk) and livestock to local and domestic markets through both formal and informal channels. Cross-border trade is common. In contrast to crops - where crop failure due to drought results in price increase - livestock destocking, in response to drought, results in price decrease due to a market flooded with poor quality animals. Caravan trade, for example using camels to carry salt, still exists in inaccessible regions of the pastoral zone, but its economic importance has been much reduced by modern transport.

Land ownership and land use / water rights: Pastoralists, due to their opportunistic grazing strategies, have fluid tenure systems that are traditionally based in customary arrangements. However, in some places these have broken down, and uncontrolled open-access regimes have emerged. Traditional wells are often collective property of a community who dug and / or maintained them, but access rights for other groups are usually negotiable. Surface water sources have less clear ownership. A combination of land 'privatisation', fragmentation of communally grazed land, loss of key resources (e.g. water points on transhumance routes), creation of barriers (fences, national parks, roads), imposition of state and district boundaries hamper these rights.

Skill / knowledge requirements: High but exist traditionally and are passed on through the generations.

Labour requirements: A weak relationship between herd size and labour up to the point at which herds beyond a certain size cannot be managed with household labour alone, and outside herders must be hired. In pastoral societies women are typically responsible for milking and dairy processing and for feeding the family. Men are responsible for herding and selling livestock products. In systems with split herds, women stay at the homesteads while men move with the animals.

Land degradation

- Erosion by water
- Erosion by wind
- Chemical degradation
- Physical degradation
- Biological degradation
- Water degradation

- High
- Moderate
- Low
- Insignificant

Land use

- Cropland
- Grazing land
- Forests / woodlands
- Mixed land use
- Other

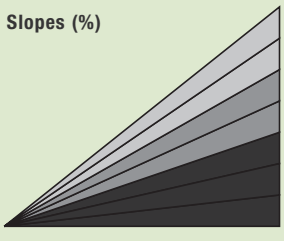
Climate

- Humid
- Subhumid
- Semi-arid
- Arid

Average rainfall (mm)

- > 3000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- < 250

Slopes (%)



- very steep (>60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Farm size

- Small scale
- Medium scale
- Large scale

Land ownership

- State
- Company
- Community
- Individual, not titled
- Individual, titled

Mechanisation

- Manual labour
- Animal traction
- Mechanised

Market orientation

- Subsistence
- Mixed
- Commercial

Required labour

- High
- Medium
- Low

Required know-how

- High
- Medium
- Low

Economics

Establishment and maintenance costs

Pastoralism entails high marketing and transaction costs, especially because of the absence of formal markets and existing monopolies, high transport costs, poor infrastructure, long distances to processing plants, poor access to information, lack of financial services such as credit facilities, and excessive government bureaucracy and fees. Transaction costs reduce the returns to labour under pastoralism.

Production benefits

Pastoral production provides multiple products. It tends to focus on animal products (especially milk), rather than animals for slaughter.

Annual direct values accruing per TLU* of cattle in Afar (Ethiopia)	
Direct value	**US$**
Estimated annual value of milk	54
Mean annual livestock sales	15
Annual herd growth rate	9
Total	78

** Tropical Livestock Unit, 4 hectares of rangeland per TLU (Source: Hatfield and Davies, 2006)*

This data does not capture the full direct value of pastoralism in Afar as it omits the value of leather, the value of processed butter and the transportation values of camels and donkeys. Nevertheless, the data provides an estimated mean pastoral livestock productivity of US$ 78 per 4 hectares. This range of products and species can make pastoral systems significantly more cost-effective and productive than the meat-focussed ranching models that have been promoted.
Transhumance in particular is an extremely productive system, yielding between 50 and 600% more protein per ha than 'modern' ranching in comparable ecological areas within the USA and Australia (Ogle, 1996). In Sub-Saharan Africa the economic importance of livestock rises as rainfall declines.

Benefit-Cost ratio

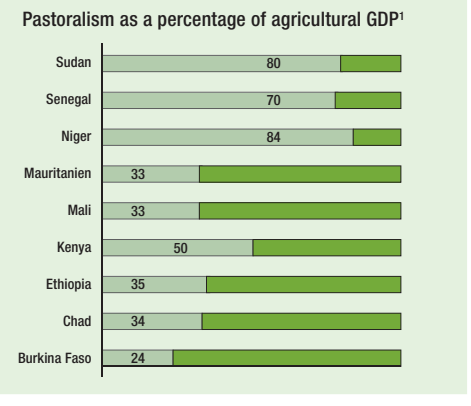
Pastoralism has considerable economic value and latent potential in the drylands but little is known or has been quantified. It encompasses less tangible benefits including financial services (investment, insurance, credit and risk management), ecosystem services (such as biodiversity, nutrient cycling and energy flow) and a range of social and cultural values.
The value of livestock production in the drylands is often grossly underestimated in official statistics, and thus does not attract the investment attention that it deserves.

Example: African pastoralism has been shown to out-produce ranching

In Botswana, communal area production (in cash, energy and protein terms) per hectare exceeds - by at least three times per hectare - returns from ranches in Australia and North America. The difference in soil erosion levels between the two production systems is negligible, despite much higher stocking rates under the communal areas (in Hatfield and Davies, 2006).

Example: Transhumant pastoral systems

In Mali, transhumant pastoral systems yield on average at least two times the amount of protein per hectare per year compared to both sedentary agropastoralists and ranchers in the US and Australia (in Hatfield and Davies, 2006). Pastoralism is economically viable to the extent that it contributes significantly to the economy of many developing countries despite continued underinvestment (Hatfield and Davies, 2006).



1 Gross Domestic Product

Impacts

Benefits	Land users / community level	Watershed / landscape level	National / global level
Production	+++ increased animal productivity ++ greater production and better survival of arid rangeland plants (fodder) ++ greater diversity of livestock and goods that are produced + improved crop yields	+++ maximising production in a highly variable environment ++ reduced risk of production	++ improved food security
Economic	+++ high overall returns due to multiple benefits ++ provides a stable livelihood (e.g. Maasai, Fulbe pastoralists)	++ can contribute 'significantly' to the national economy ++ diversification and rural employment creation ++ less damage to off-site infrastructure + enables drylands to be economically exploited	+ improved livelihood and well-being
Ecological	++ increasing live plant cover ++ reduced soil erosion (by water / wind) ++ efficient and flexible way of managing sparse vegetation and relatively low soil fertility ++ biodiversity enhancement ++ reducing old vegetation (threat of fires) + improved water availability + improved micro-climate	++ reduced degradation and sedimentation ++ efficiency of opportunism in environments that are characterised by uncertainty (intact ecosystem) + increased water availability + increased water quality	++ maintained ecosystem integrity and resilience to climate variability ++ reduced degradation and desertification incidence and intensity ++ enhanced biodiversity
Socio-cultural	++ pastoralists traditional knowledge of environment, livestock genetics, livestock breed selection, medicinal plants and weather forecasting	+ increased awareness for environmental health ++ attractive landscape ++ reduced conflicts	+++ protection of national heritage ++ knowledge leading to sustainability

	Constraints	How to overcome
Production	• Availability of feed / fodder in quantity and quality during the dry season • Increase productivity without adverse environmental consequences	➜ allow sufficient flexibility to move and destock; In SSA products such as cotton seed, groundnut cakes and molasses are now regularly sold to pastoralists, together with mineral licks
Economic	• Poor livestock prices due to lack of marketing infrastructure and knowledge of prices • Access to markets and financial services (credits and savings) • Milk (mainstay of most pastoral economies) not well marketed leading to a shift in production towards meat • Many young people now go to school, while others are moving to the cities to do unskilled jobs (availability of labour)	➜ processing facilities for dairy products and better marketing strategies ➜ Encourage banking facilities: spread of mobile phones and mobile phone-based banking; create alternative saving and investment opportunities ➜ improve image of pastoralism and show its potentials
Ecological	• Sufficient and efficient recovery of nutrients that were relocated from grazing land to cropland • Bush encroachment • Risk and vulnerability of the system	➜ reinforce customary ability to manage rangelands ➜ human capital development (education and health)
Socio-cultural	• Limited livestock mobility • Competition and conflicts over rangelands of pastoralists, farmers and foragers • Wealthier farmers and urban farmers invest their surplus capital in livestock (competition) • Sedentarisation • Traditional tenure systems (usually gained through cultivation), land access and fragmentation • Marginalisation of pastoralists (often seen as backward, archaic and a political threat) • Low education of pastoralists • Inappropriate training of extension agents and absence of useful extension packages • Inappropriate policies aiming at transforming rather than enhancing pastoralism	➜ e.g. demarcation of transhumance corridors and legalisation for trans-boundary mobility ➜ make use of group or collective rights (policies often exist) re-aggregation of fragmented grazing land to still use land communally and / or leasing arrangements ➜ qualify what pastoralists contribute to the economy ➜ political empowerment ➜ capacity building ➜ technical and institutional reforms ➜ put in place or emphasise land reforms and land use rights that support pastoralism

Adoption and upscaling

Adoption rate

Despite the high investments that were made in rangeland development projects during the last 30 years, they have generally been a failure because they based their assumptions on concepts of equilibrium systems developed for individually owned ranching systems. The projects, by changing traditional patterns of land use, weakened the indigenous pastoral production systems by misidentifying 'pastoral crisis'. Collective action arrangements are emerging:

– Awareness of pastoralists themselves
– Economic diversification
– Intensification and diversification of livestock production strategies
– Empowerment of communities through Community-Based Natural Resource Management (CBNRM)
– Reinforcement of favourable land and water use rights, access to resources and regional planning

Upscaling

Planning for / with pastoral societies must have a long term perspective, and needs to recognise that herds will recover eventually, as they always have in the past, and that the utilisation of 'inaccessible' zones will always be the preserve of pastoralists. New policy must address issues of diversity without undermining the common factors that unite pastoralists everywhere in Africa. A key is to enable pastoralists themselves to adapt and enhance their production system (e.g. through improved animal health). Adequate attention needs to be placed on learning from pastoralists' production methods and finding ways to fit new technologies into those systems.

One problem that is rarely addressed is the lack of security (e.g. theft) which acts as an inhibitor to outside investment and which leads people to invest a lot of their resources in providing their own security. Furthermore, in many places where smuggling and trade are key sources of income, pastoralists' economic dependence on livestock is low. Therefore herders may not make investments required in their livestock because their attention is directed elsewhere.

Incentives for adoption

Incentives for key elements of pastoralism such as communal tenure, seasonal movements, flexible stocking rates that can be adopted afresh are:

– legal support for communal arrangements
– legislation for transhumance
– relevant services that are tailored to the needs of communal and mobile management
– infrastructure / investments and technologies for access to water
– insurance and credit services
– animal health programmes
– market integration to survive on smaller herds than would be possible with exclusive subsistence
– promotion of mobile phones for information sharing (animal prices; climate prediction) and for banking
– contingency planning for disaster mitigation / emergency relief

Enabling environment: key factors for adoption	
Inputs, material incentives, credits	+
Training and education	+
Land tenure, secure land use rights	+++
Improved marketing	++
Research	++
Enabling policies	+++
Maintain mobility (trans-boundary)	+++
Safety net (risk and emergencies)	++
Access to services	++

Example: Ethiopia

Communal grazing lands are important sources of livestock feed in developing countries. In the highlands of Tigray, northern Ethiopia rural communities have a long tradition of developing and enforcing use and regulations of grazing areas. Restricted use of grazing lands tends to be maintained once it is established. Village organisations are responsible for the management with technical assistance from the regional Bureau of Agriculture (Gebremedhina et al, 2004).

References and supporting information:

Briske D. D., J. D. Derner, J. R. Brown, S. D. Fuhlendorf, W. R. Teague, K. M. Havstad, R. L. Gillen, A. J. Ash, and W. D. Willm. 2008. Rotational Grazing on Rangelands: Reconciliation of Perception and Experimental Evidence. Rangeland Ecol Manage 61:3–17.

Cecchi, G., W. Wint, A. Shaw, A. Marletta, R. Mattioli and T. Robinson. 2010. Geographic distribution and environmental characterisation of livestock production systems in Eastern Africa. Agriculture, Ecosystems and Environment 135 (2010) 98–110.

Davies, J., M. Niamir-Fuller, K. Kerven and K. Bauer. 2010. Extensive livestock production in transition: the future of sustainable pastoralism. In Livestock in a Changing Landscape, Volume 1, Drivers, Consequences, and Responses. Steinfeld, H., H. A. Mooney, F. Schneider and L. E. Neville (eds). Washington, DC: Island Press.

Davies, J. 2008. Turning the tide: Enabling sustainable development for Africa's mobile pastoralists Natural Resources Forum 32 (2008) 175–184.

Derry, J.F. and R.B. Boone. 2010. Grazing systems are a result of equilibrium and non-equilibrium dynamics. Journal of Arid Environments 74(2): 307-309.

FAO, 2009. Grasslands: Enabling their potential to contribute to greenhouse gas mitigation. A submission by The Food and Agriculture Organisation of the United Nations1. workshop held at FAO Rome 15 -17 April 2009.

FAO. 2004. Carbon Sequestration in drylands soils. World Soil Resources Reports 102. FAO.

FAO. 2001. Pastoralism in the new millennium. Animal Production And Health Paper 150. FAO.

Gebremedhina, B., J. Pender and G. Tesfay. 2004. Collective action for grazing land management in crop–livestock mixed systems in the highlands of northern Ethiopia. Agricultural Systems Volume 82, Issue 3 pp 273-290.

Hatfield, R. and J. Davies. 2006. Global Review of the Economics of Pastoralism. The World Initiative for Sustainable Pastoralism, IUCN, Nairobi

Homann, S., B. Rischkowsky, J. Steinbach and M. Kirk. 2005. Towards endogenous development: Borana pastoralists' response to environmental and institutional changes. Deutscher Tropen tag. Stuttgart-Hohenheim, October 11-13, 2005.

Oba, G., N.C. Stenseth and W.J. Lusigi. 2000. New perspectives on sustainable grazing management in arid zones of SSA. BioScience, Volume 50: pp 35 - 51.

Ogle, B. 1996. Livestock Systems in Semi-Arid Sub-Saharan Africa, Integrated Farming in Human Development – Workshop Proceedings.
http://www.ardaf.org/NR/rdonlyres/E0E2790E-F1FF-4F65-818E-1716735E1070/0/199618BrianOgle.pdf

Case study

NGITILI DRY-SEASON FODDER RESERVES - TANZANIA

Ngitili are traditional enclosures for in-situ conservation and rehabilitation of vegetation, practiced by the Wasukuma agropastoralists in Shinyanga, Tanzania. Shinyanga is a semi-arid area characterised by shortage of fodder associated with problems of deforestation, fuelwood scarcity, food insecurity, declining soil fertility, severe soil erosion and unsecure land use rights. *Ngitili* is a dry-season fodder reserve, an indigenous practice which has been revived by a government programme from 1986-2001.

For initial regeneration of the vegetation and rehabilitation of denuded land absolute exclusion of up to 5 years is needed. Then, areas of standing vegetation are enclosed seasonally from the onset of the rainy season till the peak / end of dry season, before they are opened up for grazing. Two distinct vegetation strata are identifiable, an upper stratum dominated by trees and shrubs (*Acacia tortilis, A. nilotica, A. polyacantha* and *A. seyal)* and a lower stratum of grasses, herbs and forbs. Structure and composition of the *ngitili* areas are closely influenced by location, age, management practices and intensity of use. The reserves are established on degraded land and around homesteads. Individual plots usually reach 2-5 ha in size, while communal *ngitili* cover 10-200 ha. Mostly, the boundaries are not rigidly marked, and physical barriers are not established. Local guards and community by-laws are used to protect and enforce the system.

Ngitili alleviates dry season fodder shortages and prevents land degradation through reducing soil erosion and deforestation. The reserves provide a wide range of woodland goods - such as timber, fodder, fuelwood, medicinal herbs, wild fruits and honey. They help to enhance livelihoods, provide a vital safety net during dry seasons and droughts and generate additional income of up to US$ 500-1,000 per year and household. *Ngitili* greatly reduced women's labour, cutting the time spent on fuelwood collection by over 80%, and have a highly positive impact on biodiversity.

SLM measure	Management and vegetative
SLM group	Pastoralism and Rangeland Management
Land use type	Extensive grazing
Degradation addressed	Vegetation degradation; Decreased soil fertility; Loss of topsoil
Stage of intervention	Rehabilitation
Tolerance to climate change	Increased tolerance to climatic extremes (e.g. prolonged dry spells and droughts)

Establishment activities

1. Demarcation and closure of sites usually on degraded land around homesteads.
2. Total enclosure during up to 5 years for initial regeneration of vegetation (if land is degraded).
3. Establishment of tree nurseries to produce seedlings of native species.
4. Enrichment planting.
5. Removal of large trees (deterring grass growth), while protecting fodder trees.

Maintenance / recurrent activities

1. Closure of *ngitili* area at onset of rainy season. No management during rainy season.
2. Open area for grazing in July or August, after the crop residues and fallow vegetation have been depleted.
3. Temporary demarcation of paddocks for specific periods for rotational grazing within *ngitili* (controlled by experienced elders; based on utilisation level and fodder availability).
4. Controlled pruning and thinning (for firewood and poles).

Labour requirements

For maintenance: low

For establishment: low to medium (depending on the extent of enrichment planting)

Knowledge requirements

For land users: low

For advisors: low

Photo 1: Cattle grazing in a dry season fodder reserve. (Edmund Barrow)
Photo 2: Regeneration of trees has multiple benefits such a production of timber, fruit and honey. (Edmund Barrow)

Case study area: Shinyanga region, Tanzania

Establishment inputs and costs per ha

Inputs	Costs (US$)
Labour	no data
Equipment	no data
Agricultural inputs	no data
TOTAL	**no data**

Maintenance inputs and costs per ha per year

Inputs	Costs (US$)
Labour	no data
Equipment	no data
Agricultural inputs	no data
TOTAL	**no data**

Benefit-cost ratio

Inputs	short term	long term
Establishment	slightly positive	very positive
Maintenance	slightly positive	very positive

Adoption

300,000-500,000 ha of woodland restored 1986-2001 (most of *Ngitilis* are individual, but area-wise half-half), over 800 villages; 60-70% of all households have *Ngitilis*.

Ecological conditions

- Climate: semiarid, unimodal rainfall
- Average annual rainfall: 600-900 mm; rainy season: October–May
- Soil parameters: medium to poor drainage; vertic soils are very extensive covering 47% of all soil types in the region
- Slopes: flat (0-2%) – gentle (2-5%)
- Landform: plains and hill slopes
- Altitude: 1,000-1,500 m a.s.l.

Socio-economic conditions

- Size of land per household: no data
- Type of land users: no data
- Population density: no data
- Land ownership: individual (cropland), individual / communal 50% / 50% (grazing land)
- Land use rights: individual / communal
- Market orientation: no data

Production / economic benefits

+++ Increased income (from selling timber / fuelwood; to purchase agricultural inputs, manpower)
+++ Increased wood production (timber, fuelwood)
+++ Increased fodder production (dry season!)
+++ Increased livestock production
+++ Reduced workload (collection of fuelwood / fodder by women)
+++ Increased production of non-timber forest products (fruit, honey, medicines, edible insects)

Ecological benefits

++ Biodiversity conservation / restoration (152 plant species; 145 bird species; also mammals returning)
+++ Vegetation regeneration / improved soil cover
+++ Reduced loss of top soil through erosion
++ Increased soil fertility
++ Increased water availability

Socio-cultural benefits

+++ Food security, diet diversification, improved health
++ Improved housing (thatched grass for roofs)
++ Improved education (school fees payment due to income from *ngitili*)
+ Income from communal *ngitili* used for village development (schools, health centres)

Weaknesses ➜ and how to overcome

- Damage to livestock and crops caused by growing wildlife populations ➜ outweighed by the benefits gained from *ngitili* (in most areas).
- Increased local inequity: benefit gap between richer and poorer households (who have no *ngitilis*); growing sales of *ngitilis* ➜ local institutions have to enable people to hold on to land and maintain *ngitilis*; allow poorer households to benefit from communal *ngitilis*.
- Scarcity of land, growing pressure (rising human and livestock populations); conflicts over grazing rights ➜ encourage villages to establish by-laws for protecting *ngitilis*.
- Insecurity of tenure impedes establishment of *ngitilis* (individual and communal) ➜ increase local people's and groups ownership and control over their resources; clearly acknowledge in national law the secure tenure of both private and communal *ngitili*.
- Productivity could still be improved ➜ introduction of improved fodder grasses. Planting of fast growing fodder trees and / or shrubs.

Key references: Kamwenda G.J. 2002. Ngitili agrosilvipastoral systems in the United Republic of Tanzania. Unasylva 211, Vol. 53, 2002. ■ World Resource Institute. 2010. Regenerating Woodlands: Tanzania's HASHI Project. http://www.wri.org/publication/content/8108; ■ Equator initiative. 2010. Nomination Form Equator Initiative. http://www.equatorinitiative.org/knowledgebase/files/2002-0128_Nom_HASHI_Tanzania.pdf; ■ Blay D., E. Bonkoungou, S.A.O. Chamshama and B.Chikamai. 2004. Rehabilitation of Degraded Lands in Sub-Saharan Africa: Lessons Learned from Selected Case Studies. Forestry research network for Sub-Saharan Africa (fornessa) ■ WRI (2005): World Resources 2005: The Wealth of the Poor—Managing Ecosystems to Fight Poverty. World Resources Institute (WRI) in collaboration with United Nations Development Programme, United Nations Environment Programme, and World Bank.

COULOIRS DE PASSAGE - NIGER

The '*couloirs de passage*' are formally defined passageways which channel the movements of livestock herds in the agropastoral zones of Niger, by linking pastures, water points and coralling areas, be it within village areas (internal *couloirs*) or on open land (external *couloirs*). The main goal of the *couloirs* is the prevention of conflict between agriculturalists and pastoralists regarding the use of limited land and water resources. These conflicts are often provoked by cattle entering cropping areas.

The establishment of demarcated passageways allows the livestock to access water points and pastures without causing damage to cropland. The corridors are regulated through the '*code rural*' – a national law defining the land use rights of the pastoralists. Demarcation of *couloirs* is based on a consensual decision of all concerned interest groups. Internal *couloirs* are negotiated in a general on-site assembly involving all stakeholders (farmers, breeders, women's groups, local authorities). For the demarcation of external *couloirs* the involvement of transhumance herders and neighboring villages is indispensable.

Once an agreement on the course of the *couloir* is achieved, demarcation with stones and / or boundary planting with selected tree species is carried out by the local land users - with financial and technical assistance of the government or NGOs. Common species involve: *Euphorbia balsamifera, Acacia spp.* (*A. nilotica; A. senegal*); and *Faidherbia albida*. Management committees at the community level draw up regulations for the management of the *couloirs* (maintenance and protection of vegetation). Protection of plants is achieved through dead branches (at the initial stage), daily control by forest guards, and information campaigns. The technology is a sustainable solution to the described conflicts. As a valuable by-product the trees along the demarcation lines provide wood and non-woody by-products.

SLM measure	Management and vegetative
SLM group	Pastoralism and Rangeland Management
Land use type	Cropland or agropastoral (before), (silvo-)pastoral (after)
Degradation addressed	Soil erosion by water; Soil erosion by wind; Biological degradation; Primary problem addressed is conflicts between livestock and agriculture producers around natural resources
Stage of intervention	Prevention
Tolerance to climate change	Technology is sensitive to climatic extremes (such as droughts and floods)

Establishment activities

1. Identification of an existing *couloir* or definition of a new passageway by means of a general assembly (photo 1).
2. Alignment of corridor boundaries e.g. by establishing stone lines. Internal *couloirs* are 10 to 50 m wide, whereas external *couloirs* exceed a width of 50 m.
3. Digging 40 cm deep pits; tree planting along boundaries (with a spacing of 1-3 meters, depending on the species selected and the secondary objective) (photo 2).

Maintenance / recurrent activities

1. Protection of trees (through dead branches, guards, information campaigns).
2. Replanting tree seedlings to fill gaps (annually, beginning of rainy season).

Labour requirements

For establishment: low
For maintenance: low

Knowledge requirements

For advisors: high (facilitator of *code rural*)
For land users: low (pastors and workers)

Photo 1: Demarcation of a *couloir de passage* with two lines of Euphorbia seedlings. (LUCOP / Abdoulaye Soumaila)
Photo 2: A herd of small ruminants passing a well established *couloir*. (Fodé Boubacar Camara, PAFN)

Case study area: Tillabéri North, Niger

Establishment inputs and costs per km

Inputs	Costs (US$)
Labour: 25 person-days	38
Agricultural Inputs: 670 tree seedlings	1374
TOTAL	**1412**
% of costs borne by land users	5%

Maintenance inputs and costs per km per year

Inputs	Costs (US$)
Labour: 4 person-days	6
Agricultural inputs: 67 tree seedlings	137
TOTAL	**143**
% of costs borne by land users	100%

Remarks: The costs of the planning meeting (general assembly) and the stones for delimitation were not taken into account. Daily salary for field work is US$ 1.5. Costs for seedlings were calculated for a couloir length of 1 km and a spacing of 3 m between plants (one tree line on each side). Seedling production is financed by projects, only transport costs are met by land users.

Benefit-cost ratio

Inputs	short term	long term
Establishment	positive	very positive
Maintenance	positive	very positive

Remarks: Peace between communities is the key result in the short and long term. Ecological and economic benefits are linked to the plantation of trees and the improved management of natural resources.

Adoption

High growing spontaneous adoption (for prevention of conflicts and land degradation).

Ecological conditions

- Climate: semi-arid
- Average annual rainfall: 250-500 mm
- Soil parameters: sandy soils, with medium fertility, low soil organic matter and good drainage (low in case of soil crusting)
- Slope: mostly flat (0-2%)
- Landform: mainly plains / plateaus, valley floors
- Altitude: 0-100 m a.s.l.

Socio-economic conditions

- Size of land per household: 1-2 ha
- Type of land user: mainly poor; land user groups / community
- Population density: 10-50 persons/km^2
- Land ownership: mostly individual, titled
- Land use rights: individual, communal (organised)
- Level of mechanisation: animal traction
- Market orientation: mostly subsistence (self-supply), partly mixed (subsistence and commercial)

Production / economic benefits

+++ Increased crop yield
+++ Increased farm income
+++ Increased animal production
+++ Increased fodder quality and fodder production

Ecological benefits

++ Increased soil cover
++ Reduced wind velocity
++ Increased soil fertility
++ Increased biomass / above ground carbon
++ Reduced soil loss
++ Reduced fire risk
++ Increased animal diversity

Socio-cultural benefits

+++ Cultural benefits
+++ Conflict mitigation
+++ Community institution strengthening through mutual aid in technology implementation
+++ National institution strengthening (*code rural* secretariat)
+++ Improved cultural opportunities

Off-site benefits

+++ Reduced damage on public / private infrastructure
+++ Reduced damage on neighbours' fields
+++ Reduced wind transported sediments

Weaknesses ➜ and how to overcome

- Implementation constraints: plant production is very expensive and reaching a consensus on the transformation of private cropland to communal passageways is very difficult ➜ definition of the *couloirs* as public infrastructure and enhancement of organisational capacities of the local population through training and information sessions.
- Maintenance constraints: maintenance can only be realised by adjacent land owners, as the community organisations are weak ➜ reinforce the institutional capacities of livestock owners and farmers to manage the *couloirs.*
- In the pastoral zone the *couloirs* lead to conflicts between pastoralists and private ranches ➜ establish community-based land tenure commissions and introduce new laws on land property in the pastoral zone.

Main contributors: Abdoulaye Sambo Soumaila, Groupe de Recherche d'Etude et d'Action pour le Développement (GREAD), Niamey, Niger ; leffnig@yahoo.fr
Key references: Projet LUCOP/Tillabéry. 2004. Referential des measures techniques de recuperation, de protection et d'exploitation durable des terres, 2nd edition, 2004, 51 pp ■ Soumaila A.S. 2003. Base de données du code rural (online): www.case.ibimet.cnr.it/den/Documents/code_rural/start.html ■ Hiernaux P., E. Tielkes, E. Schlecht. 2001.Elevage et gestion des parcours au Sahel, Workshop proceedings organised by Eric Tielkes et Abdoulaye Soumaila, Verlag Ulrich E. Grauer, Beuren, Stuttgart, Germany, 2001

Case study

IMPROVED WELL DISTRIBUTION FOR SUSTAINABLE PASTORALISM - NIGER

Pastoralism, as practised in the case study area, is the traditional mode of extensive livestock husbandry, based on the movement of herds between the rich pastures in the northern pastoral zones (rainy season) and the southern areas (dry season) according to seasonal availability of water and grazing land / fodder (including residual vegetation of cropland). Both forms of pastoralism – nomadism and transhumance – are facing increasing water and fodder availability problems, due to a variety of reasons: change of climatic conditions, expansion of cropland, overstocking and overgrazing, amongst others. In view of these problems, the government of Niger has defined by law a pastoral zone, where crop production is limited to subsistence.

Within this area 'Pastoral Modernisation Zones' have been implemented, based on a new concept of semi-pastoralism to assure the sustainability of the pastoral land use system. Several practices are promoted at field level: improved distribution of water points, establishment of water harvesting structures, improved passageways for herds, improved fodder production, etc.

An optimal and efficient network / distribution of water points is a key element of modern sustainable pastoralism: it assures a balanced distribution of herds, and thus avoids overuse of vegetation around a limited number of wells. Since 1998, the number of traditional wells within the 3,000 km² of Akoubounou pastoral area has increased from 7 to 58. Construction is done by the local community – through trained well diggers. Support is provided by different development actors (government and NGOs). Well committees on community level are responsible for proper management of the wells. A fund for maintenance is established and is topped up through contributions of well users.

As a result of the improved well distribution, pastoral areas have been utilised in a more balanced manner, and overgrazing problems have been reduced by 30-40% compared to the situation in 1990.

SLM measure	Management
SLM group	Pastoralism and Rangeland Management
Land use type	Extensive grazing; Mixed (agro-silvo-pastoral)
Degradation addressed	Soil erosion by water; Soil erosion by wind; Biological degradation (overgrazing)
Stage of intervention	Mitigation and rehabilitation
Tolerance to climate change	Technology is sensitive to droughts and rainfall decrease

Establishment activities

Preparation:

1. Information and awareness raising campaign in village. Participatory planning (1-2 days).
2. Identification of sites by population, accompanied by field technicians
3. Formation and training of members of well management committee: laws, responsibilities, steering, evaluation, organisation, etc. (3-4 days).
4. Training of traditional sinkers (by external experts 1998-2000, then farmer-to-farmer training).

Establishment of well:

5. Dig well shaft: 0.8-1.5 m in diameter and 20-60 m deep (using pickaxe, shovel, bucket).
6. Install a scoop device (with cow leather or tire-tube; wire and poles).
7. Optional: Lining of the well shaft with stones / cement (e.g. if soil is not compact enough).
8. Build a wall with stones and cement around the well for protection (0.2-0.3 m wide, 0.5-1 m high).

Maintenance / recurrent activities

1. De-silting of wells (beginning of rainy season; May-June).
2. Reinforce walls of wells with cement (end of rainy season, October-November).
3. Deepen the well in case of descending groundwater level (dry season).
4. Constant monitoring of the wells by the Management Committee.

Labour requirements

For establishment: medium
For maintenance: medium

Knowledge requirements

For advisors: medium
For land users: low

Photo 1: One of the traditional wells that have been built to achieve a more balanced grazing throughout the pastoral area of Akoubounou.
Photo 2: Touareg family with a cattle herd in the pastoral zone during the rainy season.
Photo 3: Small ruminants around a traditional well during dry season. (All photos by Abdoulmohamine Khamed Attayoub / ADN)

Case study area: Akouboubou, Abalak, Tahoua region, Niger

Establishment inputs and costs per well

Inputs	Costs (US$)
Preparation (information campaign, planning, establishment of committee, etc.)	800
Construction of well (labour, equipment and material)	1,200
TOTAL	**2,000**
% of costs borne by land users	9%

Maintenance inputs and costs per well per year

Inputs	Costs (US$)
Labour, equipment and material	280
TOTAL	**280**
% of costs borne by land users	100%

Remarks: A management fund is established and managed by each well committee. Well users contribute annually, or each time maintenance work is needed. Amounts of contribution are not fixed but up to the individual, and generally proportionate to herd size. Committee can fine land users who damage the wells.

Benefit-cost ratio

Inputs	short term	long term
Establishment	positive	very positive
Maintenance	positive	very positive

Ecological conditions

- Climate: semi-arid
- Average annual rainfall: 300 mm; rainy season May-October
- Soil parameters: good drainage, in case of soil crusting low drainage, mainly low soil organic matter but high in swampy area
- Slope: mostly flat (0-2%)
- Landform: mainly plains / plateaus, valley floors
- Altitude: 0-100 m a.s.l.

Socio-economic conditions

- Size of land per household: < 1 ha
- Type of land user: community, mainly average level of wealth
- Population density: 9 persons/km^2
- Land ownership: mostly individual, titled
- Land use rights: individual, communal (organised)
- Market orientation: mostly mixed (subsistence and commercial)

Production / economic benefits

+++ Increased animal production
+++ Increased fodder quality and fodder production

Ecological benefits

++ Increased soil cover
+++ Increased soil fertility
+++ Increased biomass / above ground carbon
+++ Reduced soil loss
+++ Increased animal diversity

Socio-cultural benefits

+++ Conflict mitigation
+++ Community institution strengthening through mutual aid in technology implementation
+++ National institution strengthening (*code rural* secretariat)
+++ Improved cultural opportunities

Off-site benefits

+++ Reduced damage on public / private infrastructure
+++ Reduced damage on neighbours' fields
+++ Reduced wind transported sediments

Weaknesses ➜ and how to overcome

- High cost of implementation and maintenance ➜ active participation of pastoralists in establishment and maintenance activities; public investments; national funding system.
- Extinction of pastoral culture and traditional practices ➜ integrate pastoralists into structural transformation process; promote capacity building of pastoralists.

Adoption

The technology is well adopted in the case study area. 50 wells have been built in 12 years within a pastoral area of 3000 km^2. Implementation is based on incentives (establishment costs mainly paid by projects). However, there is a medium trend towards spontaneous adoption (by new actors).

Main contributors: Abdoulaye Sambo Soumaila, Groupe de Recherche d'Etude et d'Action pour le Développement (GREAD), Niamey, Niger; leffnig@yahoo.fr
Key references: Soumaila A.S. 2003. Base de données du code rural (online): www.case.ibimet.cnr.it/den/Documents/code_rural/start.html ■ Hiernaux P., E. Tielkes, E. Schlecht. 2001. Elevage et gestion des parcours au Sahel, Proceedings de l'atelier organisé par Eric Tielkes et Abdoulaye Sambo Soumaila, Verlag Ulrich E. Grauer, Beuren, Stuttgart, Allemagne, 2001 ■ Project documents and annual monitoring reports of develpment projects by ADN Nourriterre and HEKS EPER Suisse (2003-2009) ■ Jochen Suchantke, Abdoulaye Sambo Soumaila (2001): Etude cadre pour le programme NIGETIP IV, KfW, Niamey, Niger, 2001

ROTATIONAL GRAZING - SOUTH AFRICA

Rotational grazing is a management system based on the subdivision of the grazing area into a number of enclosures and the successive grazing of these paddocks by animals in a rotation so that not all the *veld* (grazing area) is grazed simultaneously. Consequently, rotational grazing allows higher stocking rates than continuous grazing. The main principles of rotational grazing are: (1) Control the frequency at which pasture is grazed: adjustment of the rotation cycle ensures a good forage quality in each paddock. Pasture plants (including the most preferred and therefore overused species) are provided with a period of recovery or rest following grazing; (2) Control the intensity at which the pasture plants are grazed by controlling the number of animals which graze each paddock and their period of occupation; (3) Reduce the extent of selective grazing by confining a relatively large number of animals to a small portion of the *veld*: little opportunity for selection prevents domination of undesirable species.

Intensity of grazing should be adapted to the climatic conditions: in drier areas recovery periods should be longer due to limited plant recovery potential and high sensitivity to misuse and degradation. The ratio between periods of occupation and absence determines the plant yield and vigour: the shorter the period of occupation in a paddock the greater will be the yield of the *veld*: a second 'bite' is avoided and consequently the recovery period is at least equal to the period of absence. However, the shorter the period of occupation and the longer the period of absence, the greater is the number of paddocks required in a rotational grazing system.

Ideal resting periods vary with growth rate, and with the rate at which the *veld* loses its quality with maturity. Depending on the season, the climate and the use of irrigation, resting periods vary between 14 and 70 days, and even longer in the semi-arid grasslands (90–150 days). Appropriate stocking rates are assessed through 4 rating factors (defining the veld condition): species composition, basal cover, topography and soil erodibility.

SLM measure	Management
SLM group	Pastoralism and Rangeland Management
Land use type	Grazing land
Degradation addressed	Mainly biological degradation: reduction of vegetation cover, decreasing vegetation diversity
Stage of intervention	Prevention (partly mitigation and rehabilitation)
Tolerance to climate change	The technology is tolerant to climatic changes: land users can adjust grazing and resting periods according to changing conditions

Establishment activities

1. Farm planning: including technical design of farm plan with grazing paddocks, rotational system and livestock watering system conducted mostly by extension workers or specialists from Dept. of Agriculture.
2. Fencing.
3. Establishment of stock watering system including the construction of a dam, windmill, drinking trough, pipeline and borehole.

Maintenance / recurrent activities

1. Fencing.
2. Maintenance of windmill, pipeline, dam and drinking trough.
3. Implementing the system (moving livestock from one paddock to another, attend to livestock watering requirements (opening and closing of valves and attending to windmill brake on windy days).

Labour requirements

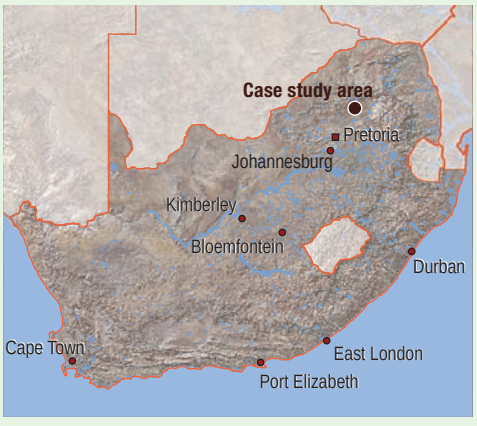
For establishment: medium
For maintenance: low

Knowledge requirements

For advisors: high (layout of the camps and design of stock watering and grazing system)
For land users: medium (implementation of the system, building of fences and stock watering system, maintenance)

Photo 1: Cattle drinking from a water trough near a windmill which pumps the water from a borehole into the dam or reservoir. From there drinking troughs are supplied. These have to be spread in a paddock to avoid local overgrazing.
Photo 2: Typical steel gate used in a rotational grazing system to allow access to and from grazing paddocks.
Photo 3: An example of a rested paddock (on the left) and a lightly grazed camp (on the right) with a barbed wire dividing the paddocks. (All photos by Lehman Lindeque)

Case study area: Crecy area, Springbokvlakte region, Limpopo Province, South Africa



Establishment inputs and costs per 500 ha

Inputs	Costs (US$)
Labour: 85 person-days	6,080
Equipment / tools: specify	1,160
Agricultural Inputs: specify	–
Construction material: specify	45,173
TOTAL	**52,413**
% of costs borne by land users	100%

Maintenance inputs and costs per 500 ha per year

Inputs	Costs (US$)
Labour: 32 person-days	3,173
Equipment / tools: specify	–
Agricultural inputs: specify	–
Construction material: specify	10,213
TOTAL	**13,386**
% of costs borne by land users	100%

Remarks: Estimated establishment time for a 500 ha farm with 8 paddocks more or less 6 months. The establishment and maintenance costs depend on farm size and the details of the farm plan / design of the paddock system including variables such as number of paddocks, number of stock watering points, number of boreholes, etc. Above mentioned costs are merely an indication for a typical livestock farm of 500 ha.

Benefit-cost ratio

Inputs	short term	long term
Establishment	very negative	positive
Maintenance	slightly negative	positive

Remarks: Establishment costs are very high and discourage many farmers from using a multi-paddock grazing system.

Ecological conditions

- Climate: mainly semi-arid, partly subhumid
- Average annual rainfall: 500 – 1,500 mm
- Soil parameters: shallow soils, medium soil organic matter, good to medium soil drainage / infiltration, soils with high fertility are used for cultivation
- Slope: 0-8 %
- Landform: plateau / plains and valley floors
- Altitude: 500 - 1000 m a.s.l.

Socio-economic conditions

- Size of land per household: 100-500 ha
- Type of land user: mainly large-scale commercial livestock farmers (large areas allow for many grazing paddocks)
- Population density: < 10 – 200 persons/km^2
- Land ownership: mainly individual not titled or partly communal village ownership
- Land use rights: mainly individual, partly communal organised
- Level of mechanisation: mechanised
- Market orientation: commercial

Production / economic benefits

+++ Increased fodder production (in available dry-material)
+++ Increased water availability / quality for livestock (through improved livestock watering systems)
++ Increased animal production (due to increased and better fodder)
++ Reduced risk of production failure
++ Increased farm income
++ Increased production area (due to better drinking water availability)

Ecological benefits

++ Increased soil moisture and reduced surface runoff
++ Reduced evaporation (through better plant cover)
++ Reduced hazards towards adverse events (floods, droughts, etc.)
++ Improved soil cover
++ Increased biomass / above ground carbon
++ Increased plant diversity and increased / maintained habitat diversity

Socio-cultural benefits

+++ Improved food security / self-sufficiency

Off-site benefits

+ Reduced groundwater and river pollution
+ Increased water availability (groundwater, spring)

Weaknesses ➜ and how to overcome

- Cost of construction or initial implementation ➜ convince farmers to see it as a long term investment to ensure sustainable production.
- *Veld* fires damage fences and drinking troughs ➜ prevent accidental *veld* fires by making fire bunds at the start of the dry season.

Adoption

Since 1994 rotational grazing is no longer subsidised by the government (subsidies restricted to small-scale communal and subsistence farmers). There is a moderate trend in adoption of the technology. Farmers realise the importance of vegetation management in sustainable livestock production, in view of the increasing pressure on grazing land and the risks of drought and climate change.

Main contributors: Lehman Lindeque, Department of Agriculture, Forestry and Fisheries, South Africa; LindequeL@arc.agric.za
Key references: Tainton N.M. 1988. Veld and Pasture Management in South Africa. Shuter & Shooter, Pietermaritzburg in association with University of Natal Press, Pietermaritzburg. ■ Department of Agriculture and Water Supply. 1989. Veld management in the Eastern Cape. Government Printer, Pretoria