Ecological Restoration of Degraded Rangelands in East Africa: Success and Failure of Traditional Enclosure

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Abstract
Increasing rangeland degradation in East Africa due to alarming land use pressure has created a serious debate which calls for quick land rehabilitation. Unsustainable utilization of range resources due to diversification of human economic activities have resulted to poor rangeland productivity. The projected increase in human population by 33% in 2050 implies more demand on scarce range resources which will intensify rangeland degradation if restoration measures are not undertaken. Although, rehabilitation plans have been developed in different countries within East African region, but implementation has been slow due to inadequate financial resources, lack of ecological restoration skills and failure to assimilate traditional range management practices. Poor integration of indigenous knowledge with ecological methods has resulted into limited constructive collaboration between scientists and local communities toward combating environmental degradation. Despite the fact that traditional range management practice using deferred

grazing system (enclosure) has successfully conserved environment and improved the livelihood of some pastoral communities elsewhere but the practice is poorly adopted for up-scaling to other communities. Traditional enclosure has been used as rehabilitation strategy to restore severely degraded rangeland through quick vegetation recovery which subsequently reduces soil erosion, increase water infiltration and provide dry season feeds for livestock. This paper therefore reviews factors limiting adaptation and adoption of tradition enclosures for rangeland rehabilitation and hence recommends the best way for integration of local knowledge with ecological restoration methods for sustainable rangeland improvement.

Key words: *Rangeland degradation, Enclosure, Rehabilitation, Ngitili, Indigenous knowledge.*

Introduction

Rangelands in arid and semi-arid regionsare one of the vital resources for human livelihood. More than 70% of total land in East Africa is ether arid or semi-arid land (Homewood, 2004) which is considered unsuitable for crop production and thus ideal for livestock grazing and wildlife habitats (Homewood *et al.*, 2012). Most of these rangelands are characterized by high spatial and temporal variability in forage resources due to differences in climatic characteristics, soil physical and chemical

properties, management practices, and topographical variation. Grazing animals from rangelands convert what is perceived to be useless forage resources to energy and protein sources required for human survival. Moreover, East African rangelands harbor millions for wildlife resources which are potential sources of nation income through tourism industry. However, over 70% of wildlife resources obtained from rangelands outside protected areas where the economic activities do not necessary conform to wildlife conservation standards (Muya *et al.*, 2013).

Arid and semi-arid rangelands in Africa are often degraded and thus considered unproductive (Vetter, 2005). Increasing human and livestock population and encroachment of rangelands by other land uses raise a serious competition over rangeland resources in East Africa and thus call for quick land rehabilitation (Selemani, 2014; Vetter, 2005). Unsustainable utilization of rangelands creates an increasing pressure on rangeland resources, resulting in declining soil fertility and general environmental degradation. Poor livestock productivity in East Africa is attributed with severely degraded rangeland

evidenced by poor nutritive value of available forage species (Kakengi *et al.*, 2005). Most native forage species in degraded rangelands are characterized by rapidly maturing annual grasses which remain with poor quality for long dry period (Mwilawa *et al.*, 2008). Grazing animals in arid and semi-arid rangelands are normally subjected to undernourished condition for long dry season; pastoralists are feeding only on natural forages and crop residues with low crude protein ranging from 3 to 4 % that is well below maintenance requirements of ruminant animals (Mtengeti *et al*., 2008).

Recently, the global human population was reported to be more than seven billion people and estimated to rise to over nine billion by 2050 (RSPB, 2012), nearly all of these population increase will occur in developing countries. This implies that, the demand for range resources (forages and water) will increase while competition for land will be intensified unless the restoration measures are undertaken. Several rehabilitation initiative plans have been developed in respective East African countries but the implementations often have been slow (Cohen 2002).

Among the recommended restoration measures include but not limited to; proper stocking rate, selection and planting of drought tolerance forage species, resting overgrazed rangelands, water development and soil conservation through alley contour farming and integrated leguminous tree fodder growing. However, lack of agronomic practical skills and scarcity of financial resources normally limit rangeland rehabilitation initiatives. Nevertheless, little information is known on the available and affordable indigenous knowledge and skills potential for rangeland restoration. Assimilation of indigenous range rehabilitation techniques in semi-arid rangeland of Eastern Africa is imperative.

Integration of local knowledge with ecological methods toward combating rangeland degradation in East Africa is very limited (Oba *et al.,* 2008). Governments' initiatives together with International Organizations' efforts against environmental degradation exclude indigenous knowledge and thus considered scientific method exclusively (Oba *et al.,* 2008). The global debate normally attributes rangeland degradation with poor local land use practice, but seldom

reflects the restoration achievement through indigenous practices. In their review of environmental policy in Tanzania, Mattee and Shem (2006) claimed that, negative perceptions pervade among scientists and policy makers that pastoral communities are environmental destructive. According to Vetter (2005) pastoral system is viewed as overstocked, overgrazed, degraded and unproductive. Oba *et al.* (2008) attributed these scientific biases to poor perceptions that herders are sources of environmental degradation. Nevertheless, the academic training of natural scientists whose understandings are largely influenced by scientific methods and theories are rarely reflecting the role of local knowledge in range management. Poor linkage between ecological methods and indigenous knowledge could hardly foster constructive collaboration among different rangeland stakeholders toward fighting against environmental degradation. This paper reviewed the roles of traditional enclosures as important ecological restoration techniques and thus recommends integration of local knowledge with ecological restoration methods.

Perceptions of Community on Communal Rangeland Management

Most rangelands in East Africa are managed under communal system which decisions on range resources utilization and management is made collectively by community members. There is general perception that degradation of communal rangeland is inevitable compared to those managed privately (Selemani *et al.,* 2013). The Hardin's Tragedy of Commons theory predicts overexploitation or degradation of all resources held in common (Hardin 1968). According to Feeny et al. (1990), Common-Property Resources (CPRs) share two main characteristics namely; excludability and sub-tractability. Excludability in this context refers to the challenge related to control access to potential users of CPRs. It is believed that control utilization of resources held in common by excluding potential users is costly and virtually impossible due to physical nature of CPRs (Feeny *et al.,* 1990). On the other hand, there is problem related to sub-tractability of CPRs whereas each user is capable to subtract from the welfare of other users. It should be noted that, the level of

exploitation of CPRs by one user can adversely affect the ability of other users to exploit the same resources.

Although, the Hardin's Tragedy of Commons theory is widely accepted and used as basis for resource management, but many scholars (Kissling-Näf *et al.*, 2002, Quinn *et al.*, 2007) argued that, the model is not sufficient to draw valid conclusion concerning behavior of all common resources. Degradation of resource does not necessarily depend on the physical nature of resource in particular, but rather, the institution framework is far important to determine the nature of management and level of utilization. Empirical evidence show that, if CPR managed properly it can be utilized sustainably (Selemani *et al.*, 2013). Quinn et al. (2007) argued that, institution design can determine the access and utilization of CPRs. The author argued that, not all CPRs are open access, instead common property regimes exist where there is shared leadership with rules and regulation governing utilization of CPRs. According to Bennett et al. (2007), Common property regimes consists of well-defined groups of authorized users, a well-defined resources and a set of

institutional arrangement with rules and regulation governing the resource in question. Common property regimes represent the regulations whereby the cost of management and benefits accrued from CPRs are shared equally (Kissling-Näf *et al.,* 2002).

A body of literature indicates that establishment of enclosures in communal rangelands has become important restoration measure for combating degraded rangelands in East Africa semi-arid regions (Verdoodt *et al.,* 2009). Rangeland restoration achievement through traditional enclosures is usually determined by institutional framework which is normally linked with the nature of benefits and the underlying incentives (Beyene, 2010). Generally, most communal enclosures in East Africa suffer from poor institution arrangement resulting in poor rangeland monitoring (Quinn *et al.*. 2007; Selemani *et al.*, 2013). Briske et al. (2008) reported that, the anticipated benefits of deferred grazing system (enclosures) have not been realized over the 60 past years in communal rangelands. Range resources assessment that compared vegetation performance of private and communal

enclosures (Ngitili) in the North-West semi-arid rangelands of Tanzania confirmed significant poor vegetation performance in communal Ngitili compared to those managed privately (Selemani *et al.,* 2013). Poor performance of communal enclosures normally attributed to lack of responsibilities and economic incentives among community members. On the other hand, a well-managed enclosure is very useful restoration technique that enhances vegetation regeneration, increase water availability, reduce water and wind erosion and augment biodiversity conservation (Verdoodt *et al.,* 2009). This implies that, institutions governing the common resources need to be reorganized by setting some rules, regulations and code of conducts to safeguard the given resources in place.

Success and Failure of Traditional Enclosures

Status of Traditional Enclosure in East Africa

Rehabilitation of degraded rangeland in arid and semi-arid regions often involves temporarily excluding animals from grazing land well known as enclosure. Yayshet et al. (2008) defined enclosure as a specific land unit protected from activities of particular class of animals using

appropriate barriers such as fencing. Although Aerts et al. (2009), differentiated between the term enclosure and exclosure but many authors (Yayshet *et al.,* 2008) use the two terminologies exchangeably. These tradition enclosures which sometime refers as deferred grazing (Selemani *et al.,* 2013) or traditional reserved pasture land (Mwilawa *et al.,* 2008) allows vegetation recovery which subsequently reduce soil erosion, increase water infiltration and provide adequate fodder biomass for livestock feeding (Aerts *et al.,* 2009). Enclosures have been used by pastoral and agro-pastoral communities in East Africa for many years to provide dry season feed for ruminants (Mwilawa *et al.,* 2008). Different local names for enclosure have been used by different pastoral communities in East, such as *Ngitili* for Sukuma, *Milanga* for Gogo, and *Olopololi* for Masaai (Table 1).

Traditional enclosures have enabled severely degraded grasslands in East Africa to recover from extensive grazing and deforested areas to become woodland again, at a surprisingly fast rate. It was reported that, about 800 ha around Amboseli National Park, that were badly degraded

have been re-greened using traditional Masaai Olopololi practice (Manki, 2015). Similarly, Ngitili practice in Sukuma-land, has successfully conserved environment and improved the livelihood of communities in the Lake region. Barrow and Shah (2011) reported that, between 300,000 to 500,000 ha of Ngitili have been restored in 833 villages of the Lake region.

Table 1: Some example of enclosure practices in East Africa

Enclosure name	Pastoral group	Description	References
Ngitili	Sukuma	Dry season Fodder reserve for Sukuma people Farmer-lead initiative involves retaining an area of standing vegetation from the onset to the end of the rainy season	Kamwenda 2002
Olopololi	Masaai	Reserved grazing land near Masaai homestead was traditionally reserved for calf grazing Olopololi is sub-divided and rotationally grazed	Anderson and Grove 1989
Milanga	Gogo	Reserve grazing land affiliated with particular clan Management is associated with ritual leadership	Rigby 1967

Although enclosure management is very useful restoration tool in most degraded rangeland, but its validity remain unknown by range ecologists and other scientists. For example, it has been noted that, Ngitili practice has poor adopted by scientists as important restoration practice system in Tanzania (Kamwenda, 2002).

Economic values of enclosures in East Africa

Apart from ecological importance of enclosing communal rangeland, enclosures have diverse economic incentives to millions of people living in arid and semi-arid East Africa region. The multiplicity of goods and ecosystem services provided by enclosing the land are critical for the livelihood of people. Vegetation recovery from enclosing the rangeland provides essential goods such as timber, firewood, fruits, medicines, honey and fodder for livestock feeding which are potential source of the household income. In addition to provision of dry season feed, enclosures are used as direct source of cash income to the owners through hiring or selling the harvested forages from enclosures (Buyene, 2009). A well-managed enclosure play major role in offering ecosystem services

such as water catchment and purification, soil and water conservation, biodiversity conservation and carbon sequestration (Table 2). For example, it was projected that, deferred grazing system (*Ngitili*) in Shinyanga region, could sequester the huge amount of carbon equivalent to USD 10,227 per village per 25 yearsin the North-western region of Tanzania (Barrow and Shah, 2011).

Table 2: Economic incentives of enclosures in Shinyanga Region, Tanzania

Issue	**Outcome**
Economic value of restored Ngitili	$ 14 per month per person
Reduced cost of Wildlife damage due to restored forestry	Approximately $65 per family per year
Average value of natural resource products used per annum	• Per household = $1,200 per annum • Per village = $700,000 per annum • Per district = $89,620,000 per annum
Biodiversity conservation	• Plant Species found = 152 (30 different families) • Birds species recorded during dry season = 145 • Mammals species recorded during dry season =13
Reduction in time for	• Fuel wood = 2 to 6 hours

collecting various goods	• Poles = 1 to 5 hours • Thatch = 1 to 6 hours • Water = 1 to 2 hours • Fodder = 3 to 6 hours
Percentage of households using Ngitili	• Education = 36% (10 to 61%) • Food = 22% (7 to 52%) • Fodder = 21% (10 to 37%) • Medicinal = 14% (5 to 36%) • Fuel wood = 57% (54 to 63%)
Estimated C sequestration	• Total carbon =23.21 million ton. • Equivalent Co_2 =42.6 million ton.

Source: Barrow and Shah 2011

Increasing market value of enclosures with time has been observed among pastoral communities. Selling grass from enclosed land has increasing become common phenomenon attributed with increasing severityof feed shortage (Beyene 2010). The survey by Wirskerke et al. (2009) found that, selling fodder grass was common in Tanzania from both private and communal/village enclosures and the prices was ranging from Tsh. 500 to 2000 per sack. Interestingly, integration of fodder trees

within enclosures has potential of maximizing economic value through Nitrogen fixation which in turn increase forage yield.

Factors limiting adaptation and adoption of traditional enclosures

Despite the fact that, various benefits of enclosure described above, up calling of this technology to the large landscape has been slow.Slow adoption rate has been associated to several factors that need be addressed using multi-approaches and disciplines. The first and foremost important factor limiting adaptation of enclosure as range management tool is the lack of awareness among pastoralists. Although, this technology has been used historically by some pastoral communities, little has been documented and hence fewer publications are available. Lack of understanding on how enclosure works is one of the challenges impending adoption of this traditional innovation to wider pastoral communities. Chi and Yamada (2002) claimed that, in absence of awareness, the adoption of technology is hardly achieved even when the farmers have positive perception toward certain

technology. Capacity building through training and awareness creation through various methods such as farmers' conferences/workshops, media (TV and Radio broadcasting) and publication are recommended.

Land scarcity is also among the factors limiting practicing and adoption of enclosure technology. Since enclosure involve excluding animals from a piece of grazing land for particular unit of time, relatively large land size is required. Excluded animals from enclosure, normally shifted to another grazing area before returning again especially during acute shortage of forage resources. The rotational movement of animals between reserved lands requires setting aside enough land. Increasing human population coupled with expansion of other land uses such as crop production and protected areas create pressure to the limited grazing land. For example, in Tanzania the agricultural population has steadily encroached the pastoral areas even those areas (such as Kiteto, Moduli and west Kilimanaro) which were considered unsuitable for cropping. Growing in land demand in Tanzania is associated with increased in human population, climate

change, economic growth and international and local political pressure (Kimaro and Heironimo 2015).

In connection to land scarcity, the land security in terms of tenure and users rights complicates the adoption of enclosure technology. Although, all lands in Tanzania are considered as public land, but the variations in users rights resulted into land use conflicts among users. Nevertheless, management of communal grazing land is constrained by several factors, including but not limited to poor management, poor monitoring and thus over-exploited. Practicing enclosure in communal land (especially with poor institution arrangement) may result into failure or less achievement. Selemani et al. (2013) established relatively poor condition of communal enclosures in Sukumaland, and recommended strengthening of institutions governing communal resources. In this context, institutions should include both formal (laws and by-laws) and informal (codes of conduct and behavior) that regulate rights to access, use, control and monitoring of communal grazing land.

Conclusion

Traditional enclosure has been used in East Africa historically as rehabilitation strategy to restore severely degraded rangeland. Ecologically enclosure results into quick vegetation recovery which subsequently reduces soil erosion, increase water infiltration and provide dry season feeds for livestock. However, there several factors limiting adaptation and adoption of tradition enclosures for rangeland rehabilitation. Some of factors impending adaptation and adoption of enclosure practices are lack of awareness, land scarcity, land security and poor institutional set up. This paper recommends creation of awareness through integration of local knowledge with ecological restoration methods for sustainable rangeland improvement. Nevertheless, it is recommended to establish a clear land use system through on-going land use plan. In addition, strong institution organization is recommended for sustainable traditional enclosure practices.

Reference

Aerts R, Nyssen J, Haile M. (2009). On the difference between "exclosures" and "enclosures" in ecology and the environment. *Journal of Arid Environments* 73: 762–763.

Anderson D. and Grove R. (1989). Conservation in Africa: People, Policies and Practice. Cambridge University Press, Cambridge, 368 pp.

Barrow, E. and Shah, A. (2011). TEEBcase: Traditional forest restoration in Tanzania. Available at: TEEBweb.org.

Bennett J, Lent PC and Harris PJC. (2007). Dry season foraging preferences of cattle and sheep in a communal area of South Africa. *African Journal of Range & Forage Science*, 24:3, 109-121.

Beyene F. (2010). Locating the adverse effects of rangeland enclosure among herders in eastern Ethiopia. *Land Use Policy* 27: 480–488.

Briske DD, Derner JD, Brown JR, Fuhlendorf SD, Teague WR, Havstad KM, Gillen RL, Ash AJ, Willms WD. (2008). Rotational grazing on rangelands: reconciliation of perception and experimental evidence. *Rangeland Ecology and Management* 61: 3–17.

Chi T.T. N. and Yamada R. (2002). Factors affecting farmers' adoption of technologies in farming system: A case study in OMon district, Can Tho province, Mekong Delta. *Omonrice* 10: 94-100.

Feeny D, Berkes F, McCay B, Acheson J. (1990). The tragedy of the commons: twenty-two years later. *Human Ecology* 18: 1–19.

Hardin G. (1968). The tragedy of the commons. *Science* 162:1243–1248.

Homewood KM. (2004). Policy, environment and development in African rangelands. *Environmental Science and Policy* 7: 125–143.

Kakengi A. M. Shem., M. N. Mtengeti E. P. and Otsyina R. (2005). *Leucaena leucocephala* leaf meal as supplement to diet of grazing dairy cattle in semiarid Western Tanzania. *Agroforestry Systems* 52: 73–82, 2001.

Kamwenda GJ. (2002). Ngitiliagrosilvipastoral systems in the United Republic of Tanzania. *Unasylva*53: 46–50.

Kimaro D. N. and Hieronimo P. (2015). Land for Agriculture in Tanzania: Challenges and Opportunities. *Journal of Land and Society*, 1(1): 91-102.

Kissling-Näf I, Volken T, Bisang K. (2002). Common property and natural resources in the Alps: the decay of management structures? *Forest Policy and Economics* 4: 135–147.

Quinn CH, Huby M, Kiwasila H, Lovett JC. (2007). Design principles and common pool resource management: an institutional approach to evaluating community management in semi-arid Tanzania. *Journal of Environmental Management* 84: 100–113.

Manki O. (2015). Keeping the Wildlife in Amboseli. https://justdiggit.org/project/kenya-amboseli/

Mattee A Z and Shem M N (2006). Ambivalence and Contradiction A review of the policy environment in Tanzania in relation to pastoralism . Landon: International institute of environment and development.

Mtengeti EJ; Phiri EC;Urio NA;Mhando DG;Mvena Z;Ryoba R;Mdegela R; Singh BR; Mo M;Wetlesen A;L⊘rken T;Reksen O. (2008). Forage availability and its quality in the dry season on smallholder dairy farms in Tanzania. *Acta AgriculturaeSc and Section* A, 58: 196-204.

Muya S. M. Kamweya A. M, Muigai A.W. T., Kariuki A., and Ngene S.M. (2013). Using Range Condition Assessment to Optimize Wildlife Stocking in TindressWildlife Sanctuary, Nakuru District, Kenya. *Rangeland Ecological Management* 66:410–418.

Mwilawa AJ;Komwihangilo DM;Kusekwa ML. (2008).Conservation of forage resources for increasing livestock in traditional forage reserves in Tanzania. *Africa Journal of Ecology*46: 85–89.

Oba, G., Sjaastad, E., and Roba, H. G. (2008). Framework for Participatory Assessments and Implementation of Global Environmental Conventions at the Local Level. *Land Degradation and Development*, 19: 65–76. doi:10.1002/ldr.811.

Rigby P. (1967). Time and Structure in Gogo Kingship. Cahiers d'étudesafricaines, 7 (28): 637-658 RSPB 2012. Balancing agricultural production and conservation. RSPB Paper to the Oxford Farming Conference of 2012.

Selemani I S, (2014). Communal rangelands management and challenges underpinning pastoral mobility in Tanzania: a review. *Livestock Research for Rural Development* 26 (5) 2014.

Selemani I S**,** Eik L O, Holand Ø, Ådnøy T, Mtengeti E and Mushi D (2013). The effects of a deferred grazing system on rangeland vegetation in a north-western, semi-arid region of Tanzania. *African Journal of Range & Forage Science*, 30 (3): 141-148.

Verdoodt A, Mureithi SM, Ye L, van Ranst E. (2009). Chronosequence analysis of two enclosure management strategies in degraded rangeland of semi-arid Kenya. *Agriculture, Ecosystemsand Environment* 129: 332–339.

Vetter S (2005). Rangelands at equilibrium and non-equilibrium: recent developments in the debate. *Journal of Arid Environments*, 62 (2): 321-341.

Wiskerke WT, Dornburg V, Rubanza CDK, Malimbwi RE, Faaij APC. (2010). Cost/benefit analysis of biomass energy supply options for rural smallholders in the semi-arid eastern part of Shinyanga Region in Tanzania. *Renewable and SustainableEnergy Reviews* 14: 148–165.

Yayneshet T, Eik LO, Moe SR. (2009). The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *Journal of Arid Environments* 73:542–549.