Need for Well Trained Personnel on Range Resources Inventory and Monitoring for Sustainable Utilization of Grazing Lands in Tanzania

Mtengeti, Ephraim Joseph

Department of Animal, Aquaculture and Range Sciences, Sokoine University of Agriculture,P.O. Box 3004, Morogoro, Tanzania. ***Corespondence****: emtengeti@gmail.com*

Abstract

Continuous extensive cultivation, unplanned conservation and unguided grazing have resulted to depletion of soil organic matter, severely threatening soil fertility and damaging soil structure and thus loss of the ecosystem ability to produce commodities and values. Therefore, families are migrating from one place to another to find fertile soils to grow their crops, and pastures and water for the livestock. The conservationists increase force to guard protected areas even those taken from the common unmanaged grazing lands. In the worst cases, bitter confrontations have erupted over land use pressure between migrating pastoralists and crop cultivators and even between the crop growers, livestock keepers and conservationists. Several approaches have been sought in resolving bitter consequences of land use pressure by relocating farmers and pastoral communities or use force to bring harmony in case of confrontations but such approaches cannot repair as quickly as possible the loss of the ecosystem ability to provide commodities and values to the poor communities. The bench mark for resolving such

chaos over land use pressure is to build capability of the farmers and pastoral communities on soil and water conservation so as to improve biomass and at least increase vegetation cover to about 75 % throughout the year. This can only be done with well skilled personnel who can efficiently conduct grazing lands resources inventory and monitoring and guide the livestock keepers on sustainable use of these lands. This will increase vegetation cover and thus rain water infiltration, organic carbon, improve soil structure, improve biomass and thus better crop and livestock production. This paper elaborates the importance of well trained personnel on efficient range resources inventory and monitoring for sustainable utilization of the public and private grazing land areas in Tanzania.

Keywords: *Benefits of grazing land, grazing land degradation, Livestock-wildlife interaction, Consortium of technical personnel*

Introduction

Tanzania has approximately 60 million ha of rangelands with a carrying capacity of 20 million Livestock Unit (LU) and providing over 90% of the feed resource for livestock (MLFD, 2011). However, out of those 60 million ha only about 9.3 million ha are designated as grazing land (NAFORMA, 2015) and only about 1.28 million has so far

been demarcated as grazing lands under village land use plans in Tanzania Main Land (MLFD, 2015).

The Tanzania Mainland Grazing-land and Animal Feed Resources Act No. 13 of 2010 reinforces the National Livestock Policy (2006) that aims at stimulating sustainable development of the livestock industry. In particular, through exploiting the available potentials to enhance the contribution of livestock sector to the national economic growth at the same time ensuring environmental conservation. The countrygrazing lands, however, are under increasing over-exploitation pressure and expansion of protected areas. Over the past 15 years livestock population in the country have been increasing by 5% per annum (MLFD, 2015). For example cattle population increased from 21.3 mil. in 2010 to 26 mil. in 2016 while over 70% of cattle population in the country is found in the lake, northern and central zones (MLFD, 2011).

Grazing lands in Tanzania are increasingly converted to other land uses such as farming, infrastructure construction and other developments. On the other hand, more than 40% of the land area in Tanzania is under some form of

conservation regime (Benjaminsen and Svarstad, 2010).Expansion of conservation areas, such as wildlife conservation, forest reserve and strategies to implement agricultural corridors have been reported to accelerate land use conflicts in the country (Abdallah *et al.*, 2014). By 2015, main results of NAFORMA showed that 32.5 % of the Tanzania mainland was under protected forest and wildlife reserved areas, while 22.5 % was under production forest area (Table 1). Thus total protected area is nearly 50 % of the Tanzania mainland land mass.

Table 1. Land use class distribution in Tanzania mainland

Land use class	**Land area in 1,000 ha**	**Percentage**
Agriculture	20,604	23.4
Shift cultivation	5,790	6.6
Grazing land	9,306	10.6
Production forest	19,798	22.5
Protected forest	9,377	10.7
Wildlife reserve	19,121	21.7
Build-up areas	1,936	2.2
Other land	1,423	1.6
Water bodies	659	0.7

Source: NAFORMA (2015)

With shrinking grazing land area and blockage of livestock migratory routes pastoral communities are forced to sedentary life.The consequence of sedentary life of pastoral communities is evidenced through decreased vegetation cover, changes in plant species composition, ease access of invasive plants and bush encroachment, reduced forage yields, reduced livestock performance including death and large patches of bare lands leadingto sheet and gully erosionin most rangeland areas in our country (Seleman *et al.*, 2016, Mtengeti, 2015).This trend have lowered grazing land productivity and thus less carrying capacity for human and livestock hence an increased encroachment by pastoralist to the protected areas. Only 2% (1.28 million ha) of the land deemed suitable for grazing is currently however, protected within village land use plans (MLFD, 2015). Given that more than 50% of Tanzanian households are engaged in livestock production (MLFD, 2015) grazing lands conservation and management should getappropriateimportance and profile in national land designation and protection. A primary task of the livestock modernization effort should therefore be to secure and strengthen integrity and health of these grazing lands.More

than 70 % of our country population earns their living from subsistence agriculture, characterized by low productivity due to low use of agricultural inputs because of lack of capital and skills. In the absence of appropriate agricultural inputs more land is required from the grazing land or conserved areas to produce enough food to meet the demand of an increasing human population. This adds more hot spots for conflict among cultivators and livestock keepers or conservationists.

One of the most fundamental problems confronting livestock keepers in the country at present is how to meet the basic requirement of their livestock on the same allocated grazing land year after year without simultaneously destroying its resource, i.e. depletion of vegetation cover and soil degradation. Essentially 60% of Tanzania grazing land (9.3 mill ha) is under light (50 %), moderate (7 %) and severe (2.7 %) erosion (Nyamoga *et al.,* 2016). This requires rehabilitation of degraded grazing lands and before they are totally unable to support the grazing animals. Rehabilitation of degraded land involves restoring some of its productive functions, even if they are

different from its original functions. Its implementation will be achieved by setting land rehabilitation targets. This involves setting baselines for monitoring, evaluating trade-offs, and prioritizing ground-level actions at appropriate scales.

Monitoring grazing land condition helps to decide whether or not the current management is affecting the land in a desirable way, compare grazing areas that are being managed differently and test new management approaches to evaluate their effects on the land, notice benefits of new management approaches,notice early signs of grazing land degradation before the land becomes more degraded, show development partners, community members, and other interested parties that grazing land health is changing.

In order to set a correct baseline for monitoring, evaluating trade-offs, and prioritizing rehabilitation actions, therefore, inventoryof grazing land resources have always been a prime tool. Grazing land resources inventory is information collected to document and describe the existing resource status within a grazing land management

unit. Features included depend on the purpose of the inventory, but for agrazing land situations are likely to entail vegetation types, key plant species, key areas, vegetative ground cover, carrying capacity, soil types, utilization patterns, topography, streams, and improvements such as roads, watering points, crushes and fences.Inventory information assist in making wise decisions on appropriate utilization and any required level of rehabilitation.

Knowledge on inventorying and setting baselines for correct monitoring of grazing land resources and interpretation skills are lacking to public (in village grazing lands) and even most private grazing lands (ranches) managers. Technical assistance on the inventory and monitoring of rangeland resources and interpretation skills should therefore be provided to grazing land users. This means training more personnel equipped with range management skills right from certificate to graduate level so as to handle field work and research.

This paper aims at providing the reader with the importance of well trained personnel in range management for a technical assistance to livestock keepers on how to utilize their grazing lands sustainably.

Main causes of grazing land degradation

There are several causes of rangeland degradation, they include:-

i) Overgrazing of the grazing lands by livestock is believed to be most widespread cause of degradation in the dry areas. However in driest or hyper arid areas stock survives for a period on xerophytic shrubs and ephemeral grasses, and therefore once these plants are grazed the animals have to be moved somewhere else. For this reason, there seems to be a balance between carrying capacity and livestock units in the hyper-arid zones. In arid and semi-arid zones, livestock density is above the potential carrying capacity most part of the year because it the prime zone for wildlife conservation and expansion of unguided crop farming to feed increasing human population. These arid and

semi-arid areas especially in central and northern Tanzania are the most degraded parts of the country.

ii) Insecure land tenure. In village grazing lands tenure may loosely be applied in a way that does not give incentive for long term grazing management development plan. Village grazing lands are the most land vulnerable to be disposed to investors, mining, and wildlife or forest expansionist.

iii) Poor market access and services. Our livestock markets are sometimes very far from the grazing lands and even when near most provide estimative prices that do not give incentive to the livestock keeper to sell their livestock. This has also contributed to less grazing animal off take and thus increased overgrazing in most of the country's grazing lands.

iv) Wildfire incidents associated with grazing have equally adverse effects as overgrazing. The dry sub-humid regions are always affected by fire outbreaks during the dry season, which contribute to degradation.

v) Shrinking of grazing land area due to encroachment of these areas by un guided crop production and expansion of conserved areas. Smallholder farmers who form the majority food crop growers in the country lack purchasing power for agricultural inputs and knowledge on how to use the inputs correctly. Thus they increase food production through expansion of the cultivated land instead of intensification.

vi) Blockage of stock routes through farming, conservation, infrastructure construction have lead the grazing livestock to concentrate in the same area for the whole year in wet and dry season. This has reduced or stopped movement of livestock and sedentarization of nomadic herders has increased local overgrazing.

vii) The availability of more secure watering centres also induces pastoralists to change their herd composition in favour of sheep, which leads to more pressure around watering centres. While increased water supplies are necessary in the drylands for a proper use of natural resources and to alleviate living

conditions, the almost inevitable result is the concentration of population and livestock around these watering points which disturbs the fragile ecological equilibrium. During the period from 1960 to 1991, over 5500 wells and boreholes were opened in central Sudan. These wells and boreholes resulted in the degradation of about 25 million ha. A study in western Sudan showed the steady increase of bare soils around boreholes with time, increased from 20 to 55 % in 30years (Al-Awad *et al.*, 1985). The area was 29000 km^2 and livestock units increased to 500,000 i.e. 17 units/km^2 which was very high for such a semi-arid area of sandy soils.

viii) Total rainfall is by far the most dominant limiting factor in the dry rangelands. Drought diminishes grazing land productivity, but also adversely affects feed quality and species diversity. Drought also affects the composition and size of the herd. Under such conditions, for example, goats suffer least and recover most quickly. If drought continues to the extent of rangeland desiccation, pastoralists abandon the area.

There is a need therefore, of appropriate methods and precise data collection to feature out on the status, trends and hazards of the current magnitude of the grazing land degradation in our country. The key areas of focus include:

- availability, condition and land tenure status of grazing lands in the country;
- assessment and evaluation of nature of grazing lands degradation;
- the collection and dissemination of information on grazing land degradation;
- the emerging issues of as nature of livestock destocking rate, migration, and marketing status.

The outputs of the assessment and monitoring activities are direct inputs into awareness-building and promoting action to combat degradation. Therefore, it is imperative to focus on acquiring, providing and disseminating information on grazing land degradation in appropriating formats to those who need it. The data generated will promote the development of options, priorities and tools to address the

issue of combating grazing land degradation and the development of action plans.

Pastoral society will benefit from well trained personnel by being provided with the technical knowhow that will allow them to make better decisions for managing the grazing resources, in a way that maximizes livestock production while at the same time minimizes the risk of land degradation.

Requirements of sustainable utilization of grazing lands

FAO (1991) define sustainable agriculture as "the management and conservation of the natural resources base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations". Therefore sustainable utilization of grazing lands will entail land uses that conserve soil, water, desirable plant genetic resources, environmentally non-degrading, technically appropriate, economically viable in terms of grazing animal productivity, and socially acceptable. This definition acknowledges the key role that

humans have a role for the current and the future in sustainable grazing lands utilization. Essentially, sustainable development of these grazing lands will require setting of strategies and tools to achieve the following:

i) Integrate conservation and development
ii) Ensure satisfaction of basic human needs
iii) Achieve equity and social justice
iv) Provide for social self-determination and cultural diversity
v) Maintain ecological integrity

Each of the above is a major goal in itself and a condition for achieving the others, thus underlining the interdependence of the different dimensions of sustainability and the need for an integrated, interdisciplinary approach for achievement of growth that is sustainable. One may ask what are the sustainability indicators and how can they be monitored? The sustainability indicators can be of two kinds i.e. physio-biotic or socio-economic. These could be healthy soils, appropriate vegetative cover and productivity, continued water availability, sustained animal productivity as physio-

biotic sustainability indicators and improved household healthy, food and income as socio-economic sustainability indicators. Bare soil patches, soil loss due to erosion, increased run-off, damage of watersheds and loss of biodiversity are some of the indicators of loss of sustainability utilization of grazing lands.

Sustainable use of grazing lands requires access to reliable baseline information. These data are provided by grazing land resources inventory and monitoring of a variety of types of information, including; the distribution, productivity and composition of natural vegetation; rainfall and temperature regimes; edaphic and hydrological data, grazing land utilization and wild and domesticated animals; land tenure and ownership; and socio-economic information and marketing.

A properly planned grazing land resource inventory and environmental monitoring program must include both an initial study to establish prevalent resource levels and, if possible, establish broad historical trends; and a longer-term monitoring exercise to maintain the currency of the

information and identify ongoing trends. Resource inventory is primarily used to establish baseline data or to provide the information required for development planning and targeting.

Assessment, monitoring, and interpretation of observed variations in inter-annual vegetative is rather difficult and the only other reliable and measurable criterion of degradation is irreversible soil and terrain degradation, or loss. The decline of biological productivity cannot be regarded as an indicator of degradation because this process might be reversible and connected with climatological cycles. The most stable soils are vertisols. Natural soil seed banks in the drylands may also be used to see the chance of recovery from degradation. It has been shown that the seed bank in the drylands could be as high as 500 seeds/m^2 which can help in re-vegetation of degraded land if rested from grazing.

Rangelands are not static entities but usually subject to major seasonal variations, as well as longer-term cycles of drought and recovery. Due to increased exploitation of

rangelands, there is often a general medium to long-term trend towards degradation due to overexploitations. It is, therefore, not enough to furnish baseline data alone but a trend perspective is essential if planning for sustainable rangeland exploitation is to be feasible.

Sustainable use of natural resources places the focus on two groups of disenfranchised people: the poor of today and the generations of tomorrow. The rapid degradation of the natural resource base of the rural poor is significantly worsening their poverty. Yet many of the threats to the environment in the developing world occur as a result of poverty. Indeed, rural poverty and degradation of the environment are mutually reinforcing. When people's survival is taken at stake they are forced to overstock fragile lands, cut trees for firewood and over exploit ground water resources.

The following questions may be raised to clarify sustainability of our grazing lands productivity.

- Is nomadism still a viable option?
- Can forage and water resources be sustained under current land use pressure?

- Are there alternative uses for these lands?
- What are the biodiversity implications of a change in land use?
- What are cost-effective techniques and tools to do resource status monitoring?
- How do we ensure involvement and participation by local people?
- Are the current nature conservation practices within the United Nation sustainable development goals?

The above questions require socio-ecological understanding that can be obtained from well trained personnel. Training of such personnel to conduct field work and research to answer the above posed questions should be given a priority by our nation in order to halt furtherdamage of the natural ecosystems that sustain our renewable resource base.

Public benefits from well managed grazing lands

There are several broad public benefits that results from well managed grazing lands. These include: - protection of grazing lands' ecosystems; prevention of soil erosion;

maintenance or enhancement of soil health; sustained forage and livestock production; improved water yield and quality; carbon sequestration; clean air and quality recreational opportunities. The benefits of our grazing lands are therefore several. These benefits of well managed grazing lands were sustained through indigenous knowledge (IK) when the human population was low and uses of land were few. With increased and disruptive agents of IK the well-being of grazing lands has deteriorated and fewer benefits from these lands may be realized. In most areas of the country, degradation has occurred due to lack of scientific knowledge (SK).

Among the obvious benefits public can enjoy from well managed grazing lands are:-

i) Improved water yield and quality. Properly managed grazing lands in the form of forage and soil leads to increased water quality and quantity with air quality improvement through carbon sequestration.. One of the factors determining water availability for either domestic or productive activities is the condition of the grazing lands

where precipitation falls. Lands with sufficient vegetative cover reduce run-off and flooding through enhancing even distribution of surface waters while promoting infiltration of precipitation to recharge groundwater aquifers. Bush and tree encroachment on grazing lands without ground vegetative cover cannot slow the run-off and thus will not recharge effectively the aquifers and lead to short lived flow springs and streams. Overgrazed grazing lands with lots of bare patches increases sedimentation load which affect water quality, aquatic habitat and reduces the depth of surface water resources including lakes and dams. As aresult, causing flooding and loss of water storage area. Properly managed grazing lands provide a natural filtering of sediments. Therefore enough clean water flow is a major product of well managed grazing land.

ii) Livestock-Wildlife interaction recreational opportunities. Adequate supplies of grazing resources on private lands throughout the year are essential for both wildlife and livestock. In areas

such as Loliondo, Serengeti, Tarime, Simanjiro and Kiteto Districts(O'Malley, 2000; Nelson, 2012) a large variety of wildlife species are dependent upon village grazing lands for some or all of their habitat needs (Figure 1 & 2). Domestic and wild ungulate species may graze or browse sometimes the same plant species. As numbers of these grazing livestock and wildlife species increase, an adequate balance of plant species must be provided to prevent reducing the performance of both wildlife and livestock. If grazing demands by either wild or domestic animals exceed the supply at any given time, adequate forage for survival may not exist at sometimes of the year. Therefore, either livestock or wildlife may require to cross over grazing area to subsist itself. This is where the two sectors i.e. livestock and wildlife should harmonize their policies, acts and regulations and thus improve ecological processes and goods for the community well-being. Separatism of these two sectorial policies, acts and regulations will continue to deteriorate the ecological health and increase hot

conflict spots over land use pressure in our country. In such a case of harmonization will need both range, veterinary, wildlife, water and social scientists to draw the right principles of sustainable natural resources utilization for a healthy environment.

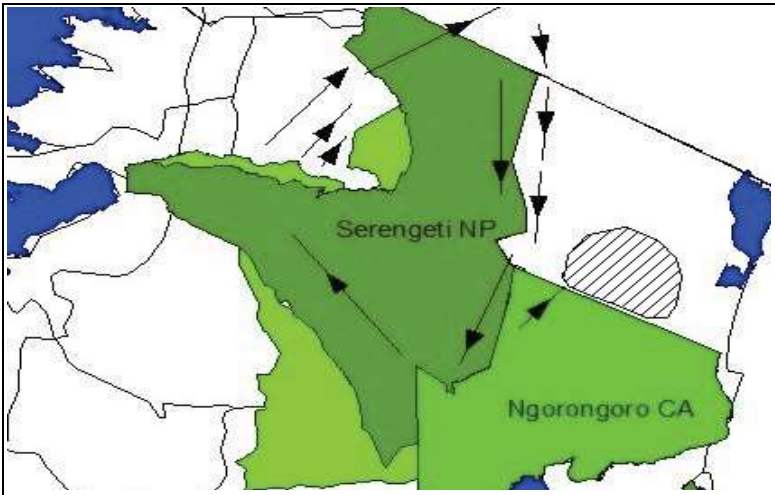

Figure. Migratory pathway of the annual wildebeest migration from the Maasai Mara to the Serengeti plains in relation to Loliondo; arrows represent wildebeest migratory route, and dashed lines represent wet season grazing area for wildebeest and other wildlife on the Sale plains. Source: TNRF(2011)

Improved grazing land management enhances long-term economic opportunity. All conservation planning must

include an economic evaluation of alternatives. Sustainable utilization of grazing lands could provide touristic beauty area that may attract photographers, sightseers, hiking, horseback riding and birdwatchers such as at Kitulo LMU where beautiful migratory birds quite often present themselves with grazing dairy animals. With improved economic affluence many people will seek to visit those scenic areas.

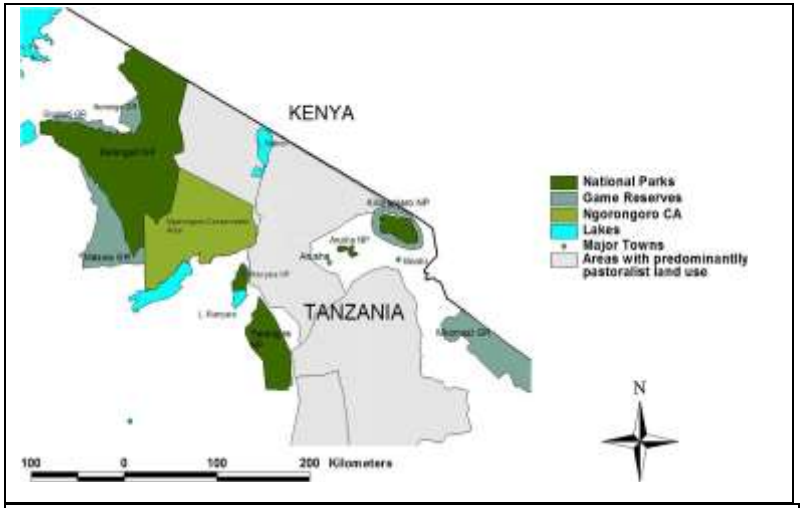

Figure 2. Grazing land area around National Parks and Game Reserve where wildlife spend sometimes in the year and are attractive to the tourists in Northern Tanzania. Source: Nelson, (2012).

The future condition of grazing lands and the benefits from these lands strictly depend on the understanding and informed decisions of the livestock farmers. Most livestock farmers/keepers have not implemented needed conservation practices on their respective grazing lands. Livestock farmers and ranchers need to be exposed to sound grazing land conservation principles, and a follow-up assistance to make them recognize the benefits of appropriate grazing management. New grazing science and technology must continually be made available in a practical manner so that these livestock keepers may make informed decisions concerning this vital resource.

Need for technical personnel for sustainable utilization of grazing lands

There should be a nationwide consortium of experts working together to maintain and improve the management and thus health of the grazing lands for land owners and public benefits. It should be founded on the principles of multidisciplinary expertise including; rangeland management specialists, agronomists, biologists, foresters, soil scientists, hydrologists, animal scientists, economists,

and other specialists who will work together to provide coordinated guidelines for use and management of grazing lands. Most land has the potential for more than one use, which is best recognized and provided for through multidisciplinary action.

It should be led by a national steering committee dedicated to sustainable grazing lands management. The Steering Committee should strongly encourage and work to help establish hamlet, village, district, zonal and national partnerships to foster grazing lands conservation and stewardship. The Steering Committee should be made up of individuals representing the agriculture and livestock societies/associations/agencies/authorities; soil, hydrologists, forest and wildlife,societies/associations//agencies/authorities; livestock and natural resources research institutions; land use commission; pastoral, ranchers and forage growers associations.

The overall function of the consortium on top of providing technical assistance to grazing land owners and managers it

should prepare and keep current technical guides for grazing lands. These technical guides should contain currently stipulated grazing land management standards to:

i) Evaluate the potential of grazing land, grazed forest land, and native and naturalized pasture by identifying and describing ecological sites and other interpretive groupings.

ii) Determine the similarity index of grazing land in relation to its potential and to assess the forage value rating on all grazing lands.

iii) Identify stable and sustainable ecological states for grazing land that provide identified and desired benefits, and describe appropriate management inputs to achieve them.

iv) Develop sound specifications for conservation practices for all grazing lands.

v) Help grazing landowners to select and apply the conservation practices needed to improve and conserve the soil, water, air, plant, and animal resources of their land for all acceptable uses.

vi) Assist landowners to develop Resource Management Systems (RMS) that meet locally

established quality criteria for their resources that prevent degradation and permit sustainable use.

The overall core function of the consortium is therefore:-

- To provide opportunities for assuring sustainability of all grazing lands,
- To inform the public on the contributions of well-managed grazing lands to the quality life of every citizen.

Conclusions

- Grazing land ecosystems are a complex set of natural resources interactions including soil, water, plants, and animals. The health of these ecosystems is dependent upon grazing land managers' decisions. Good decisions should follow scientific knowledge of grazing management transferred to these grazing land managers by well-trained technicians.
- Bush encroachment and herbaceous and non-herbaceous invasive weeds are huge problem on grazing and wildlife lands, therefore control of these problems can be more efficient through cooperative

efforts including well trained range personnel. This will help to minimize invasive plant spread from either protected or grazing lands through earlier detected and devising of control measures.

- There is an increase of individuals who would like to operate ranch business, or become forage producers but have very limited or no experience in grazing management or soil, plant, water and animal interaction management. Adequately trained technical experts should provide enough ecological skills to such individuals before they degrade their land to unhealthy condition.
- Timely technical assistance is needed to meet the resource concerns of the soil, water, air, plants and animals while enhancing the economic and social stability of grazing land enterprises and the rural communities that depend upon them.
- Technical assistance enhances the land owner's ability to achieve greater profitability on an ecologically sound and sustainable basis. There is a need to increase economic, environmental and social stability through our grazing lands. Improved grazing land

management enhances long-term economic opportunity. All conservation planning must include an economic evaluation of best alternatives. The final decision to apply any or all of the planned treatments is the responsibility of the landowner or operator.

- An increasing urban population represents an increasing need for clean water. Conservation of water and preservation of water quality are both increased by healthy grazing lands which provide optimum retention of moisture in the soil profile. This moisture is the source of stream flow and groundwater recharge for a variety of uses of great importance beyond the needs of grazing lands. Also, open space becomes critical as more of the urban ground surface is covered by pavement and buildings. Fortunately, grazing lands in healthy condition enhance watershed values and view shed qualities which are important to the urban community.
- The nation should recognize that lack of adequate technical assistance is the most limiting factor in efficient and effective implementation of sustainable utilization of our grazing lands. There is a need of a

recognized multidisciplinary consortium of all different natural resources experts including soil, range management, and animal specialists coming together with one tailored message for sustainable utilization of our natural resources including grazing lands.

- This will support technical assistance that provides grazing land managers and society as a whole with appropriate scientific knowledge on variety of benefits from proper management of natural resources on the land they own or share. The consortium will provide comprehensive resource management of all grazing land resource problems and opportunities to the livestock famers/keepers.

References

Abdallah J.M. Engstrôm L.Havnevik K.Salomonsson L. (2014). Large-scale Land Acquisitions in Tanzania: A Critical Analysis of Practices and Dynamics.The Global Land Grab. Beyond the Hype. M.Kaagand A.Zoomers.Zed Books, London, UK, pp.36–53.

A.A., Mohamed, Y.A. and El-Tayeb, S.A. (1985). Natural resources and rural development in arid lands: case studies of Sudan H.R.J. ed.) The United Nations University. Tokyo. Japan.

Benjaminsen, T.A. andSvarstad, H. (2010). The death of an elephant: Conservation discourses versus practices in Africa. *Forum for development studies*, 37(3): 385-408 pp.

Mtengeti, E.J.,Brentrup, F.,Mtengeti, E.,Eik, L.O. and Chambuya, R. (2015). Sustainable Intensification of Maize and Rice in Smallholder Farming Systems Under Climate Change in Tanzania. In: Sustainable Intensification to Advance Food Security and Enhance Climate Resilience in Africa. (Rattan Lal, Bal Ram Singh, Dismas L. Mwaseba, David Kraybill, David O. Hansen and Lars Olav Eik editors). Pp 441-465 ISBN 978-3-319-09359-8; Springer International Publishing Switzerland.

Food and Agriculture Organization of the United Nations (FAO) (1991).The FAO/Netherlands Conference on Agriculture and Environment.Herrogenbosch. (The Netherlands. 15-19 April 1991. Report of the Conference, Vol, 2.

Ismail S. Seleman, Anthony Z. Sangeda, Ephraim J. Mtengeti (2016) Adoption of Rangeland Management Strategies for Mitigating Climate Change in Agro-Pastoral Communities in Gairo District, Tanzania. In: Lessons and Implications for REDD+ Implementation Experiences from Tanzania. (Editors:- Kassimu Kulindwa, D. Silayo, E. Zahabu, R. Lokina, J. Hella, A. Hepelwa, D.Shirima, S. Macrice and S. Kalonga). Pp 25-39. ISBN: 978 9987 735 53 2. E&D Vision Publishing Ltd. Dar es Salaam. Tanzania.

Ministry of Livestock and Fisheries Development (MLFD) (2015).*Tanzania Livestock Modernization Initiative*. Dar es Salaam, Tanzania. Pp 40.

Ministry of Livestock and Fisheries Development (MLFD) (2011).*Investment opportunities in livestock industry*. Pp 40.

National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA).Main Results (2015). Ministry of Natural Resources and Tourism.Pp 124.

Nelson Fred (2012). Natural conservationists? Evaluating the impact of pastoralist land use practices on Tanzania's wildlife economy. http://www.pastoralismjournal.com/content/2/1/15.

Nyamoga, G.Z., Sjole, H.K., Malimbwi, R., Ngaga, Y.M. and Solberg (2016).Potentials for Rehabilitating Degraded Land in Tanzania. In: Climate change and multidimensional sustainability in African agriculture. (Rattan Lal, David Kraybill, David O. Hansen, Bal Ram Singh , TheodosyMosogoya and Lars Olav Eik editors). Pp 485-504 ISBN 978-3-319-41238-2; Springer International Publishing Switzerland.

O'Malley, M.E. (2000). *Cattle and Cultivation: Changing Land Use and Labor Patterns in Pastoral Maasai Livelihoods, Loliondo Division, Ngorongoro District, Tanzania.*Unpublished PhD Thesis, University of Colorado.

Tanzania Natural Resources Forum (TNRF) (2011).Integrating Pastoralist Livelihoods and Wildlife Conservation?Options for Land Use and Conflict Resolution in Loliondo Division, Ngorongoro District.Pp 32.