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Opportunities and constraints for overcoming dry season livestock feed shortages in communal semi-arid rangelands of Northern Tanzania: A case of Longido District

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Abstract

Assessment of opportunities and constraints for tackling the problem of dry seasons livestock feed shortage (DSLFS) was conducted in Longido district, Arusha, Tanzania in March 2014. The rationale for conducting this study was to contribute to a better understanding of the influential factors for persistence of DSLFS problem in Tanzania communal semi-arid rangelands. In addition, the study aimed to identify the potential opportunities for curbing DSLFS problem in Longido district and elsewhere. Data collection methods included structured questionnaires for household surveys, checklists for key informants interviewing and researcher's field observations. A total of 90 respondents were randomly selected and interviewed from four (4) pastoral villages namely Kiserian, Mairowa, Ngoswak and Tingatinga. Data were analyzed by using SPSS 20 computer program.

Major drivers for pasture inadequacy were prolonged droughts (27%), increased crop cultivation in rangelands (21%) and high stocking rates (18.3%). The time cattle spent for grazing during dry and wet seasons differed significantly (P=0.03). The time range livestock spent for grazing was 7-8 hrs and 10-12 hrs, in the wet and dry seasons respectively. The distance the livestock walked to pasture differed significantly (P<0.01) between wet (1-4 Km) and dry (8-14 Km) seasons. The time livestock spent walking to and fro watering points differed significantly between wet and dry seasons (P<0.01), the time range being less than 0.5 hr and up to 11 hrs respectively. Identified opportunities for overcoming the DSLFS problem include plentiful communal grazing land (32.1%), abundant browse resources (21.1%) and existence of strong traditional leadership (17.3%). Major constraints for overcoming the DSLFS problem were low and erratic rainfalls (26.1%), fear of free riders due to communal grazing (23.17%) and low awareness on range management due to inadequate extension services (20.7%). It is concluded that livestock feed shortage is a big problem in Longido district especially from August to November in which animal productivity declines due to sparse pasture and water resources. It is recommended that conservation of indigenous fodder trees should be undertaken due to their importance in providing feed resources at critical drought times. Moreover, livestock policies should promote range management through education provision, securing land tenure of communal grazing areas for fostering rotational grazing, selective bush control and range reseeding.

Keywords: Arusha, drought, indigenous fodder trees, Maasai, Pasture inadequacy

Introduction

Arid and semi-arid regions hereinafter rangelands cover about 45% of the Earth's land surface (Schimel 2010), 66% in Africa (Darkoh 1998), and 40% in Tanzania (BDAS 2001). Rangelands provide about 70% of the feed for domestic ruminants and worldwide support about 200 million households through livestock based livelihoods (Lund 2007and FAO 2010). In Tanzania, extensive livestock production under pastoral and agropastoral systems in rangelands accounts for 94% of about 21.3, 15.2, 5.7 million cattle, goats and sheep population respectively (MLFD 2010; NBS 2013). The domestic ruminants under pastoral and agro-pastoral systems mainly depend on natural forages that are cheap and plenteous during rain seasons but scarce in dry seasons (Mwilawa et al 2008).

Extensive ruminant production systems have shown to provide good returns compared to other forms of range management in semi-arid and arid lands (de Ridder and Wagenaar 1996). DSLFS has remained major problem causing frequent loss of animal condition and even deaths (Tolera et al 2000). For example, about 735,929 livestock were decimated by the drought in Arusha region, northern Tanzania, in the year 2009-2010 (URT 2012). Furthermore, official figures indicate that Longido district was amongst the districts that were badly devastated where livelihoods of about 6,127 livestock dependent households were adversely affected. This being due to the fact that Longido district lost about 231,832 head of cattle, 171,435 goats, 92,235 sheep and 14,600 donkeys during the 2009-2010 droughts (Arusha Times 2010 and URT 2012).

Previous studies have reported that the causes of pasture inadequacy in East- African semi-arid rangelands include rainfall shortage, overstocking and bush encroachment (Oba et al 2000), and expansion of agricultural activities into rangelands (Reid et al 2004). Proposed solutions have been rangeland re-seeding (Bogdan and Pratt 1967), promoting forage legumes (Njarui 1990), forage conservation (Mwilawa et al 2008), rotational grazing and reducing stock density (Pratt and Gwynne 1977). Despite these suggested solutions for curbing the DSLFS issues being in place for decades, the problem still exists. Moreover, the pastoral and agro-pastoral communities who are already bearing the negative consequences of poor livestock productivity are expected to suffer more if effective strategies are not devised and adopted (Dong et al 2011).

It was the overall aim of this study to explore the driving factors for persistence of the problem of DSLFS in the communal semi-arid rangelands of Tanzania and identify potential opportunities for overcoming the DSLFS problem. The study will also devise effective measures for curbing this problem at Longido district and elsewhere. Credible information for overcoming the DSLFS problem in Tanzania semi-arid areas is indispensable if sustainable livestock production under the changing environment is to be achieved.

Materials and methods

Study area

This study was carried out in Longido District, Tanzania, on March, 2014. Longido District is situated between latitude 2.2° and 3.1° south of the equator and longitude 36° and 37.3° east of Greenwich (Figure 1). It has a semi-arid climate with rainfall levels ranging between 300 and 600 mm per annum. It is bordered by Arumeru and Rombo districts to the east, Ngorongoro to the west, Monduli and Arusha districts to the South and Siha district to the South East. Northward it is bordered by the Republic of Kenya. Longido District is mainly inhabited by the pastoral Maasai tribe and the agropastoral Arusha people. The major land use system is livestock keeping in which the indigenous ruminant livestock breeds comprised of cattle, goats and sheep are reared. Other land uses include wildlife conservation and limited crop production on the western slopes of Mount Kilimanjaro.

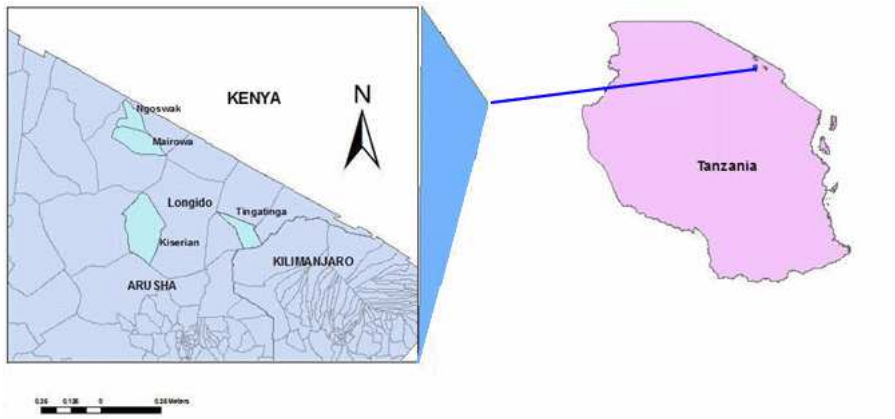

Figure 1. A map showing location of the study villages in Longido District, Northern Tanzania.

Sampling procedures

A cross-sectional research design was employed in this survey study. This method involved collection of data at one point in time and made it possible to determine relationships between different variables that were in focus at the time of the survey. Four (4) villages in Longido district were purposively selected based on preset criteria that included inhabitation by livestock keepers (at least 50% of the inhabitants). Dominance of livestock related production activities and presence of grazing areas including communal and limited crop production where amongst other study village selection criteria. Four (4) villages namely Kiserian, Mairowa, Ngoswak and Tingatinga were selected for this study (Figure 1). At least 22 households from each study village were randomly selected for structured interviews. Random selection of the households was made possible by the use of village residence list that was obtained from the respective local government offices. A total of 90 households were selected for interview and the interview was held at the respondent's home following an appointment by a local guide and village officials.

A structured questionnaire having both open and close ended questions was used for conducting the household interviews. Semi-structured questionnaires (checklists) were used to interview the key informants that included livestock officers, community elders and relevant government officials. Moreover, researchers' personal observation during field surveys was employed for information validation. The questionnaire and checklists were designed to elicit information in respect to indigenous knowledge on rangeland management and land use systems. As well as, on factors contributing to DSLFS, community perception on recurrence and intensity of DSLFS, strategies employed by both community members and government to overcome the problem in Longido district.

Secondary data including demography, climate and livestock numbers were collected from the District Agricultural and Livestock development offices, local government offices and through internet surfing. Various local government reports, the 2012 Tanzania national censuses data and web-based climate databases were the main sources of secondary data.

Data analysis

The primary data collected through structured questionnaire were analyzed using SPSS IBM 20 computer program. Descriptive statistics in particular means, frequencies, percentages and standard errors were generated. Students T test at $p \leq 0.05$ level of significance was used to test if there was significant difference in forage, water and milk availability between dry and wet seasons. Content analysis was employed to analyze the semi-structured questionnaires to generate relevant information.

Results and discussion

Socio-economic and demographic characteristics of the respondents

In terms of education, over 50% of the respondents had acquired formal education mainly primary education and approximately 39% were illiterate (Table 1). This implied that literacy level was still low at the study area and most were relying on indigenous knowledge for making decisions regarding livestock feeding strategies. Age wise, most of the respondents were youths and adults (Table 1). According to Grandin et al (1991), Maasai youths and adults are highly knowledgeable on forage and water resources within their landscapes and are the ones who decide on herd movement and splitting. Most of the respondents reported that they acquired land for settlement, pasture reserve "Olalili" or farming from the community or inherit it from parents (Table 1). This implied that most of the land is still communally owned and land use decisions are made at the community level in particular through Maasai community elders "Olegwanan" in collaboration with village governments. Moreover, most of the respondents were practicing opportunistic farming in which they were growing maize in farms averaging 5 acres. In case of crop failure, livestock were grazed in the crop fields to consume the crop residues which were mainly maize stover. Similarly, Homewood et al (2009) reported that Maasai mode of life is rapidly changing from pure pastoral to agro-pastoral (mixed farming) through adopting crop farming. In addition, Trench (2009) reported that Maasai still put much value on livestock and will plough the land for reasons like securing land tenure and minimize frequency of livestock selling for cash to meet household demands. It was further argued by some respondents that livestock keeping is more beneficial than crop cultivation as many risks are attached to cropping such as damage by wildlife. de Ridder and Wagennar (1996), also reported that livestock production pays pastoralists better than any other form of production in a similar environment. In terms of marital status, most respondents were married to single women but also there were some who are polygamists and no one reported divorce. This was attributed to the critical roles that women play in Maasai community in particular domestic roles.

Table 1. Socio-economic and demographic characteristics of the respondents in Longido district, Tanzania (N=90). Percentage (%) responses in the 4 study villages.

Variables	Village name				Overall mean ± SEM
	Kiserian	Mairowa	Ngoswak	Tingatinga	
Sex					
Male	61.4	71.6	58.2	76.4	66.9 ± 4.3
Female	38.6	28.4	41.8	23.6	33.1 ± 8.5
Age					
<25 years	4.3	0.0	4.3	0.0	2.2 ± 1.2
25-45 years	60.9	45.5	73.9	52.2	58.1 ± 6.1
>45 years	34.8	54.5	21.8	47.8	39.7 ± 7.3
Marital status					
Single	13.0	0.0	4.3	4.3	5.4 ± 2.7

Married	65.2	86.4	87.0	65.2	75.9 ± 6.2
Polygamy	17.4	13.6	8.7	17.4	14.3 ± 2.1
Widowed	4.3	0.0	0.0	8.7	3.3 ± 2.1
Literacy					
None	30.4	45.5	39.1	40.9	39.0 ± 2.4
Adult education	4.3	9.1	13.0	0.0	6.6 ± 2.2
Primary education	47.8	36.4	34.8	45.5	41.1 ± 2.5
Secondary education	13.0	9.1	13.0	9.1	11.1 ± 0.9
College education	4.3	0.0	0.0	4.5	2.2 ± 1.0
Size of land owned					
<2 acre	30.4	40.9	34.8	45.5	37.9 ± 3.3
2-5 acre	43.5	22.7	34.8	13.6	28.7 ± 6.5
>5 acre	26.1	36.4	30.4	40.9	33.4 ± 3.2
Land status					
Given by parents	30.4	18.2	21.7	27.3	24.4 ± 2.7
Given by community	56.5	68.2	73.9	72.7	67.8 ± 4.0
Given and bought	8.7	13.6	4.3	0.0	6.7 ± 2.9
Bought	4.3	0.0	0.0	0.0	1.1 ± 0.5
Occupation					
Pastoralist	26.1	36.4	60.9	45.5	42.2 ± 7.3
Agro-pastoralist	52.2	50.0	39.1	45.5	46.7 ± 2.9
Peasant farmer	4.3	0.0	0.0	4.5	2.2 ± 1.3
Casual labor	8.7	0.0	0.0	4.5	3.3 ± 2.1
Formal employment	8.7	9.1	0.0	0.0	4.4 ± 2.6
Small business	0.0	4.5	0.0	0.0	1.1 ± 0.6

Human and Livestock population in the study area

The study area was sparsely populated and the most populated village has an overall mean of around 5 ha of land per individual. Moreover, each ruminant livestock species population was over five (5) times larger than that of human population. The shoats' (goats and sheep) population was more prevalent than cattle population in the study area (Table 2). This was attributed to the greater ability of small domesticated ruminants to tolerate drought compared to large ruminants in particular cattle (Degen 2007), resulting in a higher preference by the community (Table 3).

It was further reported that the livestock population was increasing by 0.3% per annum. However, it was noticed that livestock keepers in the study villages were reluctant to reveal the real number of livestock they own. Despite the majority being unable to tell the exact number of the livestock they possess due to illiteracy, counting of ones livestock was not welcomed.

It was further revealed through informal interviews that livestock keepers are afraid that if the government noticed that the livestock population is increasing it might order destocking or stop food aid. The study villages were receiving food aid in the form of maize grains "posho" and the aid is provided based on the grounds of household poverty and food insecurity. It was also claimed by the government officials that the rapid livestock population increase in the study area was due to high influx of pastoralists and their livestock from Kenya, where land scarcity and pasture inadequacy situations was reported to be more severe. However, informal discussion with the pastoral Maasai failed to validate the claim.

Table 2. Human and livestock population at the study villages in Longido district, 2014.

Ward	Village	Land size, ha	Human population	Livestock population					
				Cattle	Goat	Sheep	Donkey	Chicken	Pigs
Longido	Kiserian	40,123.5	2,160	16,125	47,029	18,468	679	168	0
Engarenaibor	Mairowa	18,979.4	2,780	9,133	25,699	8,489	156	3,567	13
	Ngoswak	10,393.0	1,059	6,000	20,067	7,745	330	5,809	0
Mundarara	Tingatinga	56,389.9	2,039	17,309	46,500	15,450	490	90	0
Total		125,885.8	8,038	48,567	139,295	50,152	1,655	9,634	13

Source: Study village government offices, 2014.

Traditional ruminant livestock management practices and drought perseverance

Pastoralists in Longido district employed various strategies which assisted them in handling various drought related circumstances. The major adaptive strategies were as stated by Fernandez-Gimenez and Le Febre (2006) including mobility, herd splitting, species diversification, herd maximization, supplementation, and reducing stock numbers by selling. The major strategy that was repeatedly mentioned by majority of the respondents to deal with the DSLFS problem was seasonal movement of herds to various places where pasture is thought to be more available. Most reported to practice herd mobility and very few reported to be sedentary (Figure 2). It was further revealed that; "Those livestock keepers who do not practice mobility are exposed to higher risk of animal loss". The drought of late 2009 was a commonly referred example in which it was reported that "those who left their livestock at their home village did loose larger numbers of livestock compared to their neighbors who moved their livestock to other places". It was mentioned that southward movement from Longido to Manyara (Simanjiro and Kiteto districts) and Tanga (Kilindi and Handeni districts) across Monduli district was the main route. Similarly, Sangeda et al (2013) reported that most of the agro-pastoralists in semi-arid areas of Gairo district in Morogoro practice extensive grazing including out migration to natural forests at times of drought in search of pasture. This finding is supported by Homewood et al (2008) that stated that mobility in rangelands is far better in terms of livestock production and environment compared to sedentary livestock management. Angassa et al (2012) found out that animals reared in mobile systems were more productive than those reared under similar climatic conditions in ranches or sedentary systems in Botswana and Mali rangelands. Furthermore, through key informant interviewing it was argued that pastoralists at some points of the seasons are forced to migrate to new grazing areas locally named "ronjo". Whilst, the immigrants are forced to return to their home land or go elsewhere due to scarcity of pasture and water especially in extreme dry seasons.

Despite the importance of pastoral mobility in coping with drought conditions numerous constraints regarding the practice has been reported. These include the deadly land use conflicts between the Maasai of Longido and those of oldonyosambu, Arumeru which happened in late 2012. This incidence is in agreement with Adams et al (2003) who observed that in management of common resources, conflicts are unavoidable. But, understanding the actual drivers of the conflict and management it is the most essential for sustaining of the livelihood of the resource dependent community. Expounding on Adams et al (2003) opinion it was clearly observed during field surveys that imposing of laws to control as well as monitoring of livestock movements through well-defined and legally protected stock routes will help in reducing conflicts.

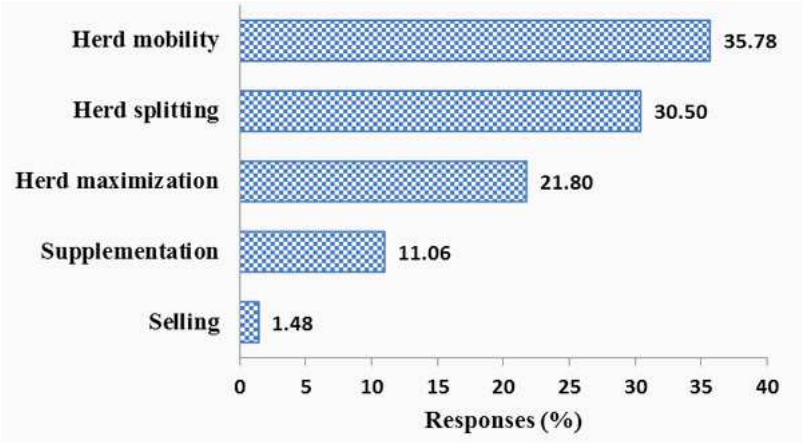

Figure 2. Showing percentage responses on ruminant livestock management strategies in response to pasture and water scarcity, Longido District, Northern Tanzania, 2014.

Herd splitting was another widely used strategy by the livestock keepers for persevering drought conditions that were reported to frequently occur between August and November (Figure 2 and Figure 3). The herds are split into various groups based on age (calf and adult stocks) and productivity (lactating and non-producing stocks) for enhancing efficiency in utilization of sparse pasture and water resources. It was reported due to water scarcity that animals are watered on alternating days preferably starting with prime herd calves, lactating, pregnant and finishing with non-producing stocks. Herding of livestock to distant pastures is mainly a young man's "moran" work while milking and tending of sick animals at home was basically a woman' duty.

Table 3. Ruminant livestock management practices in the study villages

Management aspect	Villages			
	Kiserian % of HH	Mairowa % of HH	Tingatinga % of HH	Ngoswak % of HH
Number of household (HH)	**N=23**	**N=22**	**N=23**	**N=22**
Ownership of ruminant and selling or slaughtering decision making				
Men	91.3	77.3	82.6	86.4
women	8.7	22.7	17.4	13.6
Feeding of ruminant				
Men	0	0	0	0
Women	0	0	0	0
Boys	52.2	56.5	55.2	48
Family responsibility	39.1	15	21.3	30.1
Hired labour	8.7	28.5	23.5	21.9
Source of forage				
Communal grazing areas	56.2	70.7	61.3	73.8
Private grazing area	25.1	12.9	29.4	20.1
Communal land and crop fields	18.7	16.4	9.3	6.1
Herd size (cattle)				
1-10	25	34.9	20	39.9
11-20	49.8	48.7	52.5	50.4
Above 20	25.2	16.4	27.5	9.7
Do not keep	0	0	0	0
Flock size (sheep)				
1-10	0	0	0	3
11-20	12.4	21.4	10.1	24.3
Above 20	87.6	78.6	89.9	72.7
Do not keep	0	0	0	0
Flock size (goat)				
1-10	0	0	0	0
11-20	3.3	13.6	4.7	7.8
Above 20	96.7	86.4	95.3	92.2
Do not keep	0	0	0	0

Forage and water seasonal variability

The amount of forage was reported to fluctuate seasonally and mainly dictated by rainfall patterns in which rainfall was reported to be plentiful from April to June (Figure 3). The peak month for availability of natural grasses was reported to be in May, with maize stover consumed in June to August and the natural browse was reportedly to be available almost year round. However, August to November was reported to be the time when pasture is very scarce and animals do even forage on browse resources including those ones that are avoided at times of plenty. Distance to and from pasture resources (grazing radii) including the foraging time differed significantly between wet and dry seasons (Table 4). Furthermore, the distance and walking time to water resources differed significantly between dry and wet seasons. The scarcity of water, which seems to be a recurrent problem across August to November, was reported to force people to use similar water sources for both livestock and human consumption regardless of poor quality. As a result, milk yield differed significantly between dry and wet seasons (Table 4). Fluctuations in milk yield, in which milk yield was higher in wet season and dropping in dry season was directly related to scarcity of forage and water resources coupled with energy expended in searching for feed resources (Western and Finch 1986). Thornton and Herrero (2010) asserted that poor feed quality leads to poor rangeland productivity in terms of meat and milk production which leads to higher methane production per unit livestock product.

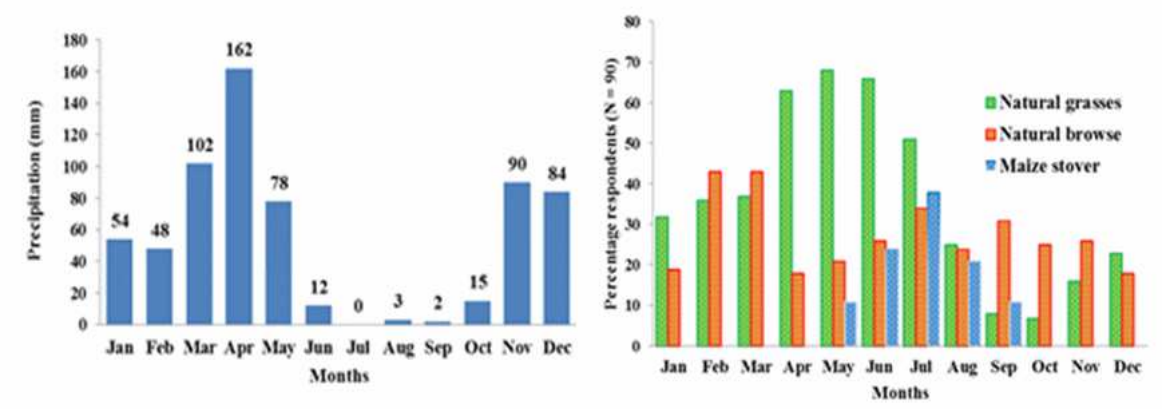

Figure 3. Monthly precipitation (3a) and seasonal fluctuation of forage resources (3b) for Longido district, Tanzania, 2014. (Precipitation data source – World Weather online, 2015)

Table 4. Seasonal variations in forage, water and milk yield, Longido district, Tanzania, 2014

Parameter	Min.	Max.	Overall Mean		P value
	Statistic	Statistic	Mean	SEM	
Foraging time – Hrs (wet season)	7	8	7.48	0.05	0.03
Foraging time – Hrs (dry season)	10	12	11.1	0.09	
Distance to pasture -Km (wet season)	1	4	1.53	0.05	<0.01
Distance to pasture -Km (dry season)	8	14	11.3	0.20	
Walking time to water - Hrs (wet season)	0.3	1	0.51	0.05	<0.01
Walking time to water - Hrs (dry season)	3	11	7.98	0.29	
Distance to water sources - Km (wet season)	0	1	0.62	0.05	<0.01
Distance to water sources - Km (dry season)	3	21	12.2	0.51	
Milk yield/cow - litre (wet season)	1	2	1.53	0.05	0.03
Milk yield/cow - litre (dry season)	0	0.5	0.47	0.05	

The major driving factors to livestock feed shortage in Longido District

Prolonged drought conditions, increase in both the size and number of crop fields and livestock population increase were identified as major driving factors for DSLFS in Longido district (Figure 4). Prolonged droughts characterized by high day temperatures were argued to hinder pasture regeneration and accelerated the drying of surface water bodies, in particular shallow wells, seasonal rivers and dams. This finding is inline with Wanner (1980) who asserted that drought affects negatively vegetation growth and results to lack of feed for animals. Also in many previous studies, Bruins and Ros-Tonen (2003), Huho et al (2011) and Campbell (2013) drought is reported as one of the major natural threats to sustainable livelihood of East African pastoralists.

Increased crop cultivation (Figure 4) was another major factor that was claimed by many respondents as a driver of livestock feed shortage because it was accelerating shrinkage of rangelands and damaging water sources. According to McCabe (2003), adoption of cultivation by pastoral Maasai living in northern Tanzania started to take place half a century ago as a livelihood strategy towards adopting to decrease in grazing areas, coping with a monetary economy, human population growth and fluctuating livestock population. Despite crop farming not being as lucrative as livestock keeping in the maasai community (Trench 2009), it was blamed for continuing to take large portions of rangeland. Moreover, Angassa and Oba (2008) found out that land use change mainly agricultural encroachment in Southern Ethiopia rangelands had a major impact on increased forage scarcity and the vulnerability of livestock loss during drought years.

Other identified factors for increased pasture scarcity in Longido district were the increase in livestock population due to immigration of pastoralists from other areas and restriction of stock mobility due to denied access to some agrarian dominated districts. Wildlife population increase in particular zebra, buffalo and giraffe was another mentioned cause of DSLFS in Longido District. Wildlife related problems were mainly reported at Tingatinga village by pastoralists claiming that wildlife from nearby reserves especially Amboseli National Park do graze in livestock grazing areas on the village land. Moreover, establishment of the Enduimet Wildlife Management area in Longido District was blamed to increase wildlife species that compete with livestock for scarce pasture during dry season (Appendix I).

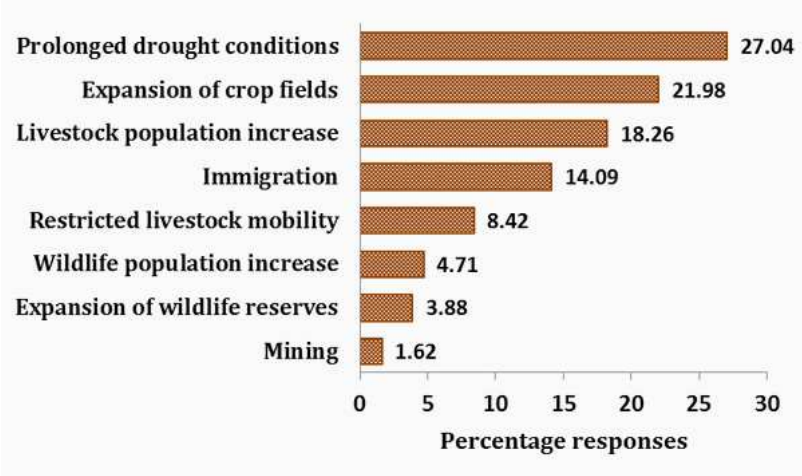

Figure 4. Perceived driving factors for livestock feed shortage in Longido District, Tanzania, 2014.

Potential constraints towards alleviation of the livestock feed shortage problem in Longido District

Major constraints for overcoming the DSLFS problem in Longido were low and erratic rainfalls, free access of pasture under communal grazing system, and limited government support (Figure 5). Rainfall was identified as a prerequisite for pasture re-growth and the refill of water sources. It was

also mentioned that; "if it does not rain nothing can be done to enhance local production of livestock feed resources". Free access to pasture was identified as another challenge, in which it was mentioned that under Maasai culture livestock have the right to graze anywhere in communal rangelands. Whereby, herders are supposed to search for pasture anywhere at times of scarcity, and this includes crossing village to regional boundaries. Thus, this grazing practice was acting as disincentive for rangeland management as herders from areas with no pasture due to degradation or drought can still access it freely elsewhere irrespective of efforts that might have been taken by others to maintain the pasture resource. Effects of free access under communal grazing were described by Hardin (1968) as "Tragedy of the commons" where individuals are maximizing their own benefits at the expense of the entire community. However, nowadays, the "Tragedy of the commons" is highly criticized and pastoral mobility is advocated but holding of pastoral responsibility for management of their rangelands is still emphasized (Derry and Boone 2010).

Another identified constraint for redressing DSLFS problem was lack of awareness on the importance of rangeland management by most of the community members. Lack of awareness can be linked to the respondents' claim of limited of government support and inadequate extension services towards resolving the DSLFS problem in Longido District (Figure 5). Few mentioned presence of an invasive weeds (*Astripomoea lachnosperma*) locally called "oltelemet" which was claimed not to be eaten by grazing animals. *A. lachnosperma*'s cover was observed to be very high during the wet season and was claimed to have replaced grasses in a large portion of Longido district's grazing lands (Appendix II). Scarcity of pasture seeds was also raised by few individuals in which it was mentioned that even if community are interest to improve rangelands pasture seeds are not available. The pasture seed scarcity complaint was validated by the district livestock officer who revealed that the use of improved commercial pasture seeds in communal rangelands is uncommon. Moreover, Kumwenda and Ngirwa (2003) reported that scarcity and the high cost of forage seed were amongst major constraints to adoption of forage establishment practices by livestock keepers in Malawi.

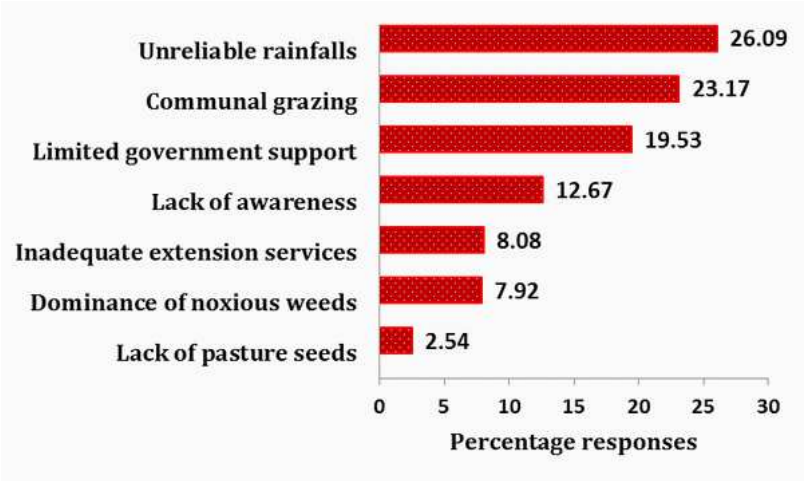

Figure 5. Potential constraints/challenges for eradicating livestock feed shortage problem in Longido District, Tanzania, 2014

Available opportunities for overcoming the livestock feed shortage problem in Longido District

Despite presence the various causative factors to the DSLFS, the pastoralists managed to identify potential opportunities for overcoming the DSLFS problem in Longido District. Identified opportunities included plenteous communal grazing land, presence of palatable shrubs and trees, strong traditional leadership and existence of traditional forage reserves "olalili" (Figure 6). Despite prior complaints on the shrinkage of rangelands due various factors it was yet revealed huge grazing lands still exist that could be capitalized upon by securing tenure and proper management.

The presence of plentiful browse resources in the form of trees and shrubs with leaves or pods that are foraged by livestock was another opportunity. *Grewia similis* "Ehrighii", *Grewia villosa* "Emangulai" and *Combretum spp* "Embikwin" were prioritized as amongst best indigenous fodder trees. It was also disclosed that these trees provide both green foliage and litter (dry leaves) that are consumed by ruminant livestock during dry season. Furthermore, it was revealed that pods from acacia tree species are important feed resources because they are normally available at the beginning of dry season. *Faitherbia albida* "olasiti", *Acacia tortilis* "Esiamalili" and *Acacia nilotica* "olkiloriti" were acknowledged as trees that produce numerous pods that help sheep and goats survive during the dry season. It was further revealed that the pods are collected, stored and used as supplements to animals in critical dry period. The responsible family groups for pods collection are children, women and herders. Nevertheless, it was mentioned that community members, especially those who are resource poor were starting to commercialize pod resources as a business with a 20Kg bag being sold at a price 2000 Tanzania shillings. The importance of browse resources in enabling the domesticated ruminants to overcome dry season weight loss is also emphasized by Rubanza et al (2007). In which, Rubanza et al (2007) reported that supplementation of small East African goats with leaves from indigenous leguminous fodder species including Acacia spp. resulted in a net weight gain during dry season. Thus, presences of browse resources in the rangelands of Longido need to be optimized through avoiding over or under use for sustainable livestock production.

Another important opportunity is the strong traditional leadership, in which it was mentioned that in Maasai community elders are highly respected and once they allow or forbid something most community members do obey. This was evidenced by preservation of watering points in which proper use and management is guided by traditional leaders where there were sanctions and penalties in form of money or animal for violators of community bylaws (Appendix III).

Other identified opportunities included the presence of traditional grazing reserves "olalili" in which there are areas set aside for extreme dry season grazing. Two types of olalili were identified that included the communal ones that are big (up to several hundred hectares) and are normally set aside for entire villages or for sharing by several pastoral villages. The second type of olalili was family or shared by a few neighbors that were relatively smaller (few hectares) and located near home. Moreover, crop residues in the crop fields offered an opportunity for livestock to be grazed insitu in the field immediately after grain harvesting. Fertile soils that support fast regrowth of pasture species shortly after rainfall was identified as another opportunity for overcoming the DSLFS in Longido District (Appendix IV).

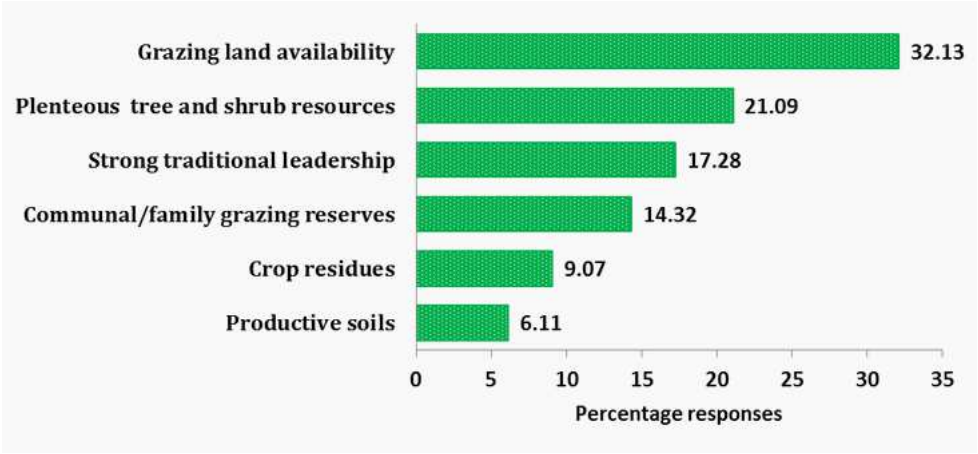

Figure 6. Potential opportunities for halting livestock feed shortage in Longido District, Tanzania, 2014.

Conclusion and recommendations

From this study it can be concluded that erratic rainfalls, communal grazing and inadequate preservation of communal rangelands are major constraints towards overcoming the DSLFS problem in Longido District. Major opportunities include plenty rangeland, abundant browse resources and strong traditional institutions. It is recommended that:

- Conservation of livestock preferred indigenous browse species should be undertaken due to their key role of providing feed resources (leaves and pods) to livestock at critical drought times.
- A thorough assessment of seasonal variations in terms of quantity and quality of the most commonly available and preferred livestock ruminant feedstuffs (forage grass, forbs, browse and crop residues) should be conducted.
- Livestock policies should promote range management through education provision and preservation of good traditional practices and institutions, securing land tenure of communal grazing areas for fostering rotational grazing, selective bush control and range reseeding.
- Initiatives towards control of the invasive weed species including *Astripomoea lachnosperma* for improving grass cover in the rangelands of Longido district should be promoted.
- Research on crop-livestock interactions for optimizing use of crop residues and manure for sustainable agricultural development in rangelands are recommended.

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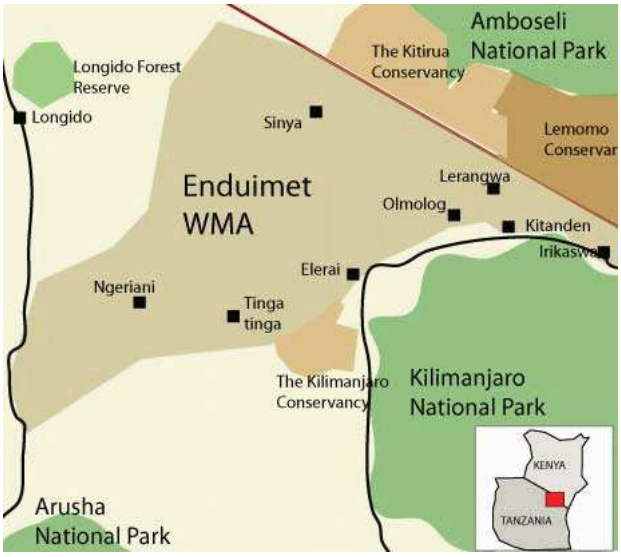
Appendices



Appendix I. A map showing location of Enduimet Wildlife Management Area (WMA) and national parks surrounding Longido district (Source: Honeyguide foundation, 2015)

Appendix II. A degraded grazing field highly infested with unpalatable invasive weed (*Astripomoea lachnosperma*) in Longido district, Tanzania. (Photo courtesy; Marco Koipap, March 2014)

Appendix III. A well-managed watering point (dam) with live fence and a wooden trough for livestock drinking at Mairowa village, Longido district, Tanzania. (Photo courtesy; Marco Koipap, March 2014)

Appendix IV. Livestock grazing in green vegetation following a month long rainfall period i Longido district, Tanzania. (Photo courtesy; Marco Koipap, March 2014)

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