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Grass species for range rehabilitation: Perceptions of a pastoral community in Narok North sub-county, Kenya

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Land degradation is a global problem leading to a diminished production capacity of the rangelands. The consequence is reduced potential to provide ecosystem services and increased vulnerability to the inhabitants. Biological soil water conservation measures can reverse the trend. Different communities prefer different grass species for rehabilitation as communities vary in location, needs, priorities, preferences and the type of livestock reared. This study, therefore, sought to identify the suitable grass species for soil erosion and rehabilitation from the community in Keekonyoie ward In Narok county, Kenya. Data collection was through individual interviews, focus groups, key informant interviews and field observations. Results showed that level, indicators, causes and impacts are known to the community. *Cynodon plectostachyus* (76%), *Chloris gayana* (73%), *Pennisetum clandestinum* (69%), *Cymbopogon citratus* (46%) and *Themeda triandra* (42%) were most preferred for rehabilitation and soil erosion control. The primary reason for the grasses choice was a yearlong provision of livestock feed. Needs and livelihood priorities significantly influence decision-making among the Maa-speaking community in Keekonyoie ward. We recommend consideration of community needs, priorities and preferences in the selection of grass species for rehabilitation to increase the adoption measures that can reverse land degradation

Key words: Indigenous knowledge, community perceptions, range grass species, rehabilitation, land degradation, Narok.

INTRODUCTION

Soil erosion is the most widespread form of land degradation in the world (Lal, 2001, 2003, 2014; Nkonya et al., 2016; Pimentel and Burgess, 2013) and in Kenya (Mganga et al., 2010; Mulinge et al., 2016). Wind and water erosion are the major forms of soil erosion resulting in degraded soils (Lal, 2014). Degraded soils are characterised by limited ability to sink atmospheric carbon, decline in plant nutrient reservoir as well as gene pool (Kimble et al., 2016). Degraded soils directly reduce vegetation cover resulting in bare land and hence risking a range of ecosystem services and livelihoods in the arid and semi-arid rangelands. Human, natural factors and

conditions and the physical features and conditions of the land aggravate the erosion process in the rangelands. The resultant is eroded hillsides, denuded plains, massive erosion shelves and deep sheer sided gullies (Sindiga, 1984; Odini et al., 2015).

Many measures have been used to control land degradation in different parts of the world. This includes the use of soil water conservation (SWC) methods like terraces, cut-off drains, semi-circular bands, ditches, water pans and stone bunds. These measures are, however, often expensive to implement and are labour intensive, making them only available and relevant to large-scale commercial entities (Riginos et al., 2012), or donor-funded rehabilitation support projects on community land. Despite the physical SWC measures being expensive, they are successful in runoff and soil erosion control (Wolka, 2014; Ruto, 2015; Saiz et al., 2016). A biological/ vegetative tool is another SWC measure that controls soil erosion and rehabilitates degraded land. It is a technique whose use has increased in the recent past due to its availability, affordability, ease of establishment and management, low labour requirement, and its ability to provide livestock feed in the arid and semi-arid rangelands (Gachene and Mureithi, 2004; Riginos et al., 2012). Trees and or grasses are used. Trees require a longer time to establish, resulting in a longer period of time before firmly executing the role of soil erosion control. Grasses have a shorter establishment time and spread and cover the ground within a short time. Quicker and faster range rehabilitation can be achieved by grasses because they are easy to establish and grow rapidly and colonise a large area due to their prolific growth nature. Moreover, vegetative tools have been found to increase the soil organic carbon at a maximum rate of 1.06Mg/year (Garcia-Diaz et al., 2018) However, selection of best grass species for rehabilitation of degraded rangelands is key to successful restoration. The grasses vary in ecological adaptability, growth characteristics, as well as preferences by the community. As indicated by Mekonnen et al. (2016) the choice of grass species for rehabilitation should consider the availability of the target species, as well as their adaptability to the local environment. Also, they should be drought tolerant, establish within a short time, have a good seedling ability, high seedling survival and provide viable seeds (Mnene, 2005; Opiyo, 2007). The grasses should also be able to stabilise soil conservation physical structures and improve hydrological properties of the soil (Nyangito et al., 2009; Garcia-Diaz et al., 2018) while producing adequate biomass for livestock feed.

Successful range rehabilitation and erosion control using grass species has been done in many countries (Troung et al., 2004; Visser et al., 2007; Mganga et al., 2010; Terefe, 2011; Wanyama et al., 2012; Mganga et al., 2015; Ogwa and Ogu, 2014; Amare et al., 2014;

Manyeki et al., 2015; Mekonnen et al., 2016). Whereas some productivity and rehabilitation suitability studies of grass species for arid and semi-arid environments are already done in Kenya (Mganga et al., 2010; Opiyo et al., 2011), little attention has been given to community views on suitable grass species that best fits their needs. Besides, variations on communities' views exist with respect to location, species performance, grass uses and preferences. According to Kangalawe (2012) and Ricart et al. (2019) local perceptions, attitudes and knowledge have far greater implications to their environment including resource management and control of land degradation. Local communities know what plants are available in the wet and dry seasons, species that are more persistent and drought tolerant, and this information complements the modern scientific knowledge in selecting species for rehabilitation (Wasonga et al., 2003; Wekesa et al., 2015). Understanding the community perceptions, needs and priority grass species that address existing environmental and livelihood challenges enhances the selection of appropriate grass species for adoption by communities for Sustainable Land Management (SLM). This study was therefore conducted to 1) determine the community's perceptions on soil erosion and degradation 2) identify grass species suitable for rehabilitation of degraded rangelands as perceived by the community.

MATERIALS AND METHODS

Study area

The study was conducted in Suswa ward, Narok County located in the Southwest of Kenya (Figure 1). The county lies between longitudes 34° 45` E and 36$^0$ 00` E and between latitudes 0^0 45`S and 2$^0$ 00` S. The temperatures are varied and ranges from 10^{0}C in the highlands to 26.5°C in the lowlands (Jaetzold et al., 2010; National Environmental Management Authority, 2009). The rainfall pattern is bimodal with long rains from mid- March to June and the short from September to November. The rainfall is uneven with high altitude areas receiving 1200 to1800 mm per annum while the lower altitude regions receive 500m or less per annum (Ojwang et al., 2010). The topography ranges from 1000 to 2500 m in plateaus in the southern parts to the mountainous parts that reach up to 3098 m above sea level (Serneels and Lambin, 2001; Jaetzold et al., 2010). Different soil types are found in the county and include andosols, luvisols, Phaeozems, vertisols and acrisols (Sombroek et al., 1982; Jaetzold et al., 2010). In Suswa, the soils are mainly humic andosols, dark brown, friable and smeary; sandy clay to clay with acidic humic topsoil and the area is characterized by sharp gradient highly liable to soil erosion (Ruto, 2015). The vegetation is predominantly grassland intercepted by trees. *Tarchonanthus camphoratus* and *Acacia drepanolobium* are the dominant tree species. Perrenial grasses include *Cymbopogon citratus, Harpache schimperi, Themeda triandra, Sporobolus fimbriatus* and *Aristida adoensis* among others. Forbs include *Euphorbia inequilatera, Satureia biflora* and *Borreria stricta* among others (Ombega, 2018).

Narok county is home to multiple land uses. In the highlands, the dominant land use is large scale crop farming of wheat while in the mid-elevation is more of small-scale farming while in the lower and
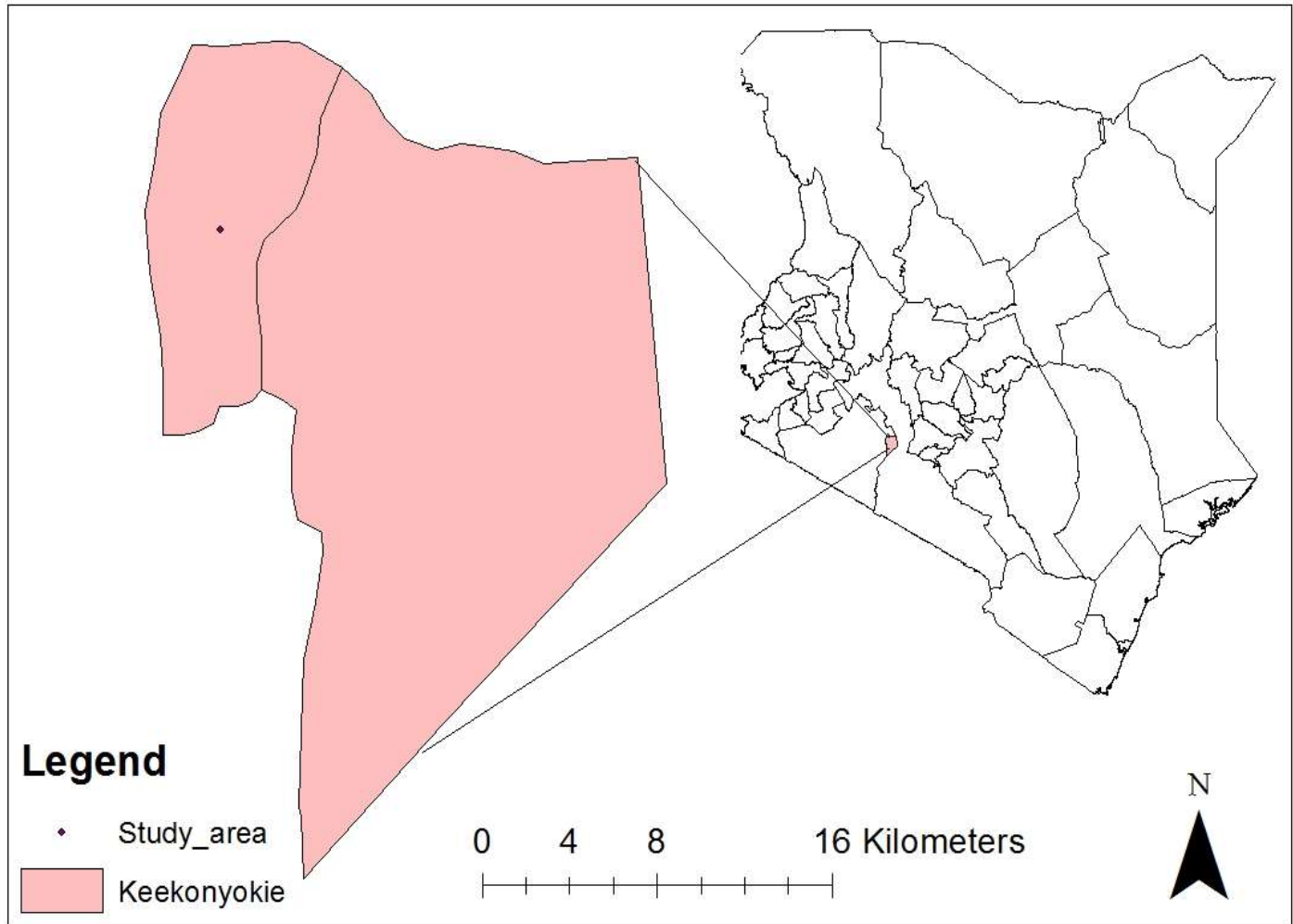
Figure 1. A map showing Keekonyoie ward in Narok County in relation to the map of Kenya Source: Hannah Kamau 2018.

drier areas is livestock production. Indigenous breeds of sheep, goats and cattle are main kinds of animals reared; however, the communities have recently started cross-breeding with exotic breeds (Maina, 2013). Other land uses include beekeeping[1] and rearing of poultry (Odini et al., 2015; Ruto, 2015). In Keekonyie ward the community is predominately agro-pastoral regardless of communal land tenure. Charcoal production is a major environmental concern in the area (Odini et al., 2015).

Research design

Keekonyoie ward was purposively selected because of the gullies and the past rehabilitation interventions under 'mainstreaming sustainable land management (SLM) in agropastoral systems of Kenya's project. The target population included households living close to the gulleys in four (Olepolos, Enkiloriti, Eluai and Olesharo) villages within the ward, state and nonstate experts on livestock production, pasture management and soil conservation, early adopters of soil water conservation (SWC) measures in the

study area.

Data collection and analysis

Individual interviews, focus groups, key informant interviews (KIIs) and field observation were the methods used for data collection. Primary data were collected from May to August 2016. A total of 33 household heads selected randomly from the purposively selected households (living one kilometer radius from the gulley) were interviewed through the interpreter. The open and close-ended questions are related to perceptions of grass uses, and abilities to control soil erosion. Data collected from the individual interviews were supplemented with focus groups, KIIs and field observation. Five focus groups each with 8-12 participants (Gill et al., 2008) were held in the villages at different locations as chosen by the village elder. Discussion with the same group was held twice on two consecutive days where the first day was the focus group and the second field observation to identify the grass species mentioned. Questions discussed during the focus groups included but not

Table 1. Demographic and socio-economic characteristics of respondents (n=33).

Variable	Respondents (n=33)	Percent
Household characteristics		
Male-headed households	28	85
Female-headed households	5	15
Age of the household head		
20-35	5	15
36-49	11	33
50-70	8	24
>70	9	27
Education of household head		
Formal	11	33
Informal	22	67
Average household size	7± 2	
Average TLU	20.1± 11.786	
Land and pasture production characteristics		
Severe level of land degradation	33	100
Causes of land degradation		
Climatic	16	48
Anthropogenic	17	52
Proportion of respondents that planted grasses (dummy)	**9**	**27**
Rehabilitation challenges using grasses		
Insufficient rainfall	33	100
Seedling mortality	26	79
Recurrent dry spells	33	100
Defoliation by animals	20	61
Destruction by flash floods	28	85

Source: Survey Data, 2016.

limited to the past rehabilitation interventions within the area, grass species perceived suitable for rehabilitation, grass species found during the wet and dry seasons, and reasons for mentioned preferred grass species for soil erosion control. The focus groups were conducted in local language (Maa) through the interpreter. A total of eight KIIs comprising experts in pasture management, livestock production and SWC with the government, state and non-state actors operating in the study area and early adopters of biological SWC measures were interviewed. A comprehensive literature review was done to contextualise the study and provide secondary data on community perspectives on grass species and rehabilitation.

The data collected were coded and analyzed using Microsoft Excel 2010 to generate descriptive statistics. Field notes were collated and consolidated into different topics to validate and complement individual interviews.

RESULTS

Demographic and socio-economic characteristics of respondents

Most (85%) of the households sampled are male headed and the average family size is 7 persons. Age of the respondents ranged from 20 to 80 years. Average tropical livestock unit (TLU) kept by the households is 20.1 (Table 1).

Agro-pastoralists' perceptions and knowledge on land degradation

Respondents agreed (100%) that the area is severely degraded (Table 1). Evidence provided was the presence of gullies, loss of vegetation and high soil deposits in the lowlands. The communities indicators of land degradation are presence and depth of the gulley, presence of undesirable plants growing and absence and decline of desirable plants. Above 50% of the interviewed attributed land degradation to anthropogenic causes. The community perceived increase in human population, overgrazing, cultivation on slopes and bush clearing for charcoal burning, fence and shelter (*manyatta*) building were the man-related causes of degradation. Communities perceived prolonged dry spells that often lead to drought, low and poorly distributed rainfall were what constituted climatical causes of land degradation.

Table 2. Common grass species found in the study area and their uses.

Grass species		Preference by livestock species	Other grass uses
Scientific name	Local names (Maa language)		
*Cynodon Plectostachyus***	*Emurua*	All livestock (cattle, sheep, goat, donkey)	
Digitaria macroblephara	*Erikaru*	Cattle and sheep	
Chloris gayana	*Olekiramatian*	All livestock (cattle, sheep, goat, donkey)	Fodder production
Cymbopogon citratus **	*Olung'u*	Cattle and sheep (dry season only)	Thatching, rehabilitation
*Aristida adoensis***	*Onkosos*		
Sporobolus fimbriatus	*Olperesi*	Sheep, goats (feed on inflorescence)	
Hyparrhenia lintonii	*Ologorroing'ok*	All livestock (cattle, sheep, goat, donkey) (cattle consume more)	
Pennisetum clandestinum	*Olobobo*	Donkeys and sheep	Fodder production
Themeda triandra	*Olperesi Orasha/Orkijitaonyokie*	Preferred by goats	Thatching, plastering
Setaria verticillata	*Olorepirepi*	All livestock (cattle, sheep, goat, donkey)but more preferred by sheep	
*Tragus barteronianus***	*Onkosos*		
Cyperus spp	*Oseyia*	All livestock (cattle, sheep, goat, donkey)but more preferred by goats	
Pennisetum mezianum	*Not specified*		
Cenchrus ciliaris	*Oshankash*	All livestock (cattle, sheep, goat, donkey) but more preferred by cattle	
Brachiaria brizantha	*Ormagutian*	All livestock (cattle, sheep, goat, donkey)	
*Harpachne schimperi***	*Onkosos*		
Not specified	*Mutanduro*	Cattle and sheep	
Not specified	*Ngonyoro*	Sheep and goats	
Not specified	*Oltiol (found in the forest)*	Cattle	
Not specified	*Olparakae*	Cattle and sheep	

** Represents dominant grasses as identified by the community in the study site.
Source: Focus Group Discussions (n=5); Survey Data, 2016.

The consequences of land degradation mentioned by the agro-pastoralists are crop failure and low yield, land fragmentation, death of animals from falling off the cliff of the gulley, separation from relatives by the barriers. The advantages perceived by the respondents as a result of land degradation are formation of ballast especially in the gullies used for construction, provision of sand that they sell and the gullies form dry feed reserves as animals cannot graze there on normal occasions.

Common grass species found in the study area and their uses

During the focus groups, 20 grass species were identified (Table 2). Nine of the grasses were identified as dry season livestock forages namely: *Cymbopogon citratus, Cynodon plectostachyus, Sporobolus fimbriatus, Chloris gayana, Eragrostis superba, Pennisetum mezianum, Cenchrus ciliaris, Hyparhennia lintonii* and *Aristida adoensis*. Out of the nine species*, Cenchrus ciliaris, Cynodon plectostachyus* and *Chloris gayana* were reported to be highly preferred by the livestock. *Cymbopogon citratus* was only fed when the

Table 3. Grass species perceived suitable for rehabilitation and soil erosion control and their reasons.

Scientific name	Respondent		Reasons for selection						
	Frequency	Percent	Livestock feed	Rapid growth	High biomass	Perennial	Drought tolerance	Continuous grass cover	Stabilize SWC
Cynodon plectostachyus	25	76	x	x	x	x	x	x	
Chloris gayana	24	73	x		x	x	x		x
Pennisetum clandestinum	23	69	x			x	x	x	
Cymbopogon citratus	15	45		x		x	x		x
Themeda triandra	14	42	x			x	x		x

n=33; SWC= Soil water conservation.
Source: Focus group Discussions (n=5); Survey Data, 2016.

animals did not have any other feed and it gave milk a distinctive citral kind of taste. During the wet season, livestock utilised annuals including *Setaria verticillata*, "mutanduro" (in Maa language) and *Sporobolus fimbriatus*. Agro-pastoralists preferred mutanduro to the other annual grasses citing its distinctive taste in the milk. Fast growing grasses following rains mentioned by the respondents were *C. citratus, Cynodon plectostachyus* and *Sporobolus fimbriatus.* The respondents perceived *Themeda triandra* to have declined in abundance.

The major grass use in the study area is livestock feed. Other uses mentioned by the community were thatching, plastering and rehabilitation. The community considers *C. citratus* more durable to *T. triandra* for use in thatching. *T. triandra* was used in traditional huts plastering where the respondents cut it in small pieces and mix it with mud.

Above a quarter per cent of the respondents had planted grasses and out of which 11% had planted *Cymbopogon citratus* for rehabilitation

purposes. Most (89%) planted Chloris gayana and *P. clandestinum* to provide for the livestock. *P. clandestinum* was planted around the homesteads and water pans due to the species high water demand. The respondents reported that *Chloris gayana* provided high biomass yield where the establishment was successful. Challenges of planting grasses were reported to be insufficient rainfall, seedling mortality, recurrent dry spells, animals grazing on young grasses leading to uprooting and destruction by flash floods (Table 1).

Perceived suitable grass species for rehabilitation and their reasons

From the 20 identified grass species, the respondents perceived five grass species to be best suited for soil erosion control and rangeland rehabilitation (Table 3). The chosen grasses were *C. plectostachyus, C. gayana, P. clandestinum, C. citratus* and *T. triandra*. Livestock feed provision

was the primary reason for the choices of the grasses. Land rehabilitation was considered secondary to the use of livestock feed. Stabilizing the already SWC structures concerned the respondents.

DISCUSSION

The Maa speaking community inhabiting the study area is aware of their surrounding environment and possesses a great pool of knowledge about their environment, which is no different from other communities in Tanzania and Ethiopia, respectively (Kangalawe 2012; Walie, 2015). The knowledge possessed by the community forms their decision-making tool on key issues of degradation, pastoralism and alternative livelihoods. The indicators used by the communities to describe the extent of degradation were close to what the modern scientists use. The Maa speaking community of Narok County considers the presence of gullies, gulley depth

and presence of desirable and undesirable species for their livestock when making their rehabilitation decisions. Based on the indicators, the pastoral communities know where to take their animals during wet or dry seasons to control erosion. Jandreau and Berkes (2016) observed a similar phenomenon at the Maasai Mara where the community uses forage characteristics like grass height, keystone species and grass colour in making rehabilitation decisions. In Dejen in Ethiopia, presence of gullies and rills was the major indicator followed by decline in agricultural productivity and soil colour change (Tegegne, 2014). The indicators perceived by community closely match with those of scientific findings. It was equally evident that anthropogenic induced land degradation was common in the study area arising from agricultural activities like unsustainable cultivation methods on hillsides and indiscriminate bush clearing (*personal observation*). Degree of slope, unsustainable farming methods, deforestation, intense rainfall and lack of physical SWC structures have been reported severally as the main results of land degradation (Tegegne, 2014; Kusimi and Yiran, 2011; Saguye, 2017). Diversification of livelihoods has increased with many starting poultry farming and bush clearing for charcoal. Mganga et al. (2015) observed a similar scenario of increased charcoal production from indigenous trees while working with the Akamba agropastoral community in South Eastern Kenya. The case is no different in Ethiopia where Gashu and Muchie (2018) reported livelihood changes alternatives to be sale of firewood and charcoal. It is evident that alternative livelihood strategies that are being adopted are no good in alleviating land degradation, therefore more community awareness programmes should be channelled towards educating communities of sustainable alternative livelihood options. The livelihood change can be attributed to declining land and net primary productivity because of degradation. Additionally, the increase in human population within the area and fragmentation of land influence the lifestyle of the community by increasing rearing of small ruminants because of their tolerance to undesirable species and their ability to utilise the rough terrain created by degradation (Odini et al., 2015).

It is evident that different grass species are perceived differently with respect to location, community perceptions, and priorities. The pastoral community in the study area uses grasses as livestock feed, for thatching and plastering, and rehabilitation. The grass species considered suitable for rehabilitation are the ones that provide adequate livestock feed. This agrees with Sacande and Berrahmouni (2016) who noted that prioritization of species not only depended on aspirations and conservation status but importantly their way of life. As opposed to modern scientists who link the plant characteristics like root length, root biomass and diameter, cover and plant density as good for rehabilitation, the community acknowledges the amount of biomass produced by the grass species for livestock as another most desirable consideration for rehabilitation. These findings agree with those of Mganga et al. (2015) in Kenya; Sacande and Berrahmouni (2016) in Ethiopia; Visser et al. (2011) in Tunisia; Sjögersten et al. (2013) in China which found that the livestock feed was a criterion used in selecting the grass species for rehabilitation.

C. plectostachyus's higher preference compared to *C. gayana, P. clandestinum, C. citratus* and *T. triandra* demonstrates their need for yearlong livestock feed. In a study that crosscut Burkina Faso, Mali and Niger, 105 of 193 grass species selected by communities was for their value in livestock feed (Sacande and Berrahmouni, 2016). *C. plectostachyus* is also available in many areas and establishes rapidly from splits or seeds (Harlan et al., 1969). Additionally, the grass species is also preferred by all kinds and classes of livestock in the area. Geissen et al. (2007) found that grass species was important in slowing the speed of runoff thereby controlling erosion while working in Mexico. *C. gayana* preference for rangeland rehabilitation was attributed to its high biomass and palatability to all livestock in the study area. Koech et al. (2016) found that the species produces high biomass even under limited water conditions. *P. clandestinum* was preferred by the community for its growth form and its ability to spread and cover the land. The grass has however been observed to effectively grow in high altitude and rainfall areas (Fukumoto and Lee, 2003; Mears, 1970), explaining why it was only planted near homesteads and water sources. The lower preference accorded to *C. citratus* can be attributed to the citral content that lowers its palatability (Thomas et al., 2012). *T. triandra* was least preferred species because of its rapid decline in abundance after establishment. This can be attributed to the grazing and trampling because it is highly sensitive to poor management (Snyman et al., 2013).

Wasonga et al. (2003) and Mutu (2017) observed that calamities and lack of resources make the pastoralists flexible in decision-making and utilisation of resources. The chosen grasses by the Maasai community as best for rehabilitation demonstrate the flexibility in decision-making depending on their needs and way of life. Indigenous knowledge among the pastoral community is increasingly evolving to suit the needs of the community and cushion them from future calamities.

Conclusion

The community in the study area is aware of the land degradation status and clearly understands the indicators, causes and effects of land degradation. Loss of vegetation and declined abundance of keystone species is one of the indicators and impacts of land

degradation respectively. The needs of the community are well articulated and the major concern is livestock feed regardless of the status of the land known. Decision-making of the choice of grass species for soil erosion control and rehabilitation of the land is based on its ability to provide livestock feed. Soil conservation and range rehabilitation are secondary reasons for provision of livestock feed in choosing suitable grass species for rehabilitation of degraded lands. There is need for a tradeoff, therefore, between the local community needs, priorities and beliefs and land rehabilitation and restoration objectives. In addition, need arises to quantify the ability of the grasses to control soil erosion and restore degraded land while providing adequate livestock feed.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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