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BENEFITS DERIVED FROM REHABILITATING A DEGRADED SEMI-ARID RANGELAND IN PRIVATE ENCLOSURES IN WEST POKOT COUNTY, KENYA

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ABSTRACT

Rehabilitating degraded rangelands using enclosures offers various benefits to agro-pastoral households. However, enclosure benefits cannot be generalized as there are variations across dryland ecosystems and societies. This study assessed the qualitative and quantitative benefits derived from rehabilitating degraded rangelands using private enclosures in Chepareria, West Pokot County, Kenya. Dry-season grazing reserves, healthier livestock, improved livestock productivity, easier livestock management, food security, reduced animal losses, ecosystem services, land ownership, independence and improved standard of living were the main qualitative benefits from private enclosures identified. Quantitative benefits were manifested through various enclosure enterprise combinations, sale of enclosure marketable products and adoption of alternative income generating activities. They included the sale of livestock and livestock products, maize, wood cutting, grass cuttings, contractual grazing, grass seeds, poultry products, fruits and honey, amongst others. Livestock production directly accounts for 42·4% of the total enclosure income and is the main source of livelihood in Chepareria. There was a significant trend of increasing total enclosure income with enclosure acreage ($p \leq 0{\cdot}05$) while enclosure age was insignificant. Enclosures cushion households against climatic shocks such as drought by providing additional flexibility in land, fodder, livestock management and the uptake of various income generating activities. We conclude that enclosures have the potential of contributing to resilience as attested from the benefits reported in this study. However, private enclosure tradeoffs such income differentiation, reduced communal land and conflict have implications on how the ecological and socio-economic aspects may be impacted as the establishment of private enclosures in Chepareria continues. Copyright © 2015 John Wiley & Sons, Ltd.

KEY WORDS: ecosystem services; Kenya; land degradation; livelihoods; rangeland rehabilitation

INTRODUCTION

Land degradation reduces the capacity of the drylands to provide essential ecosystem services (Irwin & Ranganathan, 2007; Mekuria & Veldkamp, 2011). Land degradation, particularly on soils, the worst hit component of land degradation (Brevik *et al*., 2015), deprives the soil of organic matter reducing soil fertility and productivity in drylands (FAO, 2004) hence reducing the services soils offer to societies (Keesstra *et al*., 2012). This increases food insecurity and poverty, thereby posing serious threats to livelihoods and biodiversity in drylands (Reynolds *et al*., 2007). Therefore, combating land degradation is essential to guarantee sustainable and long-term productivity in the semi-arid environments. The establishment of enclosures is a common rangeland rehabilitation strategy in semi-arid regions of Sub-Saharan Africa (SSA). Although there are few cases of successful rehabilitation initiatives in East Africa (Mureithi *et al*., 2010), the successful restoration of degraded rangelands using enclosures in Chepareria and the lake Baringo Basin has created an impetus for increased enclosure establishment (Makokha *et al*., 1999; Verdoodt *et al*., 2010; Mureithi *et al*., 2015).

Past research on enclosure benefits provides information on the qualitative benefits derived from restoring degraded rangelands in the arid and semi-arid lands (ASALs) of Baringo in Kenya and Alaba in Southern Ethiopia respectively (WOCAT, 2003; Mureithi *et al*., 2015). Across the various studies and research projects, private benefits derived from enclosures were observed to continually attract individuals into establishing enclosures (Barklund, 2004; Bauer, 2005; Keene, 2008, Bayene, 2010; Verdoodt *et al*., 2010; Napier & Desta, 2011). While these benefits have contributed to the spontaneous adoption and adaptation of rangeland enclosures in the region, variations exist across case studies with regards to the incentives and drivers for the establishment of rangeland enclosures (Behnke, 1985b; Behnke, 1986). The observed variations influence the reasons and benefits derived from the establishment of enclosures by households. It is hence fundamental to understand the benefits derived by enclosure owners in the North-Western rangelands of Chepareria in West Pokot County, Kenya.

Despite evidence of increased demarcation of common property grazing commons as communal range enclosures tend to gain momentum (Kamara *et al*., 2004; Keene,

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2008), there are limited studies on the benefits of rehabilitating degraded rangelands through private enclosures. Most studies on the benefits of enclosures have predominantly focused on the qualitative benefits derived from rehabilitated rangelands in private and communal enclosures (Kitalyi *et al*., 2002; WOCAT, 2003; Bayene, 2009), particularly on biophysical parameters such as soil carbon, vegetation cover and biodiversity. However, except for Mureithi *et al*. (2015) who assessed quantitative benefits derived from rehabilitating a degraded semi-arid rangeland in communal and private enclosures, studies on economic benefits are rare. Particularly, Mureithi *et al*. (2015) called for a need to assess the quantitative benefits derived from rehabilitating degraded rangelands in private enclosures.

This study assessed the benefits-qualitative and quantitative-of private enclosure establishment in Chepareria ward, West Pokot County in Kenya. It also sought to understand the socio-economic reasons for the continued expansion of private enclosures in order to contribute to the development of a cost-effective private enclosure management and utilization strategy. This is critical if scaling up/out of private enclosures is to take place in rangelands with similar ecological/climatic conditions in SSA.

MATERIALS AND METHODS

Study Area

Chepareria, a ward in West Pokot County (Figure 1), is situated in the northwestern rangelands of Kenya between latitude 1°15′ and 1°55′N; longitude 35°7′ to 35°27′ E. The ward is located at the lower edge of the Kamatira hills and its Southern floodplains stretching far and beyond Mount Morpus. The area is gently undulating plain with an altitude range of 1200–1600 m above sea level, and is surrounded with hills, ridges and plateaus with peaks of up to 3000 m (Touber, 1991).

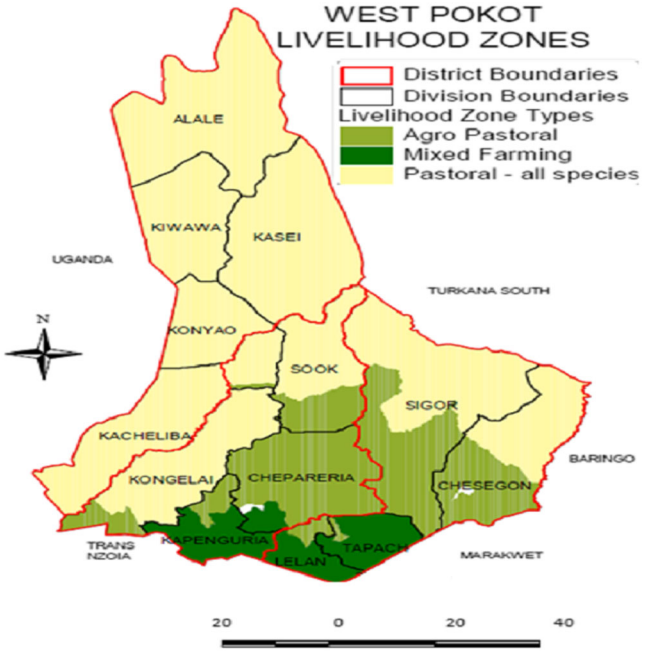

Figure 1. Location and livelihood zones of Chepareria ward in West Pokot County in Kenya (Source: National Drought Management Authority (NDMA, 2014)). This figure is available in colour online at wileyonlinelibrary.com/journal/ldr

Chepareria ward experiences a profoundly seasonal climate common in most arid and semi-arid regions of SSA. Rainfall in Chepareria averages 600 mm per year, although it varies with altitude, hence influencing livelihood zones as indicated in Figure 1. According to the National Drought Management Authority (NDMA), Chepareria has a bimodal rainfall pattern, with a long rainy period between March and May (MAM) and short rainy period from August to November (NDMA 2014). The average annual temperature in West Pokot County ranges from 15 °C to 30 °C in the highlands and 24 °C to 38 °C in the lowlands (County Government of West Pokot 2013).

Chepareria is primarily a metamorphic bedrock area, rich in ferromagnesian minerals. It is from this bedrock that rocky, moderately shallow and well drained soils have developed (Touber, 1991; Sposito, 2013). Soils vary significantly across the study area with the lower altitude and more semi-arid areas of Chepareria generally having fragile infertile soils (FAO, 2006). Generally, the vegetation is steppe-like, dominated by grasslands with scattered native and exotic tree species.

Chepareria ward covers an area of almost 495 km^2, has a population of about 41 563 people, and is mainly inhabited by the Pokot ethnic group with a long history of nomadic pastoralism as cited by the Kenya National Bureau of statistics (KNBS) (KNBS, Kenya National Bureau of Statistics, 2009). Traditionally, the Pokot moved with their animals from one area to another in accordance with the seasons. This allowed their land to recover from grazing and other natural disturbances such as drought. However, the colonialists introduced border restrictions thus halting their migratory lifestyle (Nangulu, 2009). Restricted mobility meant that herds were restrained in limited areas and for prolonged period, thus leading to overstocking, overgrazing and poor management of natural resources. Changes in livestock grazing patterns led to massive land degradation in Chepareria. The NGO Vi-Agroforestry (Vi-AF) set up a land rehabilitation program in 1987 to address land degradation in the area. Working together with diverse stakeholders in Chepareria, Vi-AF introduced sustained changes in land management by establishing enclosures, starting with churches and schools as demonstration sites.

Sampling and Data Collection

Systematic random sampling method was used to select the locations and enclosure households to be sampled. Households to be sampled were selected based on their administrative location within the ward and the years since effective protection. Three locations, namely Ywalateke, Chepkopegh and Morpus were selected for this study. These locations represent areas where Vi-AF conducted intensive extension on enclosure establishment and agroforestry in Chepareria from 1987 to

Table I. General characterization of the selected enclosures

Variable	Classification	Sampled
Age (years)	≤10	45
	10·01–20	42
	20·01–30	33
Acreage (ha)	≤5	72
	5·01–10	30
	10·01–15	12
	15+	6
Administrative location	Ywalateke	40
	Chepkopegh	40
	Morpus	40

1994. The extensive establishment of enclosure in these locations was informed by stable security, high population density and a high extent of land degradation. Systematic random sampling was used to sample forty (40) enclosure owners from each of the three administrative locations based on a checklist of more than 400 enclosure owners provided by the local administrators in each location. Some of the general characteristics of sampled enclosures are indicated in Table I.

A total of 120 semi-structured interviews, five key informant interviews (KIIs) and eight focus group discussion (FGDs) were conducted to collect data on the study subject. Qualitative benefits were captured using semi-structured interviews, KIIs and FGDs, while quantitative benefits were only captured using a semi-structured questionnaire.

Data Analysis

Data analysis combined both qualitative and quantitative approaches. First, field-notes were revised and similar information consolidated with the help of summary tables. This was important in identifying themes and concepts from the rich individual and group narratives. This information was then used to verify and confirm data collected using household semi-structured interviews, KIIs and FGDs. From all the data collected, the results were grouped into two distinct categories; the quantitative benefits [products/services that have immediate, tangible economic value or return] and qualitative benefits [improve the well-being/welfare of the individual household, community or society, but cannot be converted immediately into cash].

RESULTS

Private enclosure owners in Chepareria do not maintain utilization or sales records of the marketable products (goods or services) derived from their enclosures. Quantitative benefits from private enclosures were restricted to the preceding year—2013. This was necessary to reduce recall bias when quantifying such benefits from households. Because of their descriptive and intangible nature, private enclosure qualitative benefits were not time-bound.

Qualitative Benefits

Private enclosure owners in Chepareria indicated that they have benefitted greatly from the establishment of enclosures. Respondents indicated that enclosing previously communal rangelands has given them flexibility to engage in crop farming hence increase food production. With recurrent drought and feeds shortage, private enclosures have given individuals increased flexibility in the management and usage of livestock pasture. They indicated that enclosures enable them to preserve pasture for dry-season grazing hence reduced animal losses. Private enclosures have provided the framework for increased pasture availability, reduced livestock migration and easier livestock management. Consequently, individuals indicated improved livestock health and productivity (milk and meat). The increased need for land ownership has also been cited as a key reason for the establishment of private enclosures. Respondents indicated that enclosures have enabled them own land which they can manage appropriately and derived accruing land use benefits. Within the formerly degraded rangeland, proper land management fostered by land ownership has been instrumental in addressing land degradation and increasing ecosystem/environmental services such as vegetation cover and reduced soil erosion. Individuals indicate that vegetation cover has greatly increased compared to other neighbouring areas without enclosures. The respondents indicated that their standards of living have significantly improved as they have diversified their livelihoods to include additional income generating activities (IGAs). This was attributed to increased flexibility in pasture and livestock management. Private enclosures have fostered changes in gender roles with both men and women, highlighting that they have time for alternative tasks and IGAs besides their traditional gender roles. Qualitative benefits derived from rehabilitating degraded rangelands using private enclosures in Chepareria are broadly classified under livestock production, crop production, land ownership and management, ecological change and environmental benefits and income diversification and improved living standards as indicated in Table II.

Quantitative Benefits

Quantitative benefits derived from enclosures were classified based on various enterprises and IGAs supported by enclosures. These IGAs provide various enclosure marketable products which generate income and benefit streams once they are sold. Some of the identified enclosure marketable products as per the IGA are indicated in Table III. The resultant economic benefits of private enclosures were ranked based on their proportionate contribution to total enclosure income (Table III). The total enclosure income increases with increasing enclosure age (years) and the enclosure area in hectares (ha). The mean and standard deviations (SD) of enclosures vary across the three locations, ranging from 4·32 ± 4·54, 5·62 ± 4·81 and 4·50 ± 3·09 in Ywalateke, Chepkopegh and Morpus respectively. Average total enclosure income per hectare in the three locations ranged from US$ 225·72 (±157·27) in Ywalateke, US$ 217·44 (±204·06) in Chepkopegh and US$ 170·06 (±147·65) in Morpus. Interestingly, while Chepkopegh had the highest total enclosure income amongst the three locations, it ranked

Table II. Reported qualitative benefits derived from rehabilitated rangelands in private enclosures in Chepareria

		Number of responses ($N = 120$)	%
Livestock production	Reserve grazing pasture	100	83·3
	Healthier livestock	81	67·5
	Improved livestock productivity	61	50·8
	Easier livestock management	53	44·2
	Reduced animal losses	48	40·0
Crop production	Enable farming	57	47·5
	Land ownership	44	36·7
Land ownership and independence in land use	Independence	36	30·0
Ecosystem/environmental services	Environmental conservation/benefits	34	28·3
Income diversification and improved living standards	Improved living standards	30	25·0

second on a per hectare basis. This can be attributed to the large enclosure sizes (ha) in the location.

DISCUSSION

Livestock Production

Previous studies have shown that enclosures are used to control grazing (Shang *et al*., 2014), provide vital dry-season fodder reserve (Gaani *et al*., 2002; Bayene, 2009; Desta *et al*., 2013; Mureithi *et al*., 2015), and where the grazing pressure is moderated, they can be used to restore degraded rangelands (Mekuria & Aynekulu, 2013; Papanastasis *et al*., 2015). The reserved feeds are essential during the long dry season, especially for the lactating stock which is the core breeding stock (Kamara *et al*., 2004; Abule *et al*., 2005; Angassa & Oba, 2008; Keene, 2008; Desta *et al*., 2013).

The availability of pasture throughout the year amongst enclosure owners in Chepareria has not only reduced the loss of animals but also enabled livestock improvement. Key informants indicated that enclosure owners have healthier and more productive animals in Chepareria because of pasture availability. Healthy animals have higher fertility and production rates; hence there is higher calving, lambing and kidding rates, which generally lead to faster herd building amongst individual households. Improved health can also be associated with reduced migration and movement needs of the animal as pasture is readily available. Enclosures in Somalia were found to be exclusively used for fattening livestock for export (Gaani *et al*., 2002). Animals with access to good feeds provide more milk, lactate longer and are able to maintain their body condition. Similar findings have been reported by Makokha *et al*. (1999) and Gaani *et al*. (2002) who observed that livestock within enclosure households are of better body condition and can attain higher live-weight in shorter periods. Such animals have higher demand and fetch more money in the market. To ensure that overgrazing does not occur, most respondents indicated that they regulate grazing and animal densities within their enclosures. More importantly, those with smaller enclosures or large herd sizes tend to hire grazing lands from those who practice contractual grazing in the area. This, coupled with maintenance of grazing reserves and the use of crop residue as livestock feed, helps avoid overgrazing and loss of livestock during the dry season or even drought.

More significantly, enclosures in Chepareria are facilitating easier livestock management as individuals can easily graze their livestock within paddocks on a rotational basis during the dry and wet seasons. In developed countries where the rate of vegetation is very fast after land abandonment, previous studies have shown that enclosures are not only used to manage the livestock but also as an alternative strategy to control biomass (Álvarez-Martínez *et* al., 2013). Consequently, herding labour requirements have reduced as it is easier to monitor and manage livestock and pasture when compared to grazing on the open range. This has influenced gender roles, hence enabling men to take part in other IGAs such as agriculture, businesses or casual jobs while enabling more children to attend school (Karmebäck, 2014). Particularly, her study indicated that the workload of women has increased under the private enclosure land management approach. Both men and women are increasingly engaged in alternative IGAs such as small-scale business. This has increased women's participation in decision-making, although they are still excluded from various traditionally male-dominated spheres.

Economically, with the exception of other sources of household income such as employment (formal and informal), business (excluding sale of enclosure marketable products), remittances and income aid, livestock production accounting for 42·4% of the total enclosure income in Chepareria ranks highest in its contribution to total enclosure income associated with enclosure land use (Table III). These results are similar to findings by Mureithi *et al*. (2015) who reported that livestock production accounts for 52–97% of the total enclosure income, depending on utilization and management systems adopted by enclosure owners in Baringo. This study has found that livestock production enterprise through the sale of livestock and livestock products ranks first in its proportionate contribution to total enclosure income and practice by households as indicated in Table III. These results are similar to findings by Wernersson (2013) and Saxer (2014) who reported that livestock is still the main measure of wealth and source of livelihood amongst the agropastoral community in Chepareria. Although surplus milk is sold, most of the milk produced

Table III. Quantitative enclosure benefits for selected households (HHs) in US$ for 2013[a]Approximate minimum sales price in US$ at farm gate; Exchange rate as at 31 Dec 2013 was 1US $-86·40. [b]Used where the quantity sold and average sales price could not be determined

Enclosure enterprise	Income generating activity	Enclosure marketable product sold	% of HHs which recorded sales in 2013	Average sold	[a]Average sales price	Total enclosure income	Total enclosure income per IGA	Total enclosure enterprise income	Enterprise income as a proportion of the total enclosure income (%)	Enclosure enterprise income rank based on proportionate contribution to total enclosure income
Livestock production	Livestock	Cattle (no.)	85·8	3	191·9	575·7				
		Shoats (no.)	86·7	11	37·4	411·4	987·1			
	Livestock products	Milk (litres)	15	327	0·3	98·1	98·1	1085·2	**42·4**	**1**
Crop production	Crop farming	Maize grains (bags)	34·2	16	36·1	577·6				
		Crop residue	0·8	—	—	23·1[b]				
		Vegetables	2·5	—	—	28·5[b]	629·2	629·2	**24·6**	**2**
Fodder and pasture production	Grass cutting	Thatching grass (backloads)	10·8	25	1·3	32·5				
		Hay (bales)	3·3	63	2·1	132·3	164·8			
	Contractual grazing	Pasture (ha)	12·5	7	19·3	135·1	135·1			
	Grass seeds harvesting	Grass seeds (kg)	1·7	37	1·7	62·9	62·9	362·8	**14·2**	**3**
Agroforestry	Wood Cutting	Firewood (backloads)	3·3	80	1·2	96				
		Fencing posts (no.)	0·8	—	—	92·6[b]				
		Building poles (no.)	2·5	101	1·1	111·1				
		Charcoal (bags)	9·2	12	4·8	57·6	357·3	357·3	**14·0**	**4**
Poultry keeping	Poultry production	Poultry (no.)	74·2	16	3·8	60·8	60·8	60·8	**2·4**	**5**
Fruits production	Fruits farming	Fruits	9·2	—	—	45·1[b]	45·1	45·1	**1·8**	**6**
Bee keeping	Bee keeping	Unpurified honey	0·8	—	—	19·7[b]	19·7	19·7	**0·8**	**7**
	Total		**100**					**2560·1**	**100**	

NB. Quantitative enclosure benefits were only computed for those households that engaged in the indicated IGAs.

is consumed within the household, hence accounting for the observed low engagement in milk trade as an income generating activity of households (15%), low sales volume (3271 per year) and accruing average income per year. Similar findings were reported by Makokha *et al.* (1999) in Chepareria, West Pokot County.

Crop Production

Being an agropastoral community, crop production is a key feature of the Pokot community in Chepareria. Enclosures have enabled individuals to effectively take part in crop production, increase acreage and intensify food production. Studies in the arid and semi-arid rangelands of East Africa have shown that crop production is a necessity of East African pastoralists today, particularly where rain-fed agriculture permits (BurnSilver, 2007; Galvin, 2009). Similar to findings in other previous studies in Chepareria (Vi Agroforestry Survey, 2001, 2007; Wernersson, 2013; Awino Ochieng *et al*., 2014), the main crops grown are maize and beans while sorghum, millet and cassava are also cultivated. Bananas and mangoes in the wetter parts of Chepareria are essential fruit foods contributing to household nutrition security. The shift towards agropastoralism, commercialized maize farming, changes in dietary habitats and food preference have been accelerated by use of enclosures.

Economically, engagement in maize, crop residue and vegetable trade is low, although crop production ranks second in proportionate contribution to total enclosure income. The 34·2% of households that can sell maize are mainly from Ywalateke location which is in one the more humid areas of Chepareria. In other locations, maize production is done on subsistence basis and the harvested grains if any are consumed by the household. We are in agreement with findings by Makokha *et al*. (1999) that the sale of crop residues is not common as maize stovers are mainly stored on top of *Balanites aegyptiaca* trees as fodder for livestock during the dry season hence the low engagement in crop residue sale by enclosure owners in Chepareria.

Ecological Change, Environmental Benefits and Agroforestry Income

Previous studies have reported that productivity increase, ecological change, environmental benefits and the desire to address land degradation are some of the reasons for the establishment of enclosures in rangelands (Makokha *et al*., 1999; WOCAT, 2003; Keene, 2008; Mureithi *et al*., 2010; Wasonga *et al*., 2011; Svanlund, 2014). The establishment of "living fences" and intensive agroforestry within the formerly degraded areas has facilitated rapid ecological change in Chepareria. The simplest indicator of the ecological benefits of rangeland enclosures is the remarkable difference of vegetation cover/regeneration and soil health inside respective of outside the fence as reported by Mureithi *et al*. (2010) and Mekuria & Aynekulu (2013) respectively. The same transformational vegetative change has been observed in Chepareria and is reported in various similar studies as cited by Kitalyi *et al*. (2002) and Svanlund (2014). Notably, the establishment of enclosures has diverse environmental benefits both at the site and landscape levels as reported in various ecological studies. Some of these benefits reported include reduced soil erosion (Descheemaeker *et al*., 2006b; Napier & Desta, 2011), improved soil structure (Bronick & Lal, 2005) and fertility (Descheemaeker *et al*., 2006a; Mekuria *et al*., 2007; Mekuria & Aynekulu, 2013), soil water balance (Mureithi *et al*., 2010) and restored soil biodiversity (Su *et al*., 2005) notably the soil micro-organisms essential in soil aeration. These features when combined with other landscape benefits such as regulation of the hydrological cycle lead to improved crop, pasture and animal productivity at household level.

However, it will become difficult to sustain the above mentioned ecological change and accruing environmental benefits if associated economic benefits of resource extraction practices such as wood cutting and charcoal burning are not harnessed. According to studies by Mekuria & Aynekulu (2013), increased vegetation cover and woody cover was observed to be one of the factors contributing to improved soil within communal exclosures in Northern Ethiopia. Currently, agroforestry through wood products ranks fourth on proportionate contribution to total enclosure income, although it is only practiced by a combined 15·8% of households (Table III) indicating the intensity of resource extraction and incentives for their extraction. Although the sales of firewood, fencing and building poles and fencing posts are considerably low, they have significant economic contributions to a few households in Chepareria. Similar findings were reported in the Lake Baringo Basin by Mureithi *et al*. (2015) who observed that wood cutting with the exception of the sale of firewood accounts for approximately 7% of the total income. Species commonly used for fuel wood, poles and posts include *Acacia hockii*, *Acacia mellifera*, *Acacia nilotica*, *Terminalia brownii*, *Kigelia africana* and *Agave sisalana*. Of the various IGAs under agroforestry, charcoal burning has detrimental effects on the environment and climate, particularly if its practice rises above the current 9·2% of households.

Land Ownership and Independence in Land Use

Studies on rangeland enclosures in Somaliland reported that enclosures signify the *de facto* privatization of pastoral commons (Gaani *et al*., 2002), insinuating the allocation of grazing commons to individual private owners. In this case, it arises where the state, elders and the community have embraced the individualization of land tenure. This is based on the assumption that privatization will encourage a more responsible use of the land, or where communal use/management of rangelands has led to range degradation (McCarthy *et al*., 2003; Keene, 2008). In Chepareria, land ownership through the establishment of private enclosures has increased flexibility in land use, enhanced freedom in land management and provided a framework for the management of vast rangelands. Although there exist various communal effects because of the establishment of private enclosure such as land-based conflict, reduced communal

land and increased land prices, various studies have observed that land ownership and freedom in land use and management allow individuals to exercise and explore the various benefits and opportunities presented by individual land ownership and are important to the utilization and management of enclosures (Napier & Desta, 2011; Saxer, 2014). IGAs such as contractual grazing practiced by 12·5% of the respondents showcase opportunities presented by land ownership and independence in land use.

Income Diversification and Improved Living Standards

In Ethiopia, previous studies have reported that rangeland enclosures present opportunities for income diversification (Keene, 2008) while in Kenya they are themselves a form of diversification (Mureithi *et al*., 2015). We are in agreement with findings by Little *et al*. (2001) that multiple IGAs are carried out within enclosures. In an attempt to obtain optimal benefits from rehabilitated rangelands using private enclosures, individuals are capitalizing on the increased flexibility provided by easier livestock management, reduced livestock migration and reduced herding needs to take part in alternative forms of livelihood. Opportunities for income diversification have also been enabled by changing gender roles in Chepareria as reported by Wernersson (2013). Shifts from conventional, traditional gendered roles by men with reduced herding needs have enabled them to participate in other IGAs such as business (trade in livestock, small-scale shops) and informal jobs. Women, on the other hand, have taken up entrepreneurial duties to support family income and are increasingly participating in decision-making within the household as reported by Wernersson (2013) and Karmebäck (2014). In other studies, households with access to communal enclosures have been found to enjoy improved livelihoods owing to diversified IGAs which have enabled them to complement household income (Kitalyi *et al*., 2002; RAE, 2004; Mureithi *et al*., 2010; 2015). According to Wernersson (2013) individuals with enclosure in Chepareria are gaining various economic benefits which have led to improved standards of living. In Lake Baringo Basin, it was found that communal enclosure owners had improved standard of living hence reduced need for food relief amongst (Makokha *et al*., 1999; GoK, 2007). In Chepareria, some of the new IGAs that Chepareria residents currently engage in include:

Fodder and pasture production incorporates grass cutting, grass seeds harvesting and contractual grazing. This is similar to observations amongst communal enclosures owners in Lake Baringo Basin by Mureithi *et al*. (2015). Grass seeds harvesting is normally done before grass cutting for thatching, baling or cut-and-carry. Some of the grass seed species in the study area include *Chloris gayana*, *Enteropogon macrostachyus*, *Cenchrus ciliaris* and *Eragrostis superba*. Despite its low adoption by households, it has the potential to grow given the increasing markets and demand for grass seeds. Grass cutting, particularly for thatching grass and hay, is important as sources of fodder and household thatching materials. Trade in these enclosure marketable products is practiced by 10·8 and 3·3% of respondents, respectively, accounting for 6·4% of the total enclosure income compared to 1% observed in Baringo County by Mureithi *et al*. (2015). Common grass cutting and fodder species include *Chloris gayana*, *Themeda triandra*, *Eragrostis superba*, *Cymbopogon validus*, *Cenchrus ciliaris and Cynodon dactylon*. Contractual grazing is a key utilization of enclosures and is practiced by 12·5% of the enclosures owners who lease out an average of 2·8 ha per year. As indicated by Makokha *et al*. (1999), those who lease out their pasture tend to be enclosure owners with more pasture than their herds can make use of. They therefore tend to have large areas of rehabilitated land and comparatively few animals. On the other hand, renting pasture is a survival strategy for herds, particularly for those households with considerably large herds and less pasture.

Poultry production is a new IGA which is rapidly gaining importance in Chepareria. Its engagement by 74·2% of the households indicates increasing recognition of the IGA's capacity to contribute to food and income generation. While the sale of poultry is common in Chepareria households to cover basic needs, the sale of eggs is minimal as they are mainly used for household consumption. This is a key area which has the capacity for expansion in Kenyan rangelands given the fact that poultry income and income from the sale of eggs have not been estimated as described by Gichuki *et al*. (2000).

Fruit farming, particularly of mangoes, bananas, guava, avocados and pawpaw are common in the wetter areas of Chepareria such as Ywalateke location. Although the uptake of this IGA both for the market and household nutrition security is rising, capacity, limited access to markets, pest and diseases are major challenges.

Bee keeping is an IGA which is lowly practiced in Chepareria despite its huge potential, thus accounting for its dismal ranking as an enterprise and IGA. Research by Kosgei *et al*. (2011) to assess the structure, conduct and performance of honey marketing in West Pokot District, Kenya indicated that West Pokot County has huge potential for honey production, although the practice is significantly affected by education level, quantity and existing market prices for honey produced. Because of record keeping issues; there are no data on the amount of honey collected or sales price on kilogram basis.

Effects of Enclosure Age, Area and Location on Total Enclosure Income

Previous studies have reported varying effects of enclosure characteristics on total enclosure income (Mureithi *et al*., 2015). Owing to the observed variations in enclosure, general characteristics such as the years since effective protection (enclosure age), enclosure area (ha) and diverse geographical location, the effect of these variables on total enclosure income was determined. Research findings by Mureithi *et al*. (2015) reported increased enclosure income with time amongst communal enclosures owners in Baringo. Similarly, our findings indicated a non-significant trend of increasing total enclosure income with time amongst private enclosure owners in Chepareria. However, this study also observed a significant trend ($p \leq 0{\cdot}05$, $n = 120$) of increasing mean total enclosure

income with enclosure area (ha) as indicated by a strong positive coefficient of determination of 0·910 (Figure 2).

Ywalateke, Chepkopegh and Morpus locations selected for this study exhibited significantly differential total enclosure incomes ($p \leq 0{\cdot}05$, $n = 120$). Climatically, Ywalateke is on the higher altitude regions of Chepareria ward and receives more rainfall than Chepkopegh and Morpus locations which are on the drier lowlands of Chepareria (County Government of West Pokot, 2013; Wernersson, 2013). Similarly, the higher altitude areas (Ywalateke) have fertile soils conducive for crop production compared to Chepkopegh and Morpus on the lowlands (FAO, 2006; Sposito, 2013). In terms of enclosure area (ha), respondents in Chepkopegh have larger enclosures compared to those in Morpus and Ywalateke locations.

Owing to the observed climatic, pedological and enclosure area/size differences in Chepareria, Ywalateke is mainly a mixed farming area while Chepkopegh and Morpus are agropastoral livelihood zones as indicated in Figure 1. Crop production, mainly maize cultivation, is highly practiced in Ywalateke while livestock production has slowly shifted towards intensive livestock production. This includes rearing improved breeds and the cultivation of high-yielding grass species (Makokha *et al*., 1999). The high agricultural potential has reduced individual area holdings (acreage) because of increased sub-division and land sales hence reduced herd sizes. While enclosure sizes in Ywalateke are lower compared to those in Chepkopegh and Morpus, the location ranks higher on an enclosure income per hectare basis because of intensified crop production and improvements in livestock production, notably through improved breeds.

Chepkopegh location is mainly a livestock production area inhabited by agro-pastoralists with large enclosure and herd sizes. The establishment of a new Kenya Meat Commission (KMC) abattoir in the location has encouraged livestock production to include improved livestock species and cultivation of high-yielding grass species for fodder production. Crop production is practiced where rain-fed agriculture allows. Increased dependence on livestock production insinuates frequent livestock and livestock product sales, hence accounting for the observed higher mean total enclosure income in the location.

Livestock production and subsistence crop production are the main livelihoods amongst agro-pastoralists inhabiting Morpus location. Although individuals have large farm sizes, livestock improvement is slow; hence most households retain a mixed herd of adapted local breeds and their crossbreeds. Subsistence cultivation of maize and beans food crops is practiced where rain-fed agriculture allows boosting household food security. Consequently, Morpus ranks lowest amongst the three locations in mean total enclosure income averaging US$ 765 as indicated in Figure 2.

Negative Implication of Enclosure Establishment-Private Enclosure Tradeoffs

With increasing individual benefits derived from private enclosures, Chepareria has witnessed the continuous adoption and adaptation of enclosures as individuals seek to maximize, particularly on the quantitative benefits derived from private enclosures. Previous studies have documented that land management approaches such as enclosures have increased sedentarization, reduced available communal land and reduced pastoral mobility. These trends may have implications on the ASAL vegetation in Kenyan rangelands (Butt, 2010). Previous studies in Chepareria have reported increased conflicts associated with trespass and encroachments into private enclosures (Makokha *et al.,* 1999; Wernersson, 2013; Saxer, 2014). According to Keene (2008), trespass in communal and private enclosures is common where individual fences allow animals to pass through. Studies by Saxer (2014) in Chepareria observed that there is a new kind of conflict where individuals are brokering and selling other peoples land, especially in Ywalateke location although they are not the legitimate owners.

While there are no individuals without land in Chepareria, land sizes vary greatly depending on an individual's initiative and enthusiasm during registration with elders for land demarcation and ownership (Makokha *et al*., 1999). With the observed significant correlation between enclosure income and area (ha), individuals with bigger fields can be able to generate more income if they put the land to productive use. If individuals with smaller enclosure sizes need to lease grazing pasture, they can only do this from

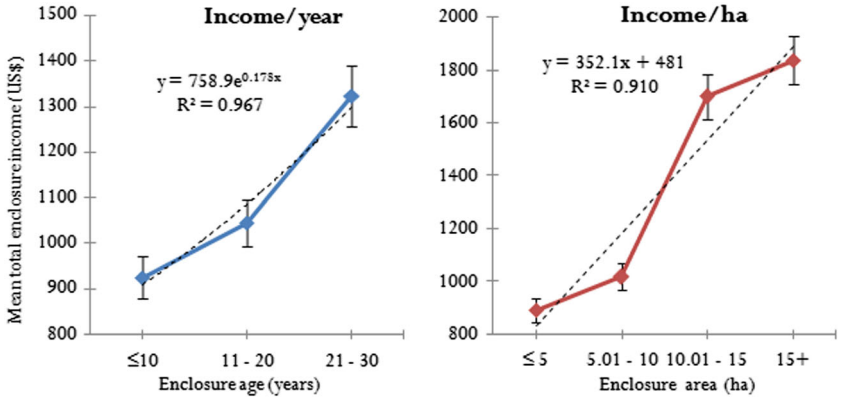

Figure 2. Effect of enclosure age, area and location on mean total enclosure income in Chepareria. This figure is available in colour online at wileyonlinelibrary.com/journal/ldr

those who have bigger fields or those without animals. Consequently, stratification is emerging in Chepareria where individuals with large enclosure sizes or quality land are better off compared to their immediate neighbours. Previous studies by Taylor (2006) in Inner Mongolia and Mureithi (2006) in Lake Baringo Basin reported that allocation bias in favour of large herders and allocation bias in the choice of land respectively leads to income differentiation and recipe for conflict by creating the haves and the have-nots situation. Overall, increasing fragmentation and registration of formerly communal rangelands in Chepareria reiterate findings reported on a study to examine the benefits of land registration for smallholders in Ethiopia by Yami & Snyder (2015).

Finally, we observed that most of the previously communal land in Chepareria has been demarcated and enclosed hence significantly reducing available communal land. Similar findings were reported by Makokha *et al*. (1999) who observed that although the land may not be fenced off, it belongs to someone and individuals are not allowed to graze their livestock there. As such, during the dry season, individuals can only hire land for contractual grazing or migrate to other areas such as Kongelai or Kacheliba wards in Pokot West Sub-County, wards which are still under communal land management, hence free for all.

CONCLUSION

The main rationale for the establishment of private enclosures in Chepareria was to alleviate pasture scarcity and create stable environments for local pastoral communities by restoring degraded rangelands. Rangeland rehabilitation through private enclosures provides additional flexibility in pasture and livestock management while providing a framework for the adoption of alternative income generating activities. To this extent, private enclosures provide various socio-economic benefits which offer resilience building pathways to rangeland communities affected by rangeland degradation. Qualitative and quantitative benefits derived from rehabilitated rangelands through private enclosures enable households to address food insecurity, poverty and lack of complementary livelihoods common in agro-pastoral regions. Across the study site, dry-season grazing reserves, increased livestock productivity, easier livestock management, food, reduced animal losses, environmental benefits, land ownership, independence and improved standard of living are some of the quantitative benefits derived from rehabilitating degraded rangelands in private enclosures. Engagement in various IGAs has helped diversify livelihood and income sources. However, livestock production is the still the mainstay of agro-pastoralists in Chepareria as observed in previous studies. Furthermore, enclosures were found to facilitate crop farming and the uptake of new income generating opportunities amongst residents. Overall, enclosures have the potential of contributing to resilience or offer pathways towards resilience as attested from the benefits reported in this study. Because of the revealed differential effects of enclosure characteristics such as age and acreage, and the existing private enclosure tradeoffs; there is a need to develop cost-effective enclosure management strategies. This calls for a comprehensive cost-benefit analysis of private enclosure establishment and management in order to adequately inform the out-and up-scaling of enclosure management and diversification options.

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