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Enclosures as a land management tool for food security in African drylands

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ABSTRACT

Increasing sedentary agro-pastoralist livelihoods may be explained by land degradation, population pressure, agricultural commodification, and economic development. We reviewed scientific and 'grey' literature for the effects of enclosures on food security. Only 8% of the 114 reviewed scientific articles addressed food production, while 69% approached environmental parameters that indirectly affect food security, most of which had positive results. Thirty-one percent focused on social and economic impacts, land tenure conflicts and elite capture with negative connotations. The 'grey' literature showed an opposite balance between positive environmental views and negative socio-economic impacts.

Enclosures are not a panacea for dryland development, but their use need to be recognized and understood. Multidisciplinary research and cooperation on the applied management of enclosures in the context of food security is highly needed. Furthermore, agro-pastoralist land-use practices need more policy space and practical management support, such as clear tenure legislation, agroforestry methodologies, and support in fodder production systems.

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African drylands; enclosures; land tenure; pastoralism; agro-pastoralism

Introduction

Drylands cover slightly over 40% of the world (Bastin et al., 2017), host 1/3 of humanity (Maestre, Salguero-Gomez, & Quero, 2012) and support over 50% of the world's livestock. Here, traditional land use is pastoralism with land tenure systems based on common property rights. Approximately 25 million pastoralists and 240 million agro-pastoralists have livestock as their primary income source (Neely, Bunning, & Wilkes, 2009), and in sub-Saharan Africa, 40% of drylands are used primarily for livestock production under pastoralist and agro-pastoralist systems.

People in the drylands are facing challenges posed by a combination of environmental and socio-economic factors, such as low and variable quantities of rainfall, which leads to fluctuations in forage availability for livestock, land degradation, and population increase, eventually resulting in resource conflicts and pasture scarcity. These challenges call for changes in production and land-use management. The major transitions experienced across most rangelands include changes from (a) nomadic to sedentary lifestyles and production systems, (b) subsistence to intensified

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commercial production, and (c) collective to private land tenure (Delgado, Rosengrant, Steinfeld, Ehui & Courbois, 1999; Thornton, 2010).

Most pastoralists and agro-pastoralists have permanent habitations. In cases of seasonal migration with livestock (transhumance), a family member, often a young man, will move with the livestock and return to their permanent home after the migration season. Hence, the term sedentarization in this article describes a change in the grazing pattern from a purely transhumant pastoralism (seasonal migration) to a more agro-pastoral, enclosure-dominated lifestyle that still has its economic base in livestock and its cultural identity in pastoralism. Recent research confirms rapid and dynamic transition processes towards intensified as well as diversified, agro-pastoralist production systems in Sub-Saharan African (SSA) drylands (Lambin, Geist, & Lepers, 2003; Nyberg et al., 2015; Woodhouse, 2003).

Enclosures (or exclosures) refer to areas closed off from grazing for a specified duration of time in order to allow the regeneration of vegetation (Benkhe, 1986). Many times live fencing is used, such as bushes or bush-like trees. Exclosures are primarily established to rehabilitate degraded landscapes and are areas that are fenced or manually protected from grazing and established for natural or sometimes planted regeneration of vegetation, in accordance with the Benkhe (1986) definition of enclosures. Exclosures are, as the term indicates, mainly focused on excluding livestock, whilst enclosures are established to keep livestock (or sometimes crops) inside (Aerts, Nyssen, & Haile, 2009). However, in most exclosures, some additional uses, such as cut and carry grass export, wood extraction or periodical grazing is allowed, and enclosure management systems do include some time of periodic rest from grazing (i.e., exclusion). Exclosures have for decades been used in Ethiopia (Nyssen, Frankl, Zenebe, Deckers, & Poesen, 2015) as a method for rehabilitation of degraded land. The biophysical effects of exclosures are very similar to those of enclosure systems; the exclosure literature is therefore reviewed as synonymous with enclosure literature in this context.

The use of enclosures covers a wide range of management techniques, from physically fencing off smaller parcels of land for private or communal purposes (Mureithi,Verdoodt, Njoka, Gachene & Van Ranst, 2015; Verdoodt, Mureithi, & Van Ranst, 2010; Yayneshet, Eik, & Moe, 2009), to more implicit social contracts regarding the use of larger areas of communal land (Barrow, 2016). In some areas, enclosures constitute a traditional periodic land management tool where enclosures are used to subdivide communally owned grazing land into parcels that are open for grazing in different seasons (Abate, 2016; Angassa & Oba, 2010), and in other areas, enclosures were introduced in order to rehabilitate degraded rangelands in an effort to address the socio-economic crisis of endemic poverty and food insecurity (Meyerhoff, 1991; Nyssen et al., 2015). However, in recent decades, the establishment of enclosures has increased in frequency, scale, and permanence and has begun to dominate individual user and access rights (Beyene, 2009; Nyberg et al., 2015).

Due to population increase and changing consumption patterns, there is an increased local and international demand for livestock products (Reid, Fernandez-Gimenez & Galvin, 2014; Thornton, 2010) and a generally more commoditized agricultural sector. Enclosures provide an opportunity for the intensification of livestock production to meet household food needs as well as the market demand for livestock and livestock products (IIRR & CTA, 2013; WISP, 2010). As a result, the expansion of enclosure systems has been termed as 'default development' when the population pressure on land resources increases (Woodhouse, 2003). The extent of this expansion motivates this literature review, in which we intend to explore enclosures, their use in sustainable rangeland production and as a management tool and the implications for food security.

Materials and methods

We did a synthesized review on the literature on enclosures and exclosures, and compared the findings to surrounding/neighboring open grazing systems. This approach was done as an

alternative to a meta-analysis since the literature showed a scarce amount of studies quantifying food production in enclosure systems. We also reviewed literature that addressed dryland pastoralist and agro-pastoralist policy and tenure issues.

We conducted a search of scientific literature in October 2017 using ISI Web of Science, Scopus databases and Google Scholar (first 100 hits out of >9000) following Reed et al. (2015). The search terms used were (1) enclosure* or exclosure* AND dryland*OR semi-arid AND Africa. We then (2) scrutinized the abstracts (>300 scientific and >100 from 'grey' literature) to find quantitative data on biophysical/ecological parameters and/or (3) mentions of food production and/or food security and/or (4) policy. Food production is one important component contributing to food security, but the terms are not identical. Therefore, as 'food security' was rarely the primary objective of the reviewed literature, mentions of 'food production' was included when scrutinizing abstracts. Articles referring solely to experimental studies on grass production or herbivore interactions in national parks/reserves were omitted. Additional articles were reviewed by backward referencing from the relevant references in the peer-reviewed articles (Gough, Oliver & Thomas, 2012; Karlson & Ostwald, 2016). Non-peer-reviewed literature was largely drawn from Google Scholar (the first 100 hits), CGSpace and FAO. From this procedure, 114 scientific and 69 grey literature articles were included for full review. Reviewed scientific literature is presented in Supplement 1 and reviewed grey literature is presented in Supplement 2.

Results

Characteristics of the scientific literature

Only 8% of the 114 articles reviewed address food production or food security (n = 9) (Table 1, Supplement 1). Most of the articles quantitatively measure environmental parameters (n = 79), such as improved soil carbon (C) and nutrients, natural vegetation recovery and production, natural tree regeneration, and land rehabilitation. In this review, and according to the above criteria's, 35 articles on socio-economic and cultural aspects and implications of enclosure systems are included. Environmental and socio-economic factors and aspects of enclosures closely interact and interdepend on each other. However, the scientific literature rarely addresses both aspects. Although 68% of the 'environmental' literature and 46% of the 'socio-economic' literature addresses more than one topic, strikingly very few addressed both environmental and socio-economic issues at any depth or based on data. Research and development, including land management details, on food production and food security is critical but sadly lacking, as is multidisciplinary research on dryland management.

There are strong geographical biases in the literature on enclosures, with the majority of articles being based on field studies and experiences from Ethiopia (42%) and Kenya (24%). The Ethiopian literature is largely made up of environmental studies on the effects of exclosures as a rehabilitation methodology, used and propagated by authorities since the 1980s (Asfaha, Frankl, Haile, & Nyssen., 2016; Nyssen et al., 2015). The literature from Kenya focuses more on enclosures established by private individuals or groups as land management measures or on socio-economic problems and land-use conflicts.

Characteristics of the grey literature

A total of 69 grey literature publications were reviewed, of which only 6% (n = 4) addressed food production/security (Table 1). The grey literature comprises 28 policy briefs, 12 working papers, 11 conference papers, 11 Msc student thesis reports, and 7 books. Thirty percent of the material reviewed is about the environmental impacts of enclosures on soil vegetation, reducing soil erosion and reclaiming degraded rangelands. Unlike the scientific literature, the majority of these documents (70%) are about the changes, challenges and opportunities in the rangelands,

Table 1. Characteristics of the scientific and grey literature.

	Environmental										Socio-economic				total		percent	
Country/Region	soil		veg		H2O + erosion		Food production/security		Clim. ch.		People & livelihoods		policy		total		%	
Botswana							1 (1)	1			1 (1)				2	1	2	1
Burkina Faso							(1)		1				1 (1)		2		2	
Ethiopia	11 (2)	(3)	20 (6)	1 (4)	6 (2)	1	1 (6)	(4)	(3)	1 (1)	8 (2)	8	2	1	48	12	42	17
Eritrea												1				1		1
Kenya	1 (4)	2 (3)	12 (2)	4 (3)	(1)	2	2 (11)	3 (8)		2 (2)	11 (5)	19 (2)	1	6 (1)	27	38	24	55
Morocco			2				(1)				(1)				2		2	
Senegal			2 (1)				1 (1)						1 (1)		4		4	
Sudan	1	1		(1)											1	1	1	1
Tanzania			3	3			(1)	(5)				5			3	8	3	12
Tunisia	1														1		1	
Global	1		1		1		4 (4)	(1)	(1)		3 (3)	1 (1)			11	1	10	1
Africa			2				(3)	(1)	(1)		4	(2)	1	2 (1)	7	2	6	3
Sub-Saharan Africa	1 (1)		1		1										2		2	
East Africa			1 (1)			(1)		(2)				2	1	2	2	4	2	6
West Africa			1										1		2		2	
Total	16	3	45	9	8	3	9	4	1	2	27	38	8	9	114	68	100	100
Percent	14	4	39	13	7	4	8	6	1	3	24	56	7	13				

Table 1. Number of reviewed publications covering Environmental respective Socio-economic aspects. White columns are scientific articles and grey columns grey literature. Numbers in brackets are indicating secondary topics addressed in the publications.

as well as policy documents regarding land use and the impacts enclosures have on peoples' livelihoods.

Most of the grey literature is from Kenya, Ethiopia, and Tanzania. In Ethiopia and Tanzania, much of the literature focuses on the impact of enclosures on pasture availability, reclaiming degraded land and on livelihoods. Most of the policy briefs are from Kenya and its concerned experiences with tenure reforms regarding rangeland access and use.

Environmental implications of enclosures

Thirty-nine percent of the science literature and 13% of the grey literature primarily addresses vegetation changes in land enclosure or as compared between enclosed and open areas (Table 1). When areas are closed off from grazing for an extended period of time, the natural vegetation recovers. This is seen in an increase in ground cover and biomass production of grasses, herbs and trees (e.g., Angassa, 2016; Asefa, Oba, Weladi & Colman, 2003; Le Houerou, 2000; Yayneshet et al., 2009), an increase in the natural regeneration of grasses, herbs and trees as well as an increase in plant biodiversity (e.g., Angassa, 2014; Asefa et al., 2003; Etafa & Raj, 2013; Hailu, 2016; Jeddi & Chaieb, 2010). Both annual and perennial grasses increase in abundance and cover, and the proportion of perennial grasses increases (Hailu, 2016; Verdoodt et al., 2010).

Studies on soil C were found in 16% and 14% of the scientific and grey literature, respectively (Table 1), and almost exclusively reported increased levels of soil C inside enclosures (Yayneshet & Treydte, 2015). Mekuria, Veldkamp, Tilahun, and Olschewski (2011) and Bikila, Zewdu-Kelkay, and Ebro (2016) report that soil C doubled over a period of 20 years to levels of 250 and 300 ton C/ha in the top 20 and 30 cm of soil, respectively, while others found an increase of approximately 30–50% over 10 years (Ayanya, 2016; Girmay, Singh, Mitiku, Borresen, & Lal, 2008; Mussa, Ebro, & Nigatu, 2017). Soil nutrient content also increases (typically N and P are measured) inside enclosures (Bikila et al., 2016; Mekuria & Aynekulu, 2013; Mureithi et al., 2015; Yayneshet & Treydte, 2015), while soil bulk densities decrease (Mekuria & Yami, 2013; Mureithi et al., 2015; Mussa et al., 2017). Baudron, Mamo,Tirfessa & Argaw (2015) report a 70% increase in yields inside enclosures (compared to outside) due to improved soil nutrient management. These processes increase productivity (Lal, 2004) and therefore relate to food production potential and food security. Interestingly, this seems to be the case both when there has been a complete exclosure and when there has been (controlled) seasonal grazing.

Increased levels of soil C lead to increases in the amount and availability of soil water and nutrients (Lal, 2004). Improved soil structure and increased vegetation cover, root canals and soil C lead to increased water-holding capacity and infiltration capacity (Descheemaeker et al., 2009; Fenta, Yasuda, Shimizu, Haregeweyn, & Negussie, 2016; Haregeweyn et al., 2015) and reduce erosion inside enclosures. Reducing and halting soil erosion, revegetation and water conservation are important steps in restoring degraded rangelands (Harris, Birch, & Palmer, 1996), and 9% respective 4% of respective science and grey literature deals with water and/or erosion issues (Table 1)

Socio-economic implications of enclosures

Most pastoral communities traditionally reserved parts of their grazing land for use at different uses spread out over time. Traditional institutions governed the decision to enclose or reserve land, where to enclose, size of the enclosure and who's livestock that can access the enclosure, as is the case in Ethiopia and Tanzania (Napier & Desta, 2011; Selemani et al., 2013). Enclosure establishment has many times been part of other land management practices where it did not erode access and use rights of communally owned land.

More recent use of enclosures as a land management tool is an adaptation to increased population and land pressure and to the increased commoditization of agriculture (including livestock) (Behnke, 1986; Delgado et al., 1999; Nyberg et al., 2015; Woodhouse, 2003).

Enclosures enable agricultural diversification (Karmebäck, Wairore, Jirström & Nyberg, 2015; Wairore, Mureithi, Wasonga, & Nyberg, 2015), which is relevant to enhanced food security. However, and importantly, livestock and livestock production remain the basis of cultural identity and a main source of livelihood, especially in semi-arid and sub-humid drylands (Beyene, 2014; Mureithi et al., 2015; Nyberg et al., 2015; Wairore et al., 2015). Nyberg et al. (2015) and Abate (2016) report on landscapes where 90% of the farmers use enclosures in rural Kenya (West Pokot) and Ethiopia (Guji zone). Wairore et al. (2015) list 17 agricultural or land-based sources of income in an agro-pastoral society, out of which seven are directly derived from livestock, which is equivalent to 65% of farm incomes. Kawira (2016) enumerates the benefits of enclosures for household practices, which are linked to improved nutritional status. Among them are increased grass, crop and livestock yields, which in turn lead to improve household food security.

Enclosure systems, particularly as they become more common and potentially dominate the landscape, fragment the landscape and thereby disable the free movement of livestock. This, together with urbanization, commercialization of land rights and global economic integration, results in a push towards individualization and commercialization of land rights, which may erode the customary traditions and institutions of land governance (Cotula, Toulmin, & Hesse, 2004). As the expansion of enclosure systems evolve, there is often elite capture, meaning that the rich and well-connected in the local society are the first to claim land (Beyene, 2008; Gavin, 2009; Karmeback et al., 2015; Mwangi & Dohrn, 2008), and conflicts between pastoralists and agro-pastoralists, as well as with crop farmers, evolve (Beyene, 2010).

Policies and tenure

Agricultural policies in most SSA countries have traditionally focused on private crop-based agriculture. Policies on dryland agriculture, and especially on pastoralism, have been lacking and/or neglected (Gonin & Gautier, 2015; Goodhue & McCarthy, 2009). Traditional land tenure in pastoralist systems is often described as 'fuzzy' (Goodhue & McCarthy, 2009; Mwangi & Dohrn, 2008), meaning different things at different times, for different resources, under different conditions and for different groups of people. Common land tenure rights have historically been ill-defined or been totally missing. Currently, there are new policies and legislation emerging in countries such as Kenya, Tanzania and in Ethiopia (Notenbaert et al., 2012) that aim at improving rangeland productivity. However, policies, incentives, and regulations for the emerging livestock based agro-pastoralism are largely missing.

Implications of enclosures on food security

In many cases, enclosures provide an opportunity for good livestock production subsequently enhancing food security. This is mainly due to the augmented ability to grow different and more nutritious grass and fodder species (Makokha, Lonyakou, Nyang, & Kareko, 1999; Meyerhoff, 1991; Mureithi, Verdoodt & Van Ranst, 2010; Nyberg et al., 2015; Wairore et al., 2015). Enclosures may also conserve standing pastures and can be used for increasing livestock weights before sales (Benkhe, 1986; Mureithi et al., 2010). To use enclosure makes livestock feed available in all seasons and within shorter walking distances. Adequate feed enables livestock to maintain milk productivity and reduces quality deterioration (Kawira, 2016). Reduced walking distances mean that the livestock spend less energy on walking and thus can quickly gain marketable weight (Butt, 2009; IIRR & CTA, 2013). By reducing walking distances to pasture sources, livestock are at a lower risk of contracting zoonotic diseases, and thus mortality rates are also reduced (Butt, 2009).

In several Ethiopian studies, it is mentioned that farmers, although not allowed to graze their livestock inside the enclosures, can harvest grass as 'cut and carry' (Hailu, 2016; Mengistu, Teketay, Hulten, & Yemshaw, 2005) and dead wood as fuelwood (Ubuy, Kindeya & Raj., 2014). In some cases, the enclosures are also used for seasonal grazing (Mussa et al., 2017). Behnke (1986) noted that in Sudan, enclosures were used to produce fodder that would be sold. This has become a viable income generating activity in many households across countries in East Africa (Beyene, 2009; Makokha et al., 1999; Mureithi et al., 2010; Wairore et al., 2015).

Few studies in this review (7%) demonstrate how enclosures help pastoralists build resilience to food insecurity (Makokha et al., 1999; WISP, 2010; Kawira, 2016; Muricho, Otieno & Oluoch-Kosura, 2017; Muricho, Otieno, Oluoch-Kosura & Jirström, 2018). By apportioning grazing lands, households and communities reserve some enclosures for use during drought periods, thus sustaining livestock feed availability despite droughts. When grass and crop yields are abundant, the surplus is reserved within the enclosures as standing hay that households can feed to livestock in seasons of deficit. Some households cut and store the hay in traditional granaries (Wairore et al., 2015). Kawira (2016) noted that most households grow fruits and vegetables within the enclosures. With improved milk, fruit and vegetable production, there was a noted improvement in household nutrition (Bostedt, Hörnell & Nyberg, 2016). Muricho et al. (2018) measured food insecurity as the number of days in a year that a household was unable to meet its food requirements. The study showed a positive correlation of enclosures with other adaptive practices. Pastoralists having enclosures had adopted agroforestry, fodder growing and pasture conservation. These households reported fewer days of food insecurity since they were able to meet their annual food demands and were more resilient to droughts and other shocks.

Discussion

Enclosures to be and to stay

The use of enclosures as a land management tool is becoming increasingly common in the African drylands. Furthermore, enclosures are becoming a self-generating phenomena, with households establishing enclosures following others who have already done so (Benkhe, 1986; Greiner, 2016; Lovschal et al., 2017; Woodhouse, 2003). Nyberg et al. (2015) found that at least 40% of present enclosures in West Pokot, Kenya, were established after the withdrawal of the NGO that provided extension service on enclosure establishment, suggesting that both exogenous and endogenous factors influence the use of enclosures for land management.

Studies by Gaani (2002) in Somalia, Mwilawa, Komwihangilo, and Kusekwa (2008) in Tanzania, Behnke (1986) and Nedessa, Ali & Nyborg (2005) in Sudan, Mengistu et al. (2005), Mekuria, Veldkamp, Halle, Muys & Gebrehiwota (2007), and Beyene (2009) in Ethiopia, and Meyerhoff (1991), Makokha et al. (1999), Macharia and Ekaya (2005), Kigomo and Muturi (2013), Mureithi et al. (2015), and Nyberg et al. (2015) in Kenya all illustrate that enclosures are indeed a successful tool for the restoration of degraded rangelands.

Studies on enclosures in West Pokot (Nyberg et al., 2015; Wairore et al., 2015), Baringo (Meyerhoff, 1991; Mureithi et al., 2015; Verdoodt et al., 2010), southeastern Kenya (Macharia & Ekaya, 2005), Tanzania (Mwilawa et al., 2008) and Ethiopia (Angassa & Oba, 2010; Beyene, 2009) have demonstrated that enclosures are facilitating improved livelihoods and living standards (including food security) among pastoral and agro-pastoral communities. Improved household and societal welfare are manifested from diverse tangible benefits and environmental services generated from enclosures. Livestock well-being has improved as a result of the considerable increase in pastures within enclosures, and this means households get more milk, sell more quality livestock and increase income. In the face of climate change, enclosures are helping pastoral and agro-pastoral communities cope through the provision of grazing reserves, reduced animal losses, improved health and animal productivity, easier livestock management

and livelihood diversification from various income generating activities (Makokha et al., 1999; Wairore et al., 2015).

Land tenure is an important impetus in sustainable land management, and even more so for the agro-pastoralists adopting enclosure systems. Without secure land tenure, there may be a reluctance to invest time and resources to make the land productive. From this review, enclosures are not synonymous with privatization of land and erosion of customary rights to land. Studies (IIRR & CTA, 2013; Mureithi et al., 2015; Napier & Desta, 2011; Selemani et al., 2013) have shown that enclosures as a land management tool can be established and managed on communal land. This has resulted in better rangeland management, improved livestock productivity, and reduced livestock mortality during droughts. In both communal and individual tenure systems (Keene, 2008), enclosures provide an opportunity for improved livestock production.

Links to food security

Enclosures provide an opportunity for sustainably producing livestock, which subsequently enhances food security. However, the direct impact of enclosures on food security is almost never quantified in terms of actual production of food or as production compared to other land use practices. Instead, the impacts are described in indirect ways, very often through the ecosystem services/environmental implications that the practice delivers, such as improved soil quality, resilience to drought or enhanced water-holding capacity (Table 1).

Availability and stability as aspects of food security is being enhanced by enclosure practices in such a way that the new land use practice diversifies the food items and their availability throughout the year, which is aligned with earlier findings on agro-pastoralist production systems in East African drylands (e.g., Lambin et al., 2003; Woodhouse, 2003). However, there is a need for a focus on further understanding on how enclosures influence income and food prices, which ultimately influence access and utilization aspects of food security.

Policy needs

Enclosures are often used for protecting crops, but even more so, enclosures are used for animal husbandry, fodder production, pasture, and rental pastures. This means that the agricultural and livelihood transition away from pastoralism is not towards crop-dominated agriculture, but rather towards livestock based agro-pastoralism. A livelihood transition, as in the case of the sedentarization of pastoralism, calls for new support in resource management.

Enclosures are not a panacea for dryland development, but with decreasing land areas for grazing and transhumant migration, the importance of establishing enclosures as a land management tool should be recognized. By helping to reclaim degraded land, ensuring livestock and human feed and food security, enclosures provide opportunities for improved and sustainable livelihoods.

Policy recommendations and legislation should endeavor to build on the local practices of land use and access. There is a need to understand that the formalization of land rights is not synonymous with individualizing land rights. Thus, more context-specific solutions are needed in addressing land issues. Properly defined rights regarding access and use are important requisite for sustainable management of both individual and communally owned land. One way of doing so is by recognizing the role of the local tenure systems in administering user rights to access and use land. This will require a multi-stakeholder inclusion in the process of addressing land use planning but will go a long way in enhancing sustainable land management. Further, it will require an active role of county/district/local governments in designing and implementing policies for the agricultural sector.

Especially the need for policies, incentives, and regulations for ongoing agricultural and land use transitions are needed, such as the transition to livestock based agro-pastoralism. These needs to be developed, anchored and understood in a local and traditional context, among local leaders and village elders.

Future research

In aligning the 'default development' (Woodhouse, 2003) of enclosures to the sustainable land management and food security discourses, we identified the need for further research on methods for sustainably intensifying and diversifying the livestock sector in drylands, including identification of reliable indicators and collecting data about the ecological and socio-economic limitations and sustainability of enclosure systems. To be able to develop sustainable and productive management methods for enclosures; such indicators and data may include enclosure sizes, rotations and partial rest, climate suitability, landscape fragmentation and co-existence with other systems, such as establishment and management of grazing corridors and grazing refugia in multifunctional landscapes. To enable the realistic application of the knowledge and research results, secure land tenure, conducive policies and enabling incentives for the above are needed.

Whilst still relevant, the 'whether or not' research (free ranging pastoralism or not, enclosures or not, natural regeneration or not, demographic drivers or not), needs to be complemented with research on the 'hows' (e.g., productive management, avoidance of social conflicts, degrees of fragmentation, grazing corridors and refugias, agricultural intensification and diversification). There is a lack of holistic analysis of enclosure systems that includes environmental, economic and social implications. Hence, constructive applied and multidisciplinary research on methods for creating sustainable livelihoods and sustainably intensifying the livestock sector(s) is more relevant and important to African development than a scientific divide on the pros and cons of pastoralism vs. livestock based agro-pastoralism.

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