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High-density grazing in southern Africa: Inspiration by nature leads to conservation?

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Abstract

High-density grazing is a form of rangeland management aiming to strategically mimic the ways grasslands are utilized by grazers in natural situations. It aims to regenerate grasslands by improving soil and vegetation productivity and diversity. More recently, high-density grazing systems have been promoted as a key approach to mitigating climate change by increasing the amount of carbon sequestered in grassland soils. In this article, we describe the historical background of grazing and rangeland degradation in southern Africa, the principles of high-density grazing, and the problems it aims to address. We briefly discuss evidence of the potential benefits of high-density grazing, though we do not aim to provide an exhaustive review on this. We explore to what extent high-density grazing can be regarded as representative of grazing in natural ecosystems and whether the assumed link between nature and high-density grazing has been helpful in capitalizing on the potential merits of high-density grazing. While high-density grazing may represent a form of sustainable rangeland management, the main attractiveness to farmers likely relates to potential increases in livestock densities and associated productivity per unit area, as well as to potential management and social benefits. Learning from nature and inspiration by nature can play an important role in the development and communication of sustainable grazing management systems. However, it is questionable to what extent high-density grazing systems can be seen as more representative of natural ecosystems than other grazing management systems. The claimed ecological superiority of high-density grazing because of its association with nature has polarised and blurred the discussion on the potential merits of high-density grazing. Moreover, the supposed relationship between nature and high-density grazing may have led to an overselling of high-density grazing principles and an embracement of them by policy makers and development agencies without sufficient empirical basis.

Keywords

Adaptive grazing, cell grazing, holistic management, natural ecosystems, rangeland degradation

Introduction

The massive numbers of grazers on the African savannahs and grasslands, and the large herds of bison that once roamed the plains of northern America, continuously on the move in dense groups in search of fresh feed and relentlessly chased by pack hunters, provide fascinating and well-known images of nature. They also act as a source of inspiration for redesigning rangeland management. High-density grazing is a form of rangeland management aiming to strategically mimic the ways grasslands are supposedly utilized by grazers in a natural situation (Hoffman, 2003; Savory and Butterfield, 2016). It aims to regenerate grasslands by improving soil and vegetation productivity and diversity. More recently, high-density grazing systems have been promoted as a key approach to mitigating climate change by increasing the amount of C sequestered in grassland soils that cover large parts of the global land surface. The association of high-density grazing with the behaviour of migratory grazers in natural systems likely stimulated the adoption of high-density grazing practices. In the popular media, such as farmers' magazines, it is often taken for granted that high-density grazing leads to favourable environmental outcomes such as increased soil C sequestration and enhanced on-farm biodiversity because of its relationship with nature. The principles of high-density grazing have gained a place in the canon of regenerative agriculture (Teague and Barnes, 2017), though various names are used to refer to the set of management practices associated with high-density grazing. In this article, we describe the historical background of grazing and rangeland degradation in southern Africa, a region that has

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played a prominent role in the development of high-density grazing systems. We describe the principles of high-density grazing and the problems it aims to address. We summarise the evidence that high-density grazing can deliver the claimed benefits. We explore to what extent high-density grazing systems can be regarded as representative for natural ecosystems and whether the assumed link between nature and high-density grazing has been helpful for assessing and capitalizing on the potential merits of high-density grazing systems.

Large parts of southern Africa are covered with rangelands. About 70% of the land surface is currently used for grazing on natural (unplanted) rangelands and these rangelands are of paramount importance for the protection of the immensely rich biodiversity of this region (Kotzé et al., 2020). Southern Africa has a long history of livestock husbandry. The original hunters and gatherers of southern Africa were gradually and partly replaced by livestock keeping tribes over a period of a 1000 years. Livestock production activities by European settlers accelerated this process from the 17th century. The demand for new land to sustain livestock grazing was a major driver for these settlers and their descendants to colonize new lands and move deeper into the interior of southern Africa (Phimister, 1978; Jarvis and Erickson, 1986). The discovery of gold and diamonds in South Africa from 1875 led to the development of urban centres and major investments in railway and road infrastructure. While overgrazing was already a problem before this discovery, the improved access to markets for agricultural products led to rangelands being subjected to unrealistic demands accompanied by improper grazing practices (Snyman, 2014). Along with the intensification of livestock production, populations of natural grazers collapsed. Anecdotes provide evidence of large populations of natural grazers in the past For instance, massive herds of springbucks once migrated in the western Cape and the Karoo region of South Africa between summer and winter rainfall areas (Skinner, 1993). It is likely that the spread of East Coast Fever and rinderpest not only reduced southern African cattle herds between 1896 and 1902, but also contributed to the decimation or annihilation of populations of wild grazers (Jarvis and Erickson, 1986; Skinner, 1993), which never recovered thereafter as grazing lands were increasingly occupied by livestock.

Rangeland management

Currently in southern Africa, grazing on private farms often exists alongside communal grazing areas. In South Africa specifically, communal grazing systems occupy only 17% of the total farming area but sustain 52% of the cattle, 72% of the goats and 17% of the sheep (DAFF, 2016). Contrarily in Zimbabwe, Botswana and Mozambique, 85–89% of the national cattle herd graze in communal areas (Rocha et al., 1991; Sebina and Düvel, 1999; Tavirimirwa et al., 2019). Livestock densities in communal areas tend to be well above recommended densities, continuous grazing is commonly practiced and limited external inputs are used (Sandhage-Hofmann et al., 2015) leading to negative effects on rangeland quality (Vetter, 2013; Yayneshet and Treydte, 2015). Large-scale rangeland farming on private farms occupies 52% of the total farming area in South Africa (DAFF, 2016), while this is less common in other southern African countries. In these systems, rotational grazing is followed while livestock is typically produced on natural pasture with supplements in the form of licks, followed by a rounding off phase in a feedlot. These systems have been widely adopted on private farms (Danckwerts and Teague, 1989; van der Westhuizen et al., 1999).

It is well established in southern Africa that poor rangeland management leads to rangeland degradation. Degraded rangelands exhibit a number of interrelated characteristics such as reduced soil C and nutrient levels, higher soil compaction, and a lower soil cover (du Preez and Snyman, 1993; Snyman and du Preez, 2005; Kotzé et al., 2020; Krenz et al., 2021). As a result, water infiltration and soil water holding ability are reduced, which directly impacts plant productivity, especially in more arid climates (Snyman, 2005). The vegetation of degraded grasslands may be less productive, have shallower and contracted rooting systems (Snyman, 2005), and be dominated by annuals and other less palatable species. Rangelands with a poor basal cover may have more water run-off and soils may be more susceptible to wind and water erosion.

While there is wide consensus on the negative impacts of rangeland degradation on sustainability indicators, there is substantial disagreement among rangeland specialists on what constitutes good rangeland management (Briske et al., 2008). According to the classical view in southern Africa, stocking rate (number of animals per unit area) is the single most important factor influencing the ecological sustainability in rangeland grazing (O'Reagain and Turner, 1992; Tainton, 1999). Grazing capacity of rangeland is a function of climate, environmental conditions and rangeland condition, determined by the ratio of palatable versus less palatable plants, basal cover and productivity (Snyman, 2005). If stocking rate is the key variable to consider, continuous grazing systems in which animals are not limited in their movement and choice of grazing are appropriate and relatively easy and cheap to implement (Smith, 2006). Proponents of rotational grazing systems however argue that over-grazing leading to rangeland degradation is also or primarily a function of the duration of grazing and the recovery time after defoliation. Rotational grazing is a system where animals are relocated in order to rest to vegetation that has been grazed (Fynn et al., 2017). Rotational systems have been designed keeping the nutritional demands of livestock as well as the physiological requirements of the vegetation in mind. In 'conventional' rotational systems, rotation among paddocks normally takes place in a cycle at a frequency varying from several weeks up to several months with 3-5 paddocks available per herd (Tainton, 1999). Typically a quarter to half of the grazing area receives, on a rotational basis, a resting period of a full growing season each year (Kirkman, 1995; Van Pletzen et al., 1995; Fynn et al., 2017). High-density grazing can be seen as a form of rotational grazing with a very high rotational frequency and a large number of small paddocks.

Description of high-density grazing and evidence of impacts

Description of the system

The key management principles of high-density grazing closely resemble those promoted under the flag of holistic grazing, adaptive grazing, mob grazing, short-duration grazing, or cell grazing. The term 'holistic grazing' is used widely these days. Its decision-making framework was conceived and advocated by Allan Savory and was originally developed based on experiences in Zimbabwe and elsewhere in the region (Hoffman, 2003), and embodies more than just a grazing management system (Savory and Butterfield, 2010; Gosnell et al., 2020). We prefer the term 'high-density grazing', as holism, systems thinking, adaptability, and similar terms, are not unique nor defining characteristics of this management system.

While there is no prescribed recipe, nor a single definition for high-density grazing, it is based on principles that are supposedly universally applicable and have been elaborated on by various reviews (Briske et al., 2008; Teague et al., 2013; Nordborg, 2016). A key management feature of high-density grazing systems is the application of intense grazing pressure for a short period of time, followed by a long resting period allowing the vegetation to recover and build up reserves. To obtain a sufficiently high grazing pressure, a large number of grazers should be concentrated in a relatively small paddock. This has the potential advantage of applying a relatively uniform grazing pressure to palatable and less palatable species in the field and a better utilisation of the available above-ground biomass (Teague et al., 2013). Better utilisation of unpalatable species may favour a shift in species composition towards more palatable species, assuming that palatable species generally show faster regrowth after defoliation than unpalatable species (Hoffman, 2003). High livestock numbers in small paddocks provide a relatively uniform distribution of dung and urine throughout the paddock and the trampling of dung, urine and left-over plant material onto the soil surface. This is in contrast with conventional systems in which dung and urine tend to accumulate nearby the resting or water point (Sandhage-Hofmann et al., 2015). This combined impact from dung, urine and hoof action is referred to as 'animal impact', which is expected to benefit nutrient cycling, soil C levels, plant biodiversity, and the production of quality biomass (Truter et al., 2015). To derive benefits from animal impact, stocking rates should be high, for instance, a minimum density of 10 head of cattle or 60 head of sheep per ha has been advised for cell grazing in Australia (McCosker, 2000). In communal grazing areas, it is possible to create similar impacts using herding rather than fencing. The time animals graze a paddock may vary from one hour (ultra high-density grazing) to several days. The key is that grazers do not get an opportunity to consume fresh vegetative re-growth, which under optimal growing conditions can occur several days after defoliation, and that the grazing period is time-controlled depending on the growth rate of the vegetation and the availability of forage. An adaptive approach towards rangeland management is often emphasised as essential for the successful implementation of high-density grazing systems (Teague et al., 2013). Rangeland conditions can change rapidly, and grazing management should be particularly responsive to this when livestock is concentrated in small paddocks. Management goals may also differ throughout the year.

Other elements are not essential to high-density grazing systems but are often applied as part of the package by farmers in southern Africa. Keeping multiple livestock species can improve the utilisation of available resources in the pasture, and help to diversify grazing pressure, manure inputs and ecological functions of livestock (Anderson et al., 2012). To facilitate activities of dung beetles and other organisms involved in nutrient cycling, the use of chemicals, especially to control internal and external parasites on livestock, is kept to a minimum (Beynon et al., 2012). Furthermore, the genetic background of livestock requires adaptation to high-density systems. For cattle, medium- to small-frame animals with a relatively large rumen capacity and a low nutritional need are regarded as more adapted.

Rangeland degradation

Originally, the main rationale to promote forms of high-density grazing was the need to halt the degradation of rangelands and the associated desertification of land (Savory, 1983). Numerous studies aimed to assess the ecological impacts of high-density grazing systems versus conventional systems on rangeland status. Reviews of literature (Holechek et al., 2000; Teague et al., 2013; Briske et al., 2014; Nordborg, 2016; Hawkins, 2017; Gosnell et al., 2020; Hawkins et al., 2022) indicate that the evidence of high-density grazing systems providing the claimed ecological benefits is rather mixed, at best, especially when high-density grazing is compared with other forms of rotational grazing. While high-density grazing in semi-arid grasslands may increase organic matter in the upper part of the soil profile (Chaplot et al., 2016), it may also result in soil compaction, reduced soil aggregate stability and decreased soil moisture (Chamane et al., 2017; Roberts and Johnson, 2021).

The inconclusive results regarding the ecological benefits of high-density grazing have fed scepticism among rangeland specialists who advocate more conventional approaches towards rangeland management (Gosnell et al., 2020). Proponents of high-density grazing systems claim that research methodologies applied by rangeland scientists to study the impacts of grazing systems are often inappropriate, or unrepresentative of real-life situations and therefore fail to measure the benefits of high-density grazing systems under farmers' conditions (Teague et al., 2013). Given the scale of rangeland farming and the importance of landscape and vegetation heterogeneity for grazing behaviour and livestock performance, it is difficult to mimic this in a replicated trial. Research on grazing systems should include long-term effects, and be adaptive and multi-disciplinary in nature, which is difficult to achieve through classical experimentation (Teague and Barnes, 2017). Assessing the performance on commercial farms practicing high-density grazing against that of ‘conventional neighbours’ in so-called fence-line studies offers an alternative approach to comparing systems (Ferguson et al., 2013; Chamane et al., 2017). On-farm research is often complicated by confounding biophysical and socio-economic factors that are difficult to control for. For instance, farmers practicing high-density grazing are typically innovative farmers, actively participating in study groups (de Villiers et al., 2014), and may thus not represent the ‘average farmer’. Also, conventional and high-density systems do not represent uniform management systems. Large differences in sustainability performance may be expected between a heavily stocked continuous grazing system and a well-managed rotational grazing system (Hillenbrand et al., 2019). Similarly, wide differences in the practical implementation of the principles of high-density grazing exist between farmers. One may conclude from this that further research is required to obtain more evidence on the potential merits of high-density grazing systems. However, if rangeland scientists cannot agree on what constitutes proper science, achieving consensus on the merits of high-density grazing through additional research is not likely to resolve the controversy (Gosnell et al., 2020).

Carbon sequestration

More recently, high-density grazing has been promoted as a tool to mitigate climate change through soil C sequestration, or even as ‘a radical plan to save the earth’ (Savory, 2013). The conversion of rangelands to arable lands leads to major losses in soil C levels, with losses in the order of 25 to 53% seen in South Africa (Swanepoel et al., 2016). When land-use reverts back to rangeland, soil C levels increase again, although this can be a slow process and it is uncertain to what extent the soil fully recovers (Baer et al., 2015; Preger et al., 2019; Krenz et al., 2021). Rangeland management, particularly grazing intensity, also impacts soil C levels and C sequestration (Schuman et al., 2002; Abdalla et al., 2018). The most likely route through which grazing can stimulate C sequestration is through stimulation of plant growth, especially of below-ground parts (Garnett et al., 2017). Manure inputs from livestock can contribute to C sequestration directly as a source of C, and indirectly by stimulating plant growth.

The evidence that high-density grazing leads to C sequestration is highly context-specific. Global reviews suggest that a high grazing intensity primarily leads to higher soil organic C levels on C_4 dominated grasslands, with lower impacts on C_3/C_4 mixed and negative impacts on C_3 dominated grasslands (McSherry and Ritchie, 2013; Abdalla et al., 2018). Furthermore, the impact of grazing on soil organic C levels is site-specific and affected by precipitation, temperatures and soil texture. To study the relationship between grazing systems and climate change mitigation, the additional methane and nitrous oxide emissions arising from increased livestock densities should also be taken into account. Assessments of the contribution that changes to livestock grazing could make to climate change mitigation suggest that, even with very optimistic assumptions, this contribution is tiny on a global scale (Garnett et al., 2017). If high-density grazing leads to increased soil C levels, the benefits thus primarily relate to locally improved rangeland status and ecosystem services.

Productivity and profitability

Better utilisation of the available vegetation and improved palatability and productivity of vegetation over the long-term, suggest that herd sizes per unit area of grazing land may increase in high-density grazing systems without degrading rangelands. Higher livestock densities and more unselective grazing generally come at an expense of animal condition and productivity, but substantially higher stocking densities may nevertheless lead to higher productivity and revenues per unit area. A switch from conventional to high-density grazing systems does require additional investments in farm infrastructure, livestock and more intensive forms of management (Teague et al., 2013). Evidence from the literature that high-density grazing systems lead to higher productivity and profitability per unit area is scarce and inconclusive (Hawkins, 2017; Venter et al., 2019; Derner et al., 2021; Hawkins et al., 2022) and studies on this topic struggle with the same methodological issues as studies on ecological impacts.

Why do farmers adopt high-density grazing practices?

We are not aware of any formal studies on the adoption rate and reasons for adoption of high-density grazing practices in southern Africa. Anecdotal evidence suggests that high-density grazing practices have become more widely accepted in recent years. While early adopters were often ideologically driven, the potential of improved farm profitability of livestock production now appears to be driving adoption. Other potential management advantages include improved control over grazing and animal performance. Moreover, there may be social benefits in the form of engagement with other farmers with similar interests. Farmers practicing high-density grazing (holistic management) in South Africa showed higher adaptive capacity, greater social networks and greater participation in study groups relative to their conventional peers (de Villiers et al., 2014). High-density grazing practices are promoted on communal rangelands in smallholder settings through NGOs, rural development programmes, and training institutes (e.g. through the Savory Institute and the Herding Academy in South Africa). As current adoption may be more practically driven and less dogmatic, farmers increasingly see high-density grazing as one of a number of grazing management tools that can be flexibly combined depending on management goals, the season and rangeland status.

How natural is high-density grazing?

The fact that principles of high-density grazing systems are inspired by phenomena in nature leads to common claims or suppositions, especially in the popular press, that high-density grazing systems are inherently ecologically superior relative to other grazing management systems. So, it is worthwhile to explore to what extent the principles of high-density grazing actually mimic nature.

Principles of high-density grazing are inspired by natural rangeland ecosystems with large numbers of migratory ungulates. In most parts of Africa, large ungulates historically made up an important component of the ecology, particularly in the grasslands and savannahs. Depending on the definition of migration, between 8 and 13 species of large herbivores in Africa have been regarded as having migratory populations (Owen-Smith et al., 2020). The migrations of the $\pm$ 1.3 million wildebeests and hundreds of thousands of zebras and Thompson gazelles on the Serengeti-Masai ecosystem in East Africa is the best known and best-studied migration of large grazers in Africa, and is often used as an example linking high-density grazing with the natural situation under which rangelands evolved. The existence of various other larger and smaller migrations of grazers have been documented on the continent, however nowadays these migrations have been severely curtailed or extinguished in many places as a result of human developments and the confinement of game in protected areas (Owen-Smith et al., 2020). The migratory behaviour of grazers does not follow a fixed pattern and is largely opportunistic, driven by the availability of feed and water, linked to highly variable precipitation in the semi-arid to arid regions of the savannahs and grasslands (Owen-Smith et al., 2020). Predatory pressure seems to play only a minor role in migratory patterns. For instance, wildebeests on the Serengeti plains mostly die of food shortages and related problems, and not of predation (Mduma et al., 1999). Wildebeests graze selectively with a preference for short, high-quality grass in an early vegetative growth stage (Martin and Owen-Smith, 2016) and their migratory behaviour improves their access to such feed. Effective population densities of migratory grazers, i.e. the number of animals per unit of land, tend to be variable over time, and is a function of the nutritional value of food resources and the level of security from predators (Owen-Smith et al., 2020). Many large herbivore species in Africa do not have migratory populations and species with migratory populations have residential populations as well. For instance, on the savannahs in and around the Masai Mare reserve, various herbivorous non-migratory species, as well as residential wildebeests, occur year-round in substantial densities (Ottichilo et al., 2001; Bhola et al., 2012).

Among the principles of high-density grazing, non-selective grazing plays a key role. As non-selective grazing implies that the poorly palatable and poorly digestible vegetation must also be consumed, practitioners of high-density grazing systems, and of other commercial livestock grazing systems, typically rely on feed supplements such as urea-based licks to improve the digestion of biomass with a high C/N ratio to keep livestock year-round in an acceptable condition. The migratory behaviour of grazers in natural situations is driven by herbivore preference to graze selectively and their need to have access to high-quality feed resources for most of the year. So, the driver behind the behaviour of migratory grazers is rather contrary to the grazing goals of practitioners of high-density grazing.

Another key principle of high-density grazing is the need for long recovery periods for vegetation between grazing events. In natural systems where migratory grazers make up an important component, grazing pressure indeed greatly fluctuates. However, when migratory grazers are absent from an area, other resident grazers may remain in substantial densities if water and feed resources allow. In other parts of the savannahs and grasslands of Africa, migratory grazers play no or only a minor role and grazers are mostly residential (Owen-Smith et al., 2020). The density of grazing ungulates in nature is highly variable. Thus, it is difficult to base recommendations for livestock densities and resting periods for vegetation on natural situations. Furthermore, livestock farmers have replaced the ecological roles of a wide variety of indigenous grazers with those of one or two species of ruminant livestock.

To claim that high-density grazing is nature-based, the system does not need to exactly copy the natural situation, as long as the system sufficiently mimics nature's structures and functions. The discussion above nevertheless prompts a number of questions about the link between nature and high-density grazing systems.

1. Historic information on rangelands before human impact is fragmented, while only a few large and relatively undisturbed rangeland ecosystems with migratory grazers still exist. Do we have enough knowledge of the grazing behaviour of herbivores and impacts on vegetation in natural situations to serve as a basis for the design of grazing management systems?
2. To what extent can information on the functioning of these natural systems, be they extant or historical, be extrapolated to rangelands in other parts of the world? Are some charismatic examples of migratory behaviour of grazers in natural ecosystems, such as that of the wildebeests of the Serengeti-Masai ecosystem, over-represented in our vision of how grasslands are used in natural situations?
3. Can the impact of livestock on a confined farm realistically mimic the variable and complex animal impact on vegetation from the wide diversity of grazers roaming in large areas in natural situations? Or is there at least sufficient similarity to assume that

a rangeland ecosystem under high-density grazing exhibits the same key structures and functions as those in a natural situation?

4. Acknowledging that livestock grazing systems, in general, are quite different from the natural situation, is there ground to claim that high-density grazing is nevertheless more representative of the natural situation than other grazing systems?
5. Should high-density grazing with a high degree of unselective grazing, long and well-respected recovery periods for the vegetation, and enabled by urea-based feed supplements be seen as an improvement in sustainability of rangeland utilisation, rather than a mimicking of the way grazers in natural ecosystems utilise grasslands?

Answers to most of the questions above are likely to be contested. Nevertheless, they raise substantial doubts about the assumed 'naturalness' of high-density gazing systems. They also illustrate the need for empirical evidence regarding the sustainable outcomes of different grazing systems, to help better comprehend what type of grazing systems are likely to work where and for who.

Inspiration by nature: A positive force?

High-density grazing systems can be considered good grazing management under certain conditions, though there is no evidence that they are inherently better than other well-managed grazing systems (Nordborg, 2016). For some farmers, high-density grazing represents a set of management techniques that helps them to increase livestock productivity per unit area of land, to improve the quality of their rangelands or the performance of their herd, to facilitate livestock management, and/or to gain access to a network of like-minded farmers. Furthermore, high-density grazing systems may have helped to increase the relative attractiveness of rangeland farming. In parts of southern Africa, rangeland grazing directly competes for space with forms of arable farming. If rangeland grazing can be regarded as a relatively benign form of food production, any grazing system that increases its relative attractiveness, reducing the conversion of rangelands into arable land and/or stimulating the restoration of arable lands to rangelands, could provide positive ecological outcomes. If nature was the source of inspiration for the design and adoption of high-density grazing systems, this inspiration has brought positive changes to some farmers' livelihoods and possibly to land-use systems. Moreover, the connotation of high-density grazing with nature has stimulated interest in it among a wider audience of farmers, extension officers and researchers. The resulting debate and communication on current grazing practices and the challenging of set ideas on what constitutes good rangeland management can be regarded as positive outcomes.

Understanding of processes in natural rangeland ecosystems can be valuable as a guide for improving grazing management systems with livestock. 'Inspiration by nature', though perhaps less science-based, can be helpful in generating new ideas on the development of sustainable grazing systems. However, looking at nature does not provide a guarantee that the resulting system is environmentally sustainable. We argue that grazing behaviour and vegetation impacts in natural rangeland ecosystems are too poorly understood in parts of the world, too variable in space and time, and too different from the situation in livestock production systems to serve as a basis for the development of universal principles. All grazing management systems, especially on confined farms, are a far cry from the historical natural situation on rangelands. The prospects of truly mimicking nature or nature's structures and functions through rangeland management appear questionable. This implies that the reasoning that high-density grazing leads to superior ecological outcomes because of its relationship with nature does not hold. This ecological superiority claimed by some of the advocates of high-density grazing systems likely contributed to a polarisation of the discussion on the potential merits of high-density grazing systems relative to other management systems. The fact that some of the principles of high-density grazing go against the conventional view of what constitutes good rangeland management did not help to achieve an open and productive debate on the potential benefits that could be derived from high-density grazing approaches. Another potential risk of the aura of sustainability created by the supposed relationship between nature and high-density grazing is the embrace of high-density grazing principles by policy makers and development agencies without a sufficient empirical basis of the claimed benefits (Briske et al., 2014). Especially in situations where the investments and the intensive and adaptive management required for the successful implementation of high-density grazing are difficult to realise, for instance among small-scale livestock farmers dependent on communal lands, simpler forms of rotational systems may provide comparable ecological outcomes and substantial benefits over unmanaged continuous grazing, and may be more likely to be adopted and maintained over time.

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References

Abdalla M, Hastings A, Chadwick DR, et al. (2018) Critical review of the impacts of grazing intensity on soil organic carbon storage and other soil quality indicators in extensively managed grasslands. *Agriculture, Ecosystems and Environment* 253: 62–81.

Anderson DM, Frederickson EL and Estell RE (2012) Managing livestock using animal behavior: Mixed-species stocking and flerds. *Animal: An International Journal of Animal Bioscience* 6: 1339–1349.

Baer SG, Bach EM, Meyer CK, et al. (2015) Belowground ecosystem recovery during grassland restoration: South African highvld compared to US tallgrass prairie. *Ecosystems* 18: 390–403.

Beynon SA, Peck M, Mann DJ, et al. (2012) Consequences of alternative and conventional endoparasite control in cattle for dung-associated invertebrates and ecosystem functioning. *Agriculture, Ecosystems and Environment* 162: 36–44.

Bhola N, Ogutu JO, Piepho H-P, et al. (2012) Comparative changes in density and demography of large herbivores in the masai mara researve and its surrounding human-dominated pastoral ranches in Kenya. *Bioversity Conservation* 21: 1509–1530.

Briske DD, Ash AJ, Derner JD, et al. (2014) Commentary: A critical assessment of the policy endorsement for holistic management. *Agricultural Systems* 125: 50–53.

Briske DD, Derner JD, Brown JR, et al. (2008) Rotational grazing on rangelands: Reconciliation and perception and experimental evidence. *Rangeland Ecology & Management* 61: 3–17.

Chamane S, Kirkman KP, Morris C, et al. (2017) What are the long-term effects of high-density, short-duration stocking on the soils and vegetation of mesic grassland in South Africa? *African Journal of Range & Forage Science* 34: 111–121.

Chaplot V, Dlamini P and Chivenge P (2016) Potential of grassland rehabilitation through high density-short duration grazing to sequester tmospheric carbon. *Geoderma* 271: 10–16.

DAFF. (2016). *Abstract of Agricultural Statistics*. South Africa: Pretoria.

Danckwerts JE and Teague WR (1989) *Veld Management in the Eastern Cape. Department of Agriculture and Water Supply*, South Africa: Pretoria.

Derner JD, Augustine DJ, Briske DD, et al. (2021) Can collaborative adaptive management improve cattle production in multipaddock grazing systems? *Rangeland Ecology & Management* 75: 1–8.

de Villiers AC, Esler KJ and Knight AT (2014) Social processes promoting the adaptive capacity of rangeland managers to achieve resilience in the Karoo, South Africa. *Journal of Environmental Management* 146: 276–283.

du Preez CC and Snyman HA (1993) Research note: Organic matter content of a soil in a semi-arid climate with the longstanding veld conditions. *African Journal of Range & Forage Science* 10: 108–110.

Ferguson BG, Diemont SAW, Alfaro-Arguello R, et al. (2013) Sustainability of holistic and conventional cattle ranching in the seasonally dry tropic of chiapas, Mexico. *Agricultural Systems* 120: 38–48.

Fynn RWS, Kirkman KP and Dames R (2017) Optimal grazing management strategeis: Evaluating key concepts. *African Journal of Range & Forage Science* 34: 87–98.

Garnett T, Godde C, Muller A, et al. (2017) *Grazed and Confused? Ruminating on Cattle, Grazing Systemsm Methane, Nitrous Oxide, the Soil Carbon Sequestration - and What it all Means for Greenhouse gas Emissions*. Oxford: Food Climate Research Network, 127.

Gosnell H, Grimm K and Goldstein BE (2020) A half century of holistic management: What does the evidence reveal? *Agriculture and Human Values* 37: 849–867.

Hawkins H-J (2017) A global assessment of holistic planned grazing compared with season-long, continuous grazing: Meta-nalaysis findings. *African Journal of Range & Forage Science* 34: 65–75.

Hawkins H-J, Venter ZS and Cramer MD (2022) A holistic view of holistic management: What do farm-scale, carbon, and social studies tell us? *Agriculture, Ecosystems and Environment* 107702.

Hillenbrand M, Thompson R, Wang F, et al. (2019) Impacts of holistic planned grazing with bison compared to continuous grazing with cattle in south dakota shortgrass prairie. *Agriculture, Ecosystems and Environment* 279: 156–168.

Hoffman MT (2003) 'Nature's method of grazing': Non-selective grazing (NSG) as a means of veld reclamation in South Africa. *South African Journal of Botany* 69: 92–98.

Holechek JL, Gomes H, Molinar F, et al. (2000) Short-Duration grazing: The facts in 1999. *Rangelands* 22: 18–22.

Jarvis L and Erickson R (1986) Livestock herds, overgrazing and range degradation in Zimbabwe: How and why the herds keep growing? *ALPAN - African Livestock Policy Analysis Network Paper*: 19 pages.

Kirkman KP (1995) Effects of grazing and resting on veld productivity. *Bulletin of the Grassland Society of Southern Africa* 6: 9–11.

Kotzé E, Snyman HA and Du Preez CC. (2020) Rangeland management and soil quality in South Africa. In: Lal R and Stewart BA (Eds.) *Soil Degradation and Restoration in Africa*. Boca Raton, London, New York: CRC Press, 145–170.

Krenz J, Greenwood P and Kuhn NJ (2021) Anthropogenic erosion-indicued small-scale soil heterogeneity in South African rangelands. *Anthropocene* 34: 100290.

Martin J and Owen-Smith N (2016) Habitat selectivity influences the reactive responses of african ungulates to encounters with lions. *Animal Behaviour* 116: 163–170.

McCosker T (2000) Cell grazing - the first 10 years in Australia. *Tropical Grasslands* 34: 207–218.

McSherry ME and Ritchie ME (2013) Effects of grazing on grassland soil carbon: A global review. *Global Change Biology* 19: 1347–1357.

Mduma SAR, Sinclair ARE and Hilborn R (1999) Food regulates the serengeti wildebeest: A 40-year record. *Journal of Animal Ecology* 68: 1101–1122.

Nordborg M (2016) *Holistic Management - A Critical Review of Allan Savory's Grazing Method*. Uppsala: Swedish University of Agricultural Sciences & Chalmers.

O'Reagain PJ and Turner JR (1992) An evaluation of the empirical basis for grazing management recommendations for rangeland in Southern Africa. *Journal of the Grassland Society of Southern Africa* 9: 38–49.

Ottichilo WK, De Leeuw J and Prins HHT (2001) Populations trends of resident wildebeest [*Connochaetes taurinus hecki* (Neumann)] and factors influencing them in the Masai Mare ecosystem, Kenya. *Biological Conservation* 97: 271–282.

Owen-Smith N, Hopcraft G, Morrison T, et al. (2020) Movement ecology of large herbivores in african savannas: Current knowledge and gaps. *Mammal Review* 50: 252–266.

Phimister I.R. (1978) Meat monopolies: Beef cattle in Southern Rhodesia, 1890–1938. *Journal of African History* 19: 391–414.

Preger AC, Kösters R, Du Preez CC, Brodowski S, et al. (2019) Carbon sequestration in secondary pasture soils: A chronosequence study in the South African highveld. *European Journal of Soil Science* 61: 551–562.

Roberts AJ and Johnson NC (2021) Effects of mob-grazing on soil and range quality vary with plant species and season in a semi-arid gassland. *Rangeland Ecology & Management* 79: 139–149.

Rocha A, Starkey P and Dionisio C (1991) Cattle production and utilisation in smallholder farming systems in southern Mozambique. *Agricultural Systems* 37: 55–75.

Sandhage-Hofmann A, Kotzé E, van Delden L, et al. (2015) Rangeland management effects on soil properties in the savanna biome, South Africa: A case study along grazing gradients in communal and commercial farms. *Journal of Arid Environments* 120: 14–25.

Savory A (1983) The savory grazing method or holistic resource management. *Rangelands* 5: 155–159.

Savory A (2013) *The Grazing Revolution: A Radical Plan to Save the Earth*. New York: TED Books.

Savory A and Butterfield J (2010) The holistic management framework: Ensuring social, environmental, and economically sound development. In: Ukaga O, Maser C and Reichenbach M (eds) *Sustainable Development, Principles, Frameworks and Case Studies*. Boca Raton: CRC Press, 28.

Savory A and Butterfield J (2016) *Holistic Management - a Commonsense Revolution to Restore our Environment (Third Edition)*. Washington DC 20036, USA: Island Press.

Schuman GE, Janzen HH and Herrick JE (2002) Soil carbon dynamics and potential carbon sequestration by rangelands. *Environmental Pollution* 116: 391–396.

Sebina NV and Düvel GH (1999) Intentions regarding fencing of communal grazing areas for facilitating better management. *South African Journal of Agricultural Extension* 28: 77–92.

Skinner JD (1993) Springbok (*Antidorcas marsupialis*) treks. *Transaction of the Royal Society of South Africa* 48: 291–305.

Smith B (2006) *The Farming Handbook*. Pietermaritzburg. South Africa: Interpak Books.

Snyman HA (2005) Rangeland degradation in. Semi-arid South Africa - I: Influence on seasonal root distribution, root/shoot ratios and water-use efficiency. *Journal of Arid Environments* 60: 457–481.

Snyman HA (2014) *Gids tot Volhoubare Produksie van Weiding*. (2nd Edition). South Africa: Cape Town.

Snyman HA and du Preez CC (2005) Rangeland degradation in a semi-arid South Africa - II: Influence on soil quality. *Journal of Arid Environments* 60: 483–507.

Swanepoel CM, van der Laan M, Weepener HL, et al. (2016) Review and meta-analysis of organic matter in cultivated soils in Southern Africa. *Nutrient Cycling in Agroecosystems* 104: 107–123.

Tainton NM (1999) *Veld Management in South Africa*. Pietermaritzburg. South Africa: University of Natal Press.

Tavirimirwa B, Mazungu E, Washaya S, et al. (2019) Efforts to improve Zimbabwe communal grazing areas: A review. *African Journal of Range & Forage Science* 36: 73–83.

Teague R and Barnes M (2017) Grazing management that regenerates ecosystem function and grazingland livelihoods. *African Journal of Range & Forage Science* 34: 77–86.

Teague R, Provenza F, Kreuter U, et al. (2013) Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience? *Journal of Environmental Management* 128: 699–717.

Truter WF, Botha PR, Dannhauser CS, et al. (2015) Southern African pasture and forage science entering the 21st century: Past to present. *African Journal of Range & Forage Science* 32: 73–89.

van der Westhuizen HC, van Rensburg WLJ and Snyman HA (1999) The quantification of rangeland condition in a semi-arid grassland of South Africa. *African Journal of Range & Forage Science* 16: 49–61.

Van Pletzen HW, Becker JD, De villiers M, et al. (1995) Nuwe veldbestuurstelsel vir wildebeesfontein proefplaas. *Bulletin of the Grassland Society of Southern Africa* 6: 22–25.

Venter ZS, Hawkins H-J and Cramer MD (2019) Cattle don't care: Animal behaviour is similar regardless of grazing management in grasslands. *Agriculture, Ecosystems and Environment* 272: 175–187.

Vetter S (2013) Development and sustainable management of rangeland commons – aligning policy with the realities of South Africa's rural landscape. *African Journal of Range and Forage Science* 30: 1–9.

Yayneshet T and Treydte AC (2015) A meta-analysis of the effects of communal livestock grazing on vegetation and soils in sub-saharan Africa. *Journal of Arid Environments* 116: 18–24.