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Original Research

Tightly Bunched Herding Improves Cattle Performance in African Savanna Rangeland☆

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ABSTRACT

Rotational grazing management approaches are regarded as strategies for sustaining rangeland productivity and continue to be applied across many parts of the world. In Africa, livestock farmers implementing rotational grazing often switch from traditional loosely bunched herding (LBH), in which animals within a herd are allowed to spread out naturally when foraging, to tightly bunched herding (TBH) with limited herd spread to increase animal impact on the range. However, there is little scientific information on the actual direct (short-term) effects of this altered herding strategy on livestock productivity. We investigated the direct effects of TBH versus LBH on foraging behavior, nutrition, and performance (weight gain) of cattle in a semiarid savanna rangeland in central Kenya. We conducted the study across two habitat types: a heterogeneous red soil habitat and a relatively homogeneous black cotton soil habitat. Across both habitats, cattle traveled 9–15% less, foraged 10–29% more efficiently, and put on 14–39% more weight when managed with TBH as compared with LBH. These changes occurred despite the fact that stock densities were double to several times higher under TBH, and cattle under this herding regime foraged less selectively, consuming preferred plants less (especially in the black cotton soil habitat) and consuming diets with lower crude protein content (in the red soil habitat). Financial projection showed that the benefit of increased cattle performance under TBH could sufficiently outweigh increased cost of additional labor required to implement this herding strategy. These findings suggest that TBH, as practiced here, can be implemented without livestock production or financial losses. Further, the research demonstrated reduced grazing selectivity under TBH indicates that this herding strategy could potentially be used to reduce grazing pressure on preferred forage plants and maintain herbaceous species diversity without sacrificing cattle performance.

Introduction

Rangelands provide habitats for wildlife and livestock and support the livelihoods of millions of people globally. However, many rangeland ecosystems, especially those in the developing world, are under threat of degradation and associated negative environmental, social, and economic consequences (Narjisse, 2000; Millennium Ecosystem Assessment, 2005; Bedunah and Angerer, 2012; Mussa et al., 2016). The way that grazers are managed in rangelands can influence their productivity and ability to provide ecosystem services desired by society presently and in the future. Therefore, understanding the effects of different grazing management approaches is vital in finding ways of maintaining and/or improving ecological and socioeconomic sustainability of rangeland ecosystems.

Rotational grazing (or stocking) management approaches are regarded as strategies that can sustain or enhance the productivity of rangeland systems (Savory and Butterfield, 1999; US Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS], 2003; Barnes and Hibbard, 2016; but see Briske et al. [2008, 2011] and Hawkins [2017] for opposing views). Rotational grazing involves strategies that use recurring periods of grazing and rest among two or more paddocks in a grazing management unit throughout the period when grazing is allowed (Society for Range Management [SRM], 1998). This grazing management approach contrasts markedly with continuous grazing where herbivores have unrestricted and uninterrupted access to a specific unit of land throughout the time period when grazing is allowed (SRM, 1998). Rotational grazing approaches are generally applied with a view to achieving one or more environmental and livestock

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production objectives including 1) enhancing forage species composition and productivity by ensuring rest periods for key plant species, 2) reducing grazing selectivity by increasing stock density to minimize patch grazing, 3) improving forage quality and quantity for improved animal health and productivity, and 4) improving soil condition, water quality and quantity, and riparian watershed function (USDA-NRCS, 2003). A continuum of management intensities can be used, ranging from simple deferred rotation (moderate intensity) to short-duration, high-intensity rotational grazing (Briske et al., 2011). Different stocking density levels are applied both within and among these broad categories of management intensity. The choice of management intensity and stocking density levels is generally dictated by economic constraints and goals of the landowner (Sollenberger et al., 2012).

Implementing rotational grazing typically necessitates fencing the land into paddocks to facilitate grazing rotation. However, such fencing can be expensive and thus economically unfeasible for many livestock farmers, especially those in developing countries. Moreover, for livestock-dominated landscapes that also host wildlife, as is the case in many parts of Africa, fencing is usually unsuitable, particularly when the goal is to manage for both livestock production and wildlife conservation. This is because fenced paddocks can be detrimental to wild animals by impeding their movement and access to critical resources and causing their mortality through entanglement (Boone and Hobbs, 2004; Harrington and Conover, 2006). When economic and conservation considerations preclude fenced paddocking, active herding (by herders) can be used to implement rotational grazing (Vallentine, 2001). An additional advantage of active herding across landscapes that also harbor large predators is that it can help lower predation on livestock (Ogada et al., 2003). In general, livestock can be herded using two methods: loosely bunched herding (LBH) in which individual animals within a herd are allowed to spread out naturally when foraging and tightly bunched herding (TBH) in which herd spread is limited (SRM, 1998; Vallentine, 2001).

In many African rangelands, livestock have traditionally been managed with LBH. Due to the nature of habitats and presence of predators in these rangelands, herders and livestock are accustomed to staying together in a loose formation, which markedly contrasts with unherded grazing management commonly applied in many other parts of the world. Where stocking rates are moderate, as is the case in many commercial ranches in these rangelands, livestock within a given property are typically herded across a specific general grazing area for a period of time depending on forage availability and desired level of utilization, then moved to a new area while forage regenerates in the previous grazing area (Veblen et al., 2016). This traditional grazing approach results in some form of rotational grazing, which contrasts with conventional (continuous) grazing commonly employed in many other parts of the world. However, it is worth noting that the traditional loosely bunched rotational grazing practices have been altered in many communal rangelands where livestock numbers are too high to enable rest from grazing (Odadi et al., 2017). In East Africa, some livestock farmers implementing rotational grazing often switch from the traditional LBH to TBH with the intent of increasing positive aspects of animal impact (e.g., reduced grazing selectivity, enhanced distribution of dung and urine) on the range (Odadi et al., 2017).

By concentrating grazing animals within small areas for short periods, TBH effectively increases stock density, which can affect individual animal performance both directly through altered foraging patterns (Barsila et al., 2015; Brunsvig et al., 2017), and indirectly through cumulative long-term effects on the range (Derner and Hart, 2007; Derner et al., 2008). Whereas farmers adopt TBH anticipating long-term improvement in rangeland health (e.g., enhanced nutrient cycling, forage productivity and nutritional quality), they are also often concerned that it may directly depress livestock performance in the short run. Previous studies have largely compared rotational grazing with continuous (season-long or year-long) grazing, especially using free-ranging (unherded) livestock. At present, there is limited information on the direct short-term effects on livestock productivity of TBH versus the traditional LBH. Yet such information could be useful for better understanding the ecological and economic implications of implementing one herding approach as opposed to the other.

Here, we investigated differences between the direct (short-term) effects of TBH versus LBH in cattle foraging behavior, nutrition, and performance in a semiarid savanna landscape in central Kenya. We conducted the study across two habitat types—a spatially heterogeneous sandy red soil habitat with high plant species diversity and low herbage biomass and a spatially homogenous clayey black cotton soil habitat with relatively low plant species diversity and high herbage biomass. We hypothesized that TBH would reduce grazing selectivity by cattle, thereby negatively altering cattle nutrition and performance as measured by weight gain. We also hypothesized that these effects would be less pronounced under more homogeneous forage distribution conditions where the postulated effects of TBH on grazing selectivity by cattle might be muted.

Materials and Methods

Study Area

We conducted the study at Mpala Research Centre (0°17′N, 36°52′E; 1 800 m above sea level) in Laikipia County, Kenya. The research center is located within Mpala Conservancy, a 200-km^2 livestock ranch that is also managed for wildlife conservation. The mean annual rainfall is 625 mm based on a long-term (1999–2014) average. Generally, there are three rainy periods: April–June ("long" rains), August ("continental" rains), and October–November ("short" rains). The study area comprises two distinctive habitat types, a black cotton soil habitat (hereafter called "black soil") and a red soil habitat ("red soil"). Soil in the black soil habitat is black colored, clayey (42–62% clay), and imperfectly drained and has relatively high cation exchange capacity (CEC; 26–28 meq/100 g), while soil in the red soil habitat is dark (or reddish) brown, well-drained sandy loam (~66% sand) with relatively low CEC (~11 meq/100 g) (Ahn and Geiger, 1987). Vegetation on the black soil is fairly homogenous (Sensenig et al., 2010), comprising a relatively continuous herb layer dominated by six perennial grass species, namely *Setaria anceps* Stapf, *Themeda triandra* Forssk., *Lintonia nutans* Stapf, *Brachiaria lachnantha* (Hochst.) Stapf, *Pennisetum stramineum* Peter, and *P. mezianum* Leeke. The tree and shrub layers are dominated by *Acacia drepanolobium* Sjøstedt (whistling thorn) and few other woody species (Young et al., 1998). By contrast, the herbaceous vegetation layer on the red soil habitat is relatively heterogeneous and is characterized by higher plant diversity and a mosaic of grass-dominated patches with varying levels of biomass interspersed with bare ground patches of varying sizes (Augustine, 2003). In general, herbage biomass is higher in the black than red soil. Dominant grasses in the red soil include *Cynodon plectostachyus* (K. Schum.) Pilg., *Enteropogon macrostachyus* (Hochst.) Munro, *Eragrostis papposa* (Roem. & Schult.) Steud., and *C. dactylon* (L.) Pers., while common woody species include *Acacia etbaica* Schweinf., *A. mellifera* (Vahl) Benth., *A. brevispica* Harms, and *Grewia tenax* (Forssk.) Fiori.

Eighty-five mammal species occur on Mpala Conservancy, among them large wild herbivores including elephant *(Loxodonta africana)*, giraffe *(Giraffa camelopardalis)*, eland *(Tragelaphus oryx)*, plains zebra *(Equus burchelli)*, Grevy's zebra *(E. grevyi)*, African buffalo *(Syncerus caffer)*, oryx *(Oryx gazella beisa)*, impala *(Aepyceros melampus)*, Grant's gazelle *(Gazella granti)*, and Jackson's hartebeest *(Alcelaphus buselaphus)*. The major large carnivores in the area include African lion *(Panthera leo)*, African leopard *(Panthera pardus pardus)*, spotted hyena *(Crocuta crocuta)*, and African wild dog *(Lycaon pictus)*. Cattle *(Bos indicus)* is the primary livestock species at Mpala Conservancy (and similar properties in our study region) and occurred at moderate stocking rates (0.1–0.2 head ha^{-1} yr^{-1}; Odadi et al., 2007) by the time we conducted the present study.