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SYMPOSIUM

INVITED REVIEW: Getting more information from your grazing research beyond cattle performance[1,2]

Stacey A. Gunter,*[3] PAS, and N. Andy Cole,† PAS

*USDA, ARS, Southern Plains Range Research Station, 2000 18th Street, Woodward, OK 73801; and †USDA, ARS, Conservation and Production Research Laboratory, 2300 Experiment Station Road, Bushland, TX 79012

ABSTRACT

Research examining the nutrition of grazing ruminants can be a rewarding career; however, this type of science possesses great challenges. Grazing research requires the scientist to make many assumptions, deal with great variability across a landscape, and carefully plan and manage unknown effects and finally produce a published experiment that has applications across an extensive region. Probably the most rewarding aspect to researchers in this field is the ability to collaborate with researchers from other disciplines to evaluate the entire system. The knowledge that can be gained from studying a grazing system with collaborating scientists is valuable beyond a quantifiable number. Animal performance is a function of the soil–plant–animal–climate interaction with one factor affecting the other. One area of research that has been demonstrated in recent years has been that plant structure and mass will effect instantaneous intake rate and possibly total DMI. Struggles to predict DMI by grazing livestock have not been gifted with high predictive quality; the low prediction quality has probably resulted from minimal characterization of the sward and its integration in predictive models. Furthermore, grazing management affects the other ecological services provided by a landscape. Ecological services are often thought of as just wildlife habitat, but these services also include carbon sequestration, water infiltration and runoff, nutrient management, and food and fuel production for a growing world population. We know that ruminants are significant emitters of methane, and with the current level of interest in climate change, research examining the effects of grazing management on ecological services can possibly be as valuable to producers as animal performance data alone. The only way producers will adapt sustainable grazing systems is if these systems are as profitable as other opportunities for the same land resource. In the future, producers will need data showing the effects of their production systems on other ecological services. Visionary teams of agricultural scientists need to collect these ecological impact data in the present, because the public will be unwilling to wait decades for them to be collected in the future.

Key words: beef cattle, ecological service, grazing, pasture

INTRODUCTION

Rangelands and pastures produce food for the world's people, and these grasslands are an important form of income for agricultural enterprises and rural communities (Oltjen and Gunter, 2015). A common challenge arises

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[3] Corresponding author: stacey.gunter@ars.usda.gov

from the management of grazinglands for 2 important and often conflicting roles: (1) fulfilling human needs for food, timber, energy, recreation, and additional ecosystem goods and services, while (2) maintaining ecosystem functions and habitat for native plants and wildlife species (Dale et al., 2000). Rangelands (grasslands, shrublands, deserts, and tundra) and pastures cover approximately half of the Earth's terrestrial surface (Scurlock and Hall, 1998). Sown pastures of improved grasses predominate in more mesic regions, whereas native plant communities predominate in more arid regions. Hence, these systems must be managed differently and require different management metrics to be used effectively. The standing herbage mass of grazinglands provides habitat for wildlife, protects plant species that have not been selected to endure high utilization rates, and protects soil surfaces (Milchunas and Lauenroth, 1993; Khumalo and Holechek, 2005; Gillen and Sims, 2006; Adiku et al., 2010). So, to maintain the sustainability of grazinglands, the residual herbage mass must be maintained at quantities sufficient to enable plant survival and service other critical ecological functions.

To understand and predict the future performance of grazing cattle, the estimation of herbage utilization and intake is paramount because it quantifies energy intake and reproductive and growth performance and helps to assess the animal's effect on ecological services. Although nutrient demand is the major driver of herbage intake (Forbes and Gregorini, 2015), characteristics of the sward (Chilibroste et al., 2015) and the landscape (Bailey et al., 2015; Larson-Praplan et al., 2015) dictate the animal's ability to meet this demand, whether desired performance is realized, and if supplementation is required (Coleman et al., 1999, 2014). Estimates of herbage intake for grazing cattle and the parallel estimates of ingestive and digestive behaviors pose considerable difficulties for researchers, owing to dynamic interaction between the sward, the rumen, and the animal (Gregorini et al., 2008, 2013). Hence, advances in the area of estimating herbage intake have been slow and costly. However, our understanding of herbage intake suggests that, rather than short-term constraints, longer-term effectors of intake, such as changes in weather, stocking rate, plant species, and herbage mass distribution, are more dominant factors (Carvalho et al., 2015). Hence, for animal performance from grazing research experiments to be more effective, experiments need to be designed so additional data can be gathered to know the conditions the animals are experiencing and the impact they are having on ecosystem services.

Because animal performance is a function of the soil–plant–animal–climate interaction with one factor affecting the other, this review outlines several options that can be included in grazing research that animal scientists do not normally include. Adding additional areas of research to grazing experiments through collaborations and technology can increase its breadth of application.

VALUE OF GRAZING RESEARCH TO SOCIETY

Global demand for animal products continues to increase because of the combined effects of population growth, projected to reach 9.2 billion by 2050, and the increased affluence of the population in emerging economies (Pacheco et al., 2014). In the last 15 yr, the consumption of meat and milk products has grown in absolute terms by 34% in developing countries and by 9% in developed countries, and the trend is expected to continue in the next 15 yr (FAO, 2006; Steinfeld et al., 2006). Furthermore, the predicted demands for animal products are much greater than the predicted food availability in the future, particularly in developing regions (Thornton, 2010). As a result of this increased demand, the global population of domesticated ruminants has increased by 17% between 2000 and 2012 (FAO, 2014). Sustainable intensification of livestock production systems is fundamental to meeting this large increase in demand for livestock products, both current and future. Sustainable animal diets, such as through pasture utilization, are expected to be beneficial for the animal, the environment, and society and are likely to generate socioeconomic benefits for rural areas and provide food security as well (Makkar, 2013).

Because grazinglands cover almost half the terrestrial surface of the Earth (Scurlock and Hall, 1998), the importance of the livestock sector as a user of natural resources, as a source of livelihood, and as a driver of economic growth received considerable research in the past decade (Herrero et al., 2013b). As the largest land-use system on Earth, livestock production occupies 30% of the ice-free surface of the Earth, contributes 40% of the world's agricultural domestic product, and provides income for more than 1.3 billion people (Herrero et al., 2013b). In underdeveloped countries, livestock production from grazinglands is often the only cash-crop available to the very poor and provides nourishment for at least 800 million food-insecure people (Dumanski at al., 2010; Smith et al., 2013). Even with the significant contributions of livestock production to food security and the growth of rural economies, it uses vast amounts of land, one-third of the freshwater, and one-third of the croplands for feed production. Hence, the livestock production system contains dualities: (1) the system can provide valuable nutrition for crop and pasture production through manure management, but it can be responsible for water pollution and soil erosion; (2) the system can provide balanced protein and micronutrients in food to the human diet, but it can contribute to obesity when overconsumed; and (3) the system can improve the function of ecosystem services to wildlife and the environment, but if mismanaged it can result in grazingland degradation (Herrero et al., 2013a). Hence, grazinglands provide not only food and habitat for wildlife, but provide clean water and contribute to the economies of rural