Grazing Management and Stocking Strategies for Pasture-Beef Systems: Experimental Confirmation vs Testimonials & Perceptions

Monte Rouquette, Jr. PAS
TAMUS Regents Fellow and Professor
Texas A&M AgriLife Research
Texas A&M AgriLife Research & Extension Center, Overton

One of the most universal similarities of grazing systems is that "everyone has one!" And, whether the grazing management and stocking strategies are based on experimental evidence, experience, or perceptions-philosophy, grazing systems may be difficult to change, alter, or amend. What is the target? Rouquette and Aiken (2020) stated that "forage-based livestock production is challenged to enhance sustainability of pastures and cattle production, and to maintain economic stability in the presence of changes in market prices of cattle, fertilizer, feed, and other requirements. Management strategies that meet production goals while maintaining soil and ecosystem health and with minimal impact on the environment require a basic understanding of how: 1) the intensity, rate, and duration of stocking will impact cattle performance and production; 2) grazing systems can be used to maintain sustainable, productive pastures; 3) innovations in feeding and watering systems can be used to minimize negative impacts on water and soil health; 4) management of soil nutrients, which are components of nutrient cycling, can be effective in minimizing environmental impacts and controlling input costs; 5) control of noxious weeds is needed to maintain forage composition, pasture condition, and ecosystem stability; and 6) forage systems can accommodate wildlife habitat and diet requirements." The Global Roundtable for Sustainable Beef (2016) defined "sustainable beef" as a socially responsible, environmentally sound, and economically viable product that prioritizes natural resources, efficiency and innovation, people and community, animal health and welfare, and food.

Vegetational Hardiness Zones and Forages

Grazing management strategies and implementations vary among introduced forages on pastures and native grasses on rangelands. Although management and mindsets may be targeted toward sustainable beef cattle systems, the Vegetational-Hardiness Zones of semi-arid vs humid conditions dictate and control adapted and persistent forages in each region. In the more humid regions, warm-season perennial sod-forming grasses such as bermudagrass and bahiagrass are forages that are best adapted and tolerant to increased grazing pressures. These forages may also be harvested for hay, baleage, or silage. In semi-arid regions, native perennial warm-season bunch grasses and other forbs and browse are the best-adapted forages for rangelands. Tolerance to frequency and severity of defoliation regimens differs for sod-forming rhizomatous grasses in humid vs bunch grasses in semi-arid regions. Thus, stocking strategies and expected economic returns may be substantially different between introduced and native grass pastures. Figure 1 shows the annual precipitation in the Southern US. Stocking strategies vary within climatic and vegetational zones based on growing conditions for adapted forages.

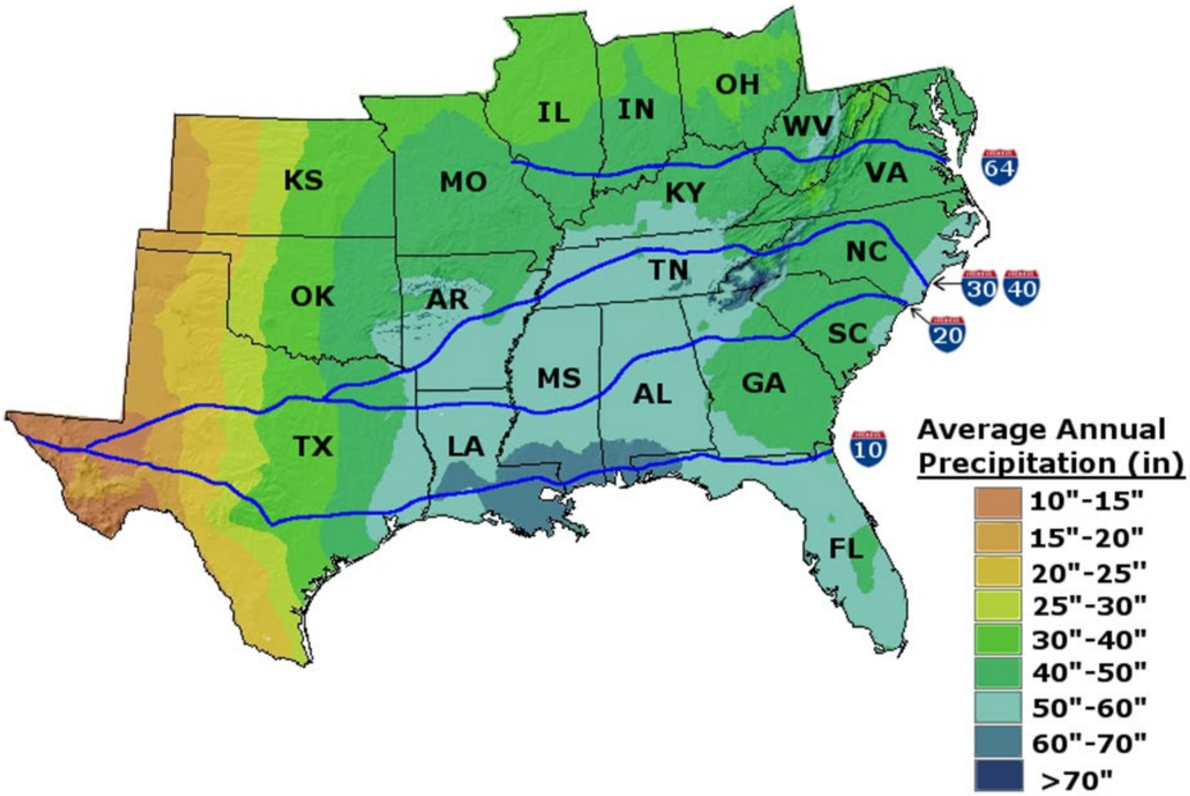

Figure 1. Thirty-year average annual precipitation in the Southern Region, 1981-2010.

Grazing Management

Grazing management has been defined as the manipulation of grazing in pursuit of a specific objective or set of objectives (Allen et al., 2011). Those strategies that can be manipulated include grazing intensity, grazing frequency and timing of grazing (Sollenberger et al., 2020). Sollenberger et al. (2020) further described that grazing intensity is related to severity of grazing and may be animal-based such as stocking rate, or pasture-based such as forage mass or plant height. However, these descriptions refer to only one component of the grazing system i.e., animal or forage; it does not integrate both components for purposes of management. Thus, grazing intensity would be best described as forage allowance (amount of forage dry matter per unit animal liveweight; Forage DM:Animal BW), or as grazing pressure (relationship between animal body weight and amount of forage); thus, both factors of pasture-based and animal-based components are combined (Allen et al., 2011; Sollenberger et al., 2005). Figures 2 and 3 show long-term relationships of forage mass and forage allowance with cow and calf ADG.

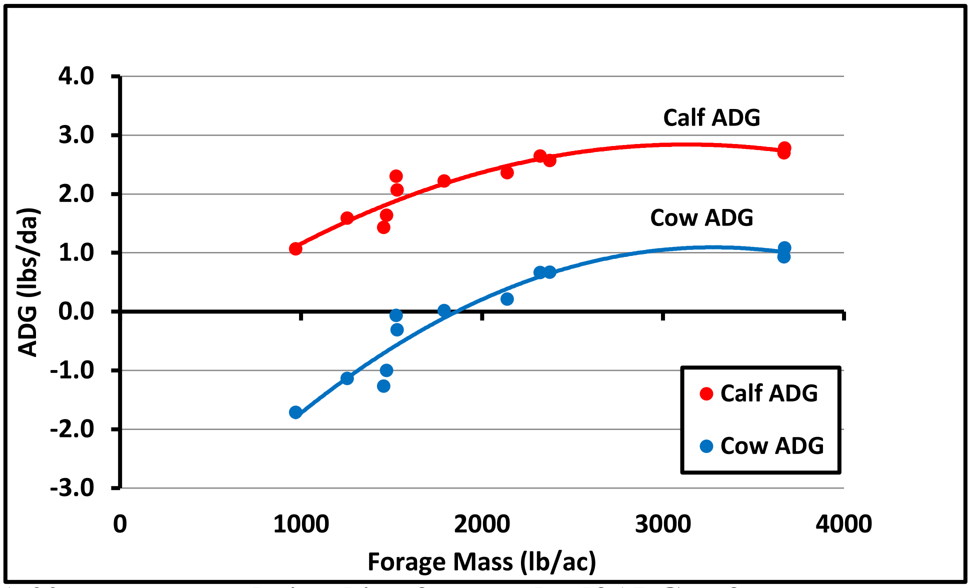

Figure 2. A 29-yr average relationship of cow and calf ADG to forage mass on common and Coastal bermudagrass overseeded with ryegrass or clover. Rouquette, 2017.

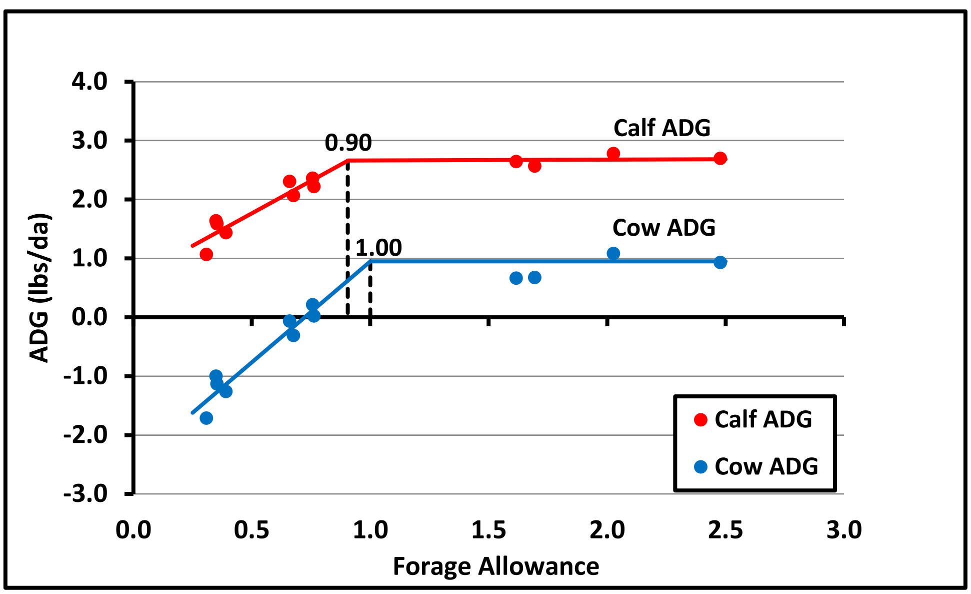

Figure 3. A 29-yr average relationship of cow and calf ADG to forage allowance on common and Coastal bermudagrass overseeded with ryegrass or clover. Rouquette, 2017.

Grazing frequency is related to stocking method in that one of more than 20 stocking methods (Allen et al., 2011) affects grazing frequency. Timing of grazing relates to the physiological stage of forage growth and maturity when grazed, or to the chronological time in the season when grazing occurs.

Stocking Methods

Stocking method has been defined as a "procedure or technique to manipulate animals in space and time to achieve a specific objective" by Allen et al., 2011. They suggested that the objectives of a specific stocking method could vary from: a) allocate forage nutritive value among livestock classes; b) enhance efficiency of forage utilization; c) diminish the detrimental or negative effects on soils and/or plants; to d) extend the stocking season. Stocking methods can be considered as variations of continuous or rotational stocking. Some examples of stocking methods presented are:

Alternative Stocking	Mob Stocking
Continuous Stocking	Non-Selective Stocking
Creep Stocking	Put-and-Take Stocking
Deferred Stocking	Ration Stocking
First-Last Stocking	Rotational Stocking
Forward Creep Stocking	Seasonal Stocking
Frontal Stocking	Sequence Stocking
Intensive Early Stocking	Set Stocking
Intermittent Stocking	Strip Stocking
Mixed Stocking	Variable Stocking

Pastures: Continuous vs Rotational Stocking

With respect to published experimentation on pastures, Sollenberger et al. (2012) compiled the results of continuous vs rotational stocking in a review of 19 refereed journal papers. These publications included 29 separate experiments on the comparison of gain per animal, ADG responses, and 26 separate comparisons for gain per acre on continuous vs rotationally stocked pastures. These nearly 60 experiments were conducted in different states over a period of more than 20 years. Data collected included forage mass, nutritive value, gain per animal, stocking rate, and gain per acre.

More than 70% of these experiments showed no effect of stocking method on nutritive value components. However, nearly 85% of these studies showed an advantage for rotationally stocked pastures in forage quantity or carrying capacity. The average increase in forage mass was about 30% for rotationally stocked vs continuously stocked pastures.

With no effect of stocking method on nutritive value, but with an increase in forage quantity, how does this translate to gain per animal and gain per acre for stocking method?

With respect to ADG:

- 66% of the studies showed no difference in stocking methods.
- 20% showed continuous to be better than rotational.
- 14% of the studies showed on advantage for rotationally stocked pastures.

The primary explanation for a reduced to non-effect of rotational stocking on ADG was that cattle are "forced" to graze the pasture to achieve a high percent forage utilization in the resident paddock (Rouquette, 2015). Forced consumption of forage into the lower part of the standing crop (sward) results in intake of low nutritive value stem portions. Cattle on continuous stocked pastures have opportunities for selective grazing. When given a choice of forage availability, cattle select more than 80% of their diet as leaves (Roth et al., 1990). Thus, higher nutritive value of diet usually favors continuous stocking.

Forage mass and forage allowance (DM:BM) set the boundaries for potential ADG. However, forage nutritive value is responsible for setting the upper limits on ADG. Therefore, both forage mass and nutritive value are collectively responsible for attaining maximum ADG from pastures (Rouquette, 2015).

What about gain per acre and stocking methods? In the Sollenberger et al. (2012) review of 26 grazing experiments that reported results for Gain per Acre:

- 73% of the studies showed no difference between continuous vs rotational stocking.
- 23% showed an advantage for rotational stocking (all cool-season forages).
- 4% showed an advantage for continuous stocking (Coastal bermudagrass).

What's Best for Pastures: Continuous or Rotational?

"Few topics in agriculture have been addressed with such charismatic language with such abandonment of scientific evidence and logic" as discussions of continuous vs rotational stocking (Bransby, 1988, 1991). In many stocking method discussions, the debates are often focused on experimental confirmation data vs testimonials and perceptions. The stocking method of choice eventually becomes a personal decision for management and does not have to be assessed as the "Best Method." Selecting management and stocking strategies to make optimum use of forage production, individual animal performance, and overall gain per acre led to the concept of Flexible Grazing Systems (Blaser et al., 1962). These grazing systems may not be "hardcore rotationally, time-scheduled stocked," but they do involve multiple pastures with strategies to incorporate flexible movement of cattle based on forage needs for grazing, and stored forages in concert with desired ADG for economic returns per unit area of land. Some examples of these flexible stocking strategies include:

- Two-Herd System of First and Last Grazers (Rouquette et al., 1992);
- Three-Herd System using different classes of cattle (Rouquette et al.,1994);
- Creep or Forward-Creep Grazing (Blaser et al.,1986);
- Systems for Fattening Steers on pasture (Blaser et al.,1956).

Rangeland: Continuous vs Rotational Stocking

Briske et al. (2008) reviewed experiments related to stocking rangelands with strategies comparing continuous vs rotational stocking. Although rotational stocking was a viable stocking strategy for rangelands, the perception that rotational was superior to continuous grazing was not supported by the majority of experimental investigations. They further concluded that the continued advocacy for rotational stocking as a superior system was based on perception and anecdotal interpretations rather than on experimental results. Briske et al. (2014) conducted an assessment of holistic management and concluded that, "the vast majority of experimental evidence does not support claims of enhanced ecological benefits in Intensive Rotational Grazing compared to other stocking strategies and including the capacity to increase storage of soil organic carbon". Thus, of all the practices one may adopt for grazing, the primary factor that controls the resultant sustainability of forage pasture rangeland is that of **stocking rate.**

Mob Stocking

Allen et al. (2011) defined mob stocking as "a method of stocking at a high grazing pressure for a short time to remove forage rapidly as a management strategy." What is a mob? How are livestock mobs controlled? One of the first uses of "mob stocking" has been attributed to G.O. Mott who used this term after visiting with Australian researchers (Gurda et al., 2018). The terminology and application were first used in evaluation of warm-season perennial grass cultivars and germplasm (Mislevy et al., 1983; Rouquette and Florence, 1983; Gildersleeve et al., 1987). Although there were no prescribed stocking standards, the defoliation technique simulated high-intensity, rotational grazing using a high stocking density. From these initial defoliation techniques for forage cultivar evaluation, mob stocking has been promoted as a viable, economic, and biological enhancement strategy; thus, a philosophical approach without experimental evidence. Thus, non-replicated demonstrations on semi-arid and humid environments have not been well-defined but have been implemented and promoted without comparative data on stocking rates and effects on soil health attributes.

A multi-year and replicated mob stocking experiment was conducted in the Nebraska sandhills (Redden, 2014; Lindsey, 2016; Andrade et al., 2022). During an approximate 75-day period in each of 8 years, a 120-paddock rotational system with 1 grazing event was compared to a 4-paddock rotational stocking system with either 1 or 2 grazing events. The ADG of yearling steers at the same stocking rate was different for each method at about 0.4 lb/day for the 120-paddock, 1.25 lb/day for 4-paddock with 1 grazing event, and about 2.2 lb/day for 4-paddock with 2 grazing events. The overall summary from this experiment was that there was no grazing treatment effects on plant species composition, forage mass, or root growth dynamics. They concluded that the additional infrastructure, labor, and management costs could not be justified using this mob stocking system in this vegetational area.

Mob, rotational, and continuous stocking were evaluated in a temperate grassland area with endophyte-infected Tall Fescue, Orchardgrass, Kentucky bluegrass, white clover and red clover during three years (Tracy and Bauer, 2019). Forage mass and nutritive values were similar across all grazing methods. Cow-calf performance was reduced under mob stocking. They concluded that mob stocking may be a beneficial strategy for short-term vegetation management rather than for season-long stocking. In addition, authors suggested that mob stocking appeared to be an unwise investment due to the limited benefits for forage and livestock in the Virginia environment.

Mob stocking may offer a management strategy in environments and conditions with a diverse, multi-species forage and browse vegetation. Management should be reminded that mature dry cows may be the “best” cattle for use with this stocking method due to nutrient requirements, which are primarily for maintenance and not for growth, lactation, and/or estrus. And the “least desirable” cattle to use in mob stocking are young, lightweight (450-700 lb) stocker-yearlings due to the reduced nutritive value of the more mature forage available for selection.

Is Regenerative Grazing a Mob Stocking Method? Regenerative grazing has been self-defined as practices or methods of stocking that enhance ecosystem services, soil health, etc. And it often includes Intensive Rotational Grazing that may range from one to a few days’ residence on a pasture with 30 to 60 days or more rest, which is a form of mob stocking. Regenerative agriculture has been generally described/defined as methods or approaches for soil conservation and enhancing ecosystem services. Thus, regenerative agriculture is not a specific practice but rather is based on philosophies of a variety of management practices or strategies that promote soil health and sustainability. Giller et al. (2021) reviewed the origins of regenerative agriculture and the various philosophies and definitions for its implementation. They found that many producer testimonials on the internet suggested their adoption of Regenerative Agriculture was “underpinned by the philosophy that seeks to protect and enhance the environment.” They also reported that many “regenerative practices” such as crop residue retention, cover cropping, and reduced tillage were central to the “canon of good agricultural practices”; whereas other practices were contested and at best were “niche” such as permaculture and holistic grazing.

Regenerative or Sustainable Agriculture. Giller et al. (2021) investigated the recent terminology of "Regenerative Agriculture" from an agronomic perspective. Although this terminology has been in use from the early 1980's, only since 2016 has regenerative agriculture been adopted and incorporated into a "buzz word" used by multi-national companies, charitable foundations, USDA, etc. Regenerative agriculture has shown to be no different than sustainable agriculture, sustainable intensification, climate-smart agriculture, organic farming, agroecology, etc. Giller et al. (2021) further suggested that academic and research agronomists need to engage constructively with individuals, organizations, and corporations that champion regenerative agriculture and address the scientific method. They provided areas and questions to be addressed that would assess the agronomic aspects of the mechanism and dynamics of regeneration. In summation, they suggested that such investigations "will also help to separate the philosophical baggage and some of the extraordinary claims that are linked to Regenerative Agriculture, from the areas and problems where agronomic research might make a significant contribution."

Stocking Strategies and Sustainability of Pasture-Beef Systems

Some of the positive attributes of various rotational stocking strategies are:

- A more uniform level of forage utilization and perhaps an "improvement in efficiency" of grazing.
- Vegetation cover may be enhanced with "proper stocking rate;" however, vegetation may be destroyed at high stocking rates.
- Potential for more uniformity of excreta distribution.
- Mandates regular inspection of livestock and pastures.
- Grazing can be combined with mechanical harvesting.
- Management perception that the system is a "best management practice" for the soil/plant-animal ecosystem.

Grazing intensity measured as stocking rate or pasture height is the most important factor in grazing management and stocking strategies. Stocking rate has overriding effects on forage production, pasture persistence, animal performance, and environmental impact of pasture-based livestock systems. Rouquette (2015) suggested that managers must consider some of the following factors to optimize output from the system: a) understanding forage growth and regrowth; b) experience with animals and animal husbandry; c) intuitive application of decisions for input and outputs; d) knowledge of current and forecasted weather conditions in an ecoregion; e) ability to assume the risks associated with stocking outcomes; f) constant awareness of vegetation and land resources; and g) an alternative or "escape plan" for animals in the event of extreme climate conditions.

Stocking strategies should be characterized or designed within a specific Vegetation or Hardiness Zone and combined with the art and science of management for efficient-strategic forage utilization and sustainability for the desired optimum pasture-animal production. Thus, management strategies are site-specific for multiple input-output decisions with objectives to 'match' forage-animal requirements to production and economic rewards (Rouquette, 2015). Grazing management strategies control the degree of intensity of beef cattle production based on level of economic risk and desired-expected environmental stewardship goals These management strategies should be focused on integrating relationships of pasture ecosystems and stand maintenance, environmental awareness, economic implications, and legacy-heritability objectives of property for sustainable forage-livestock production (Figure 4; Rouquette, 2017).

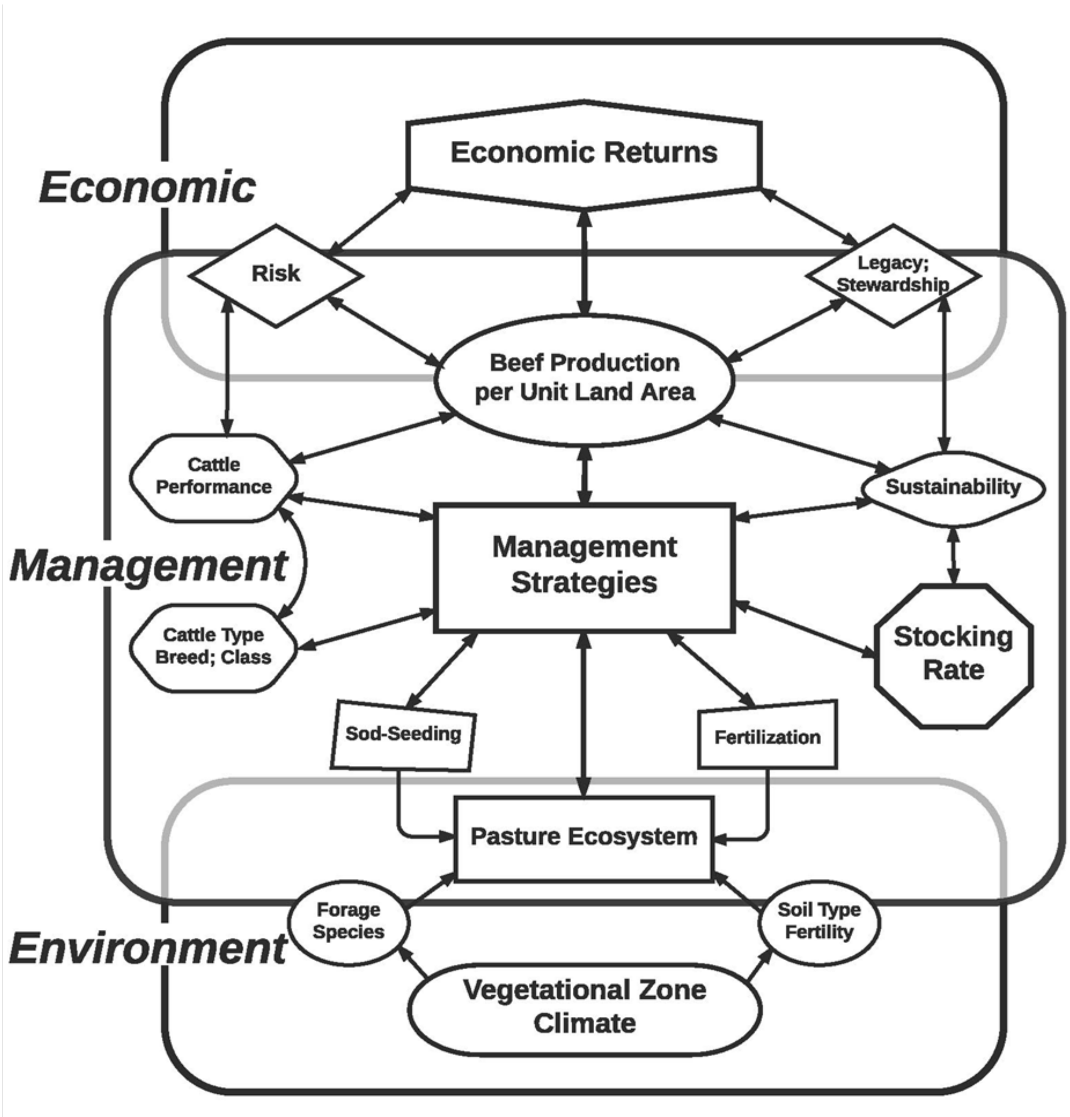

Figure 4. Sustainability of pasture-cattle production systems guided by environment, management, and economic considerations. Rouquette, 2017.

Experimental Data or Testimonials

Implementing revised or new management strategies requires attention to detail and the use of results from comparative experiments. Some of these strategies may include fertilizer ratio and fertilization rate for hay or pasture; supplementation ingredients and amount to deliver to specific classes of livestock; breed type for cow-calf and/or stocker operations; forage cultivars for perennial and/or annual pastures; stocking method for sustainable beef system and economic returns; and seasonal and/or year-long stocking rate or carrying capacity of property. Sollenberger et al. (2020) summarized that "Within the community of grazing management practitioners, proponents of one approach or another may rely too heavily on anecdotes and too lightly on data." They also suggested that "before adopting a new grazing management approach, there is value in requesting DATA that support the recommendations being made. It is equally important that the source of the data be an independent organization without conflict of interest, and that the experiments be conducted on a time and size scale that provides relevant results to producers." The Land Grant System was designed to disseminate these types of data results through State Agricultural Experiment Stations and Extension Service publications and short courses. And their recommendations-suggestions are routinely based on multi-year and/or multi-locational comparative research and experimental data. Grazing systems should be viewed as "work in progress" as management fine-tunes input strategies for sustainable pasture-livestock systems and positive economic returns.

Literature Cited

Allen, V.G., C. Batello, E.J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne, C. Morris, A. Peeters, and M. Sanderson. 2011. An international terminology for grazing lands and grazing animals. Grass Forage Sci. 66:2–28.

Andrade, Bianca O. et al. Walker Schacht. 2022 Vegetation and animal performance responses to stocking density grazing systems in Nebraska sandhills meadows. Rangeland Ecol. Manage 82:86-96

Blaser, R.E., J.R. Harlan, and R.M. Love. 1962. Grazing management. *In*: G.O. Mott (Ed). Pasture and range research techniques. Comstock Publ. Cornell Univ. Press, Ithaca, NY. p. 11–17.

Blaser, R.E., R.C. Hammes, Jr., H.T. Bryant, C.M. Kincaid, W.H. Skrdla, T.H. Taylor, and W.L. Griffeth. 1956. The value of forage species and mixtures for fattening steers. Agron. J. 48:508–513. https://doi.org/10.2134/agronj1956.00021962004800110008x

Blaser, R.E., R.C. Hammes, Jr., J.P. Fontenot, H.T. Bryant, C.E. Polan, D.D. Wolf, F.S. McClaugherty, R.G. Kline, and J.S. Moore. 1986. Forage–animal management systems. *In*: M.C. Holliman (Ed). V.P.I. Bull 86-7. Virginia Agric. Expt. Sta. Virginia Polytechnic Inst. and State University, Blacksburg, VA. p. 1–90.

Bransby, D.I. 1988. Rotational and continuous grazing interactions with stocking rate on warm season perennial pastures. *In*: Proc. Am. Forage and Grassl. Conf., Baton Rouge, LA. 11–14 Apr. 1988. AFGC, Beltzville, PA. p. 97–101.

Bransby, D.I. 1991. Biological implications of rotational and continuous grazing: A case for continuous grazing. *In*: Proc. Am. Forage Grassl. Conf. Columbia, MO. 1–4 Apr. 1991. Am. Forage Grassl. Counc. Georgetown, TX. p. 10–14.

Briske, D. D., J. D. Derner, J. R. Brown, S. D. Fuhlendorf, W. R. Teague, K. M. Havstad, R. L. Gillen, A. J. Ash, and W. D. Willms. 2008. Rotational grazing on rangelands: Reconciliation of perception and experimental evidence. Rangeland Ecol. Manage 61: 3-17.

Briske, David D., Andrew J. Ash, Justin D. Derner, and Lynn Huntsinger. 2014. Commentary: A critical assessment of the policy endorsement for holistic management. Agricultural Systems 125: 50-53.

Gildersleeve, R.R., W.R. Ocumpaugh, K.H. Quensenberry, and J.E. Moore. 1987. Mob-grazing of morphologically different *Aeschynomene* species. Tropical Grasslands 21: 123-132.

Giller, Ken E., Renske Hijbeek, Jens A. Andersson, and James Sumberg. 2021. Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture 50: 13-25.

Global Roundtable for Sustainable Beef. 2016. The global beef value chain manages natural resources responsible and enhances ecosystem health. Accessed Sep. 1, 2016. https://grsbeef.org/what-sustainable-beef/naturalresources.

Gurda, Anders M., Mark J. Renz, and Geoffrey E. Brink. 2018 Defining mob grazing in the upper midwestern United States. Journal of Extension 56: 1-8.

Lindsey, T. 2016. Grazing method effects on forage production, utilization, animal performance and animal activity on Nebraska sandhills meadow. (MS Thesis), Univ Nebraska-Lincoln.

Mislevy, P., G.O. Mott, and F.G. Martin. 1983. Screening perennial forages by mob-grazing technique. Symp. Intl. Grassland Cong. Lexington, KY. 516-519.

Redden, M. D. 2014. Grazing method effects on forage production, utilization, and animal performance on Nebraska sandhills meadow. (MS Thesis), Univ Nebraska-Lincoln.

Roth, L.D., F.M. Rouquette, Jr., and W.C. Ellis. 1990. Effects of grazing pressures upon herbage and dietary attributes of Coastal bermudagrass. J. Anim. Sci. 68:193–205.

Rouquette, F.M. and M.J. Florence. 1983. Evaluation of bermudagrass selections with mob grazers. Forage Research in TX. CPR 4141: 47-49.

Rouquette, F.M., Jr., M.J. Florence, and S.J. Gaertner. 1992. Rotational grazing of Coastal bermudagrass using one herd vs. two herds. Texas A&M Univ. Res. Ctr. Tech. Rep. 92-1. Tex. Agric. Exp. Stn., College Station. p. 85–86.

Rouquette, F.M., Jr., M.J. Florence, G.H. Nimr, and J.L. Kerby. 1994. Three-herd rotational grazing of bermudagrass with cow–calf pairs and weaned steers. Texas A&M Univ. Res. Ctr. Tech. Rep. 94–1. Tex. Agric. Exp. Stn., College Station. p. 103–104.

Rouquette, F. M., Jr. 2015. Grazing systems research and impact of stocking strategies on pasture–animal production efficiencies. Crop Sci. 55:2513-2530. https://doi.org/10.2135/cropsci2015.01.0062

Rouquette, Jr., F.M. 2017. Invited Review**:** Management strategies for sustainable, intensive cow-calf production in southeastern US: Bermudagrass pastures overseeded with cool-season annual grasses and legumes. Prof. Anim. Sci. 33:297-309. https://doi.org/10.15232/pas.2016-01591.

Rouquette, Monte, Jr. and Glen E. Aiken. 2020. Introduction: Management strategies for sustainable cattle production in Southern pastures. p.1-10. *In:* Monte Rouquette, Jr. and Glen E. Aiken (Ed). Management strategies for sustainable cattle production in Southern pastures. Elsevier Academic Press. San Diego, CA. USA. Book Chapter.

Sollenberger, L.E., J.E. Moore, V.G. Allen, and C.G.S. Pedreira. 2005. Reporting forage allowance in grazing experiments. Crop Sci. 45:896–900. https://doi.org/10.2135/cropsci2004.0216

Sollenberger, L.E., and E.S. Vanzant. 2011. Interrelationships among forage nutritive value and quantity and individual animal performance. Crop Sci. 51:420-432.

Sollenberger, L.E., C.T. Agouridis, E.S. Vanzant, A.J. Franzluebbers, and L.B. Owens. 2012. Prescribed grazing on pasturelands. p. 111-204. *In* C.J. Nelson (Ed). Conservation outcomes from pastureland and hayland practices: Assessment, recommendations, and knowledge gaps. Allen Press, Lawrence, KS.

Sollenberger, Lynn E., Glen E. Aiken, and Marcelo O. Wallau. 2020. Chapter 5: Managing grazing in forage-livestock systeme. p. 77-100. *In:* Monte Rouquette, Jr. and Glen E. Aiken (Ed). Management strategies for sustainable cattle production in Southern pastures. Elsevier Academic Press. San Diego, CA. USA.

Tracy, Benjamin F., and Robert B. Bauer. 2019. Evaluating mob stocking for beef cattle in a temperate grassland. PLoS ONE 14(12): e0226360. https://doi.org/10.1371/journal.pone.0226360.