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Invited Review: Management Strategies for Intensive, Sustainable Cow-Calf Production Systems in the Southeastern United States: Bermudagrass pastures overseeded with cool-season annual grasses and legumes[1]

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ABSTRACT

Sustainability of cow-calf production in the United States has received increased attention during the past few years. The ever-increasing land values and ownership scenarios, redirected agricultural production objectives, and financial requirements for new ownership affects land use, livestock enterprises, and sustainability of the beef industry. Bermudagrass [*Cynodon dactylon* (L.) Pers.] is the most sustainable and persistent warm-season perennial grass used for N-fertilized pastures in the southeastern United States. Management strategies that affect bermudagrass persistence and DM production goals include soil nutrient management, primarily N and K, and stocking rate, intensity, and duration. Overseeding bermudagrass with cool-season annual forages such as small grains, annual ryegrass (*Lolium multiflorum* L.), or clovers (*Trifolium* sp.) extends the active grazing period of pastures and provides the highest nutritive value of any forage class. Stocking strategies that incorporate the most adapted bermudagrass cultivars with soil type, soil nutrient availability, and use of cool-season annual forages provide the best options to achieve intensive forage utilization. Using stocking rates appropriate for forage utilization intensity objectives provides for enhanced gain per animal and gain per unit land area relationships. The economy of scale of operation, management objectives, and acceptable risk allow stakeholders to select their site-specific level of intensive cow-calf production. The most noteworthy aspects of bermudagrass pasture management have shown that the magnitude of forage mass can be immediately altered with implementation of levels of N fertilization and stocking rate to affect beef production per unit land area.

Key words: sustainable, cow-calf, bermudagrass pasture, clover, ryegrass

INTRODUCTION

Most companies and management systems have been concerned about the sustainability of their operations, products, customers, and employees. Agriculture has similar concerns of sustainability with various livestock components and products. The US Roundtable for Sustainable Beef (**USRSB**) is a multi-stakeholder initiative that was developed to support sustainability of the United States beef value chain (USRSB, 2016). The USRSB (2016) works in collaboration with the Global Roundtable for Sustainable Beef (**GRSB**, 2016) to meet beef value goals. The GRSB (2016) has defined "sustainable beef" as a socially responsible, environmentally sound, and economically viable product that prioritizes natural resources, efficiency and innovation, people and the community, animal health and welfare, and food. The natural resources principles of the GRSB (2016) are also components of sustainable pasture systems in the southeastern United States in that the following criteria are included: (1) practice environmental stewardship with adaptive management; (2) implement practices to improve air quality; (3) minimize net greenhouse gas emissions; (4) protect grasslands, native ecosystems, and high conservation value areas from land conversion and degradation; (5) implement land management practices that conserve and enhance ecosystem health; (6) incorporate efficient management of water resources to support ecological function and availability; (7) use appropriate management practices to maintain or improve soil health; (8) enhance native plants and animal biological diversity; and (9) implement management practices for sustainable-product feed sources.

The primary themes of GRSB (2016) and sustainable beef value are dependent on management strategies and practices as the criteria for success. In the southeastern United States, bermudagrass pastures overseeded with cool-season annual forages, management strategies based on foundational databases, and the objectives to enhance livestock product without degradation of the soil-pasture-

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water resources are components of sustainable cow-calf production. Intensive cow-calf production in any vegetational zone or climatic area is subject to definition and clarity of the intent of "intensive." In general, "intensive" may have an array of intended and unintended uses and perceptions of definition. In the southeastern United States with bermudagrass and other warm-season perennial grass pastures, intensive cow-calf is uniquely linked to management strategies such as fertilization, overseeding, stocking rate, and economic viability.

The objectives of this review were to review attributes of bermudagrass pastures in the southeastern United States as influenced by (a) defoliation regimens and fertilization requirements for sustainable, productive pastures; (b) sustainable cool-season annual grass and legume varieties suitable for overseeding on bermudagrass pastures; and (c) long-term effects of different intensive stocking strategies on bermudagrass pastures overseeded with cool-season annual forages stocked with cows and calves.

ADAPTED FORAGES IN BERMUDAGRASS BELT OF SOUTHEAST

Plant Hardiness Zones and Adapted Forages

The southeastern United States includes the following 13 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. A geographical description of the southeastern states is bounded on the west by Texas and Oklahoma and includes all of the states bordering the Gulf of Mexico; the Atlantic seaboard states of Georgia, South Carolina, North Carolina, and Virginia; and the land-locked states of Arkansas, Tennessee, and Kentucky. These states are located in 6 of the southern-most USDA Plant Hardiness Zones (USDA/ARS, 1990). These Plant Hardiness Zones include rainfall and temperature gradients that serve to better define the vegetational zones for these southeastern states. In the northern half of the southeastern United States, which approximates that area north of Interstate 20, tall fescue (*Lolium arundinaceum* Schreb.) is the most adapted, perennial grass for pastures. Some bermudagrass (*Cynodon dactylon*) ecotypes are adapted north of Interstate 40 and along a line that connects the southern boundaries of Kansas and Virginia. The most abundant, prolific pastures of bermudagrasses, and other warm-season perennial grasses, however, are predominately located in the vegetational zones south of Interstate 20 and along the Atlantic seaboard states of South and North Carolina (Ball et al., 2002). The hardiness zones and associated climatic conditions set the unique soil type–fertility characteristics and adapted forages.

Bermudagrass

Bermudagrasses are geographically widely distributed but are most adapted and sustainable in tropical and subtemperate environments and vegetational zones (Taliaferro et al., 2004). The release of Coastal bermudagrass in the mid-1940s (Burton, 1948), and relatively inexpensive nitrogen fertilizer, resulted in significant, increased forage production for pastures and hay. Several experiments conducted in the 1940s and 1950s documented DM responses to N rates and sources (Holt et al., 1951; Burton and DeVane, 1952; Burton, 1954; Burton et al., 1956). Accompanying the N rate experiments were clipping studies to assess the effect of DM production and sustainability of bermudagrass with frequency and extent of defoliation (Prine and Burton, 1956; Burton et al., 1963; Holt and Lancaster, 1968). Using 5-cm stubble heights as measurement standards, most studies showed that stubble height was less important than either defoliation frequency or N rate for Coastal bermudagrass production and persistence. Clapp et al. (1965) and Ethredge et al. (1973) were among the first to evaluate Coastal bermudagrass DM production at 0-cm stubble height. These studies showed DM production to be at a maximum with 5- to 7-wk frequencies and close (0- to 5-cm) stubble heights. During the course of these 2- to 3-yr studies, all defoliation treatment plots of Coastal bermudagrass maintained vegetative cover. Several clipped-plot experiments were conducted across the lower southeastern states to characterize best management practices for total biomass, hay harvesting recommendations, and stand persistence. The relatively short duration of nongrazed, clipped plots was not designed to evaluate sustainability under long-term stocking conditions.

Following the experimental results with Coastal bermudagrass and the substantially increased DM with nitrogen fertilizer, USDA/ARS and several state scientists evaluated bermudagrass germplasm and naturally occurring ecotypes. Numerous bermudagrass varieties have been released based on adaptation to specific climatic conditions, soil type, drought tolerance, disease tolerance, biomass production, nutritive value, and persistence (Taliaferro et al., 2004). Some of the current, preferred-variety lists for establishing bermudagrass for pasture include Coastal, Tifton 85 (Burton et al., 1993), Jiggs (Bade, 2000), state-specific types, and seeded bermudagrasses.

Fertilization of Bermudagrass and Sustainability

Sustainability and persistence of bermudagrass were shown to be dependent on fertilizer ratios of N-P_2O_5-K_2O. Burton (1954) suggested fertilizer ratios of 4-1-2 may be most appropriate with high rates of N and ratios of 3-1-2 with low rates of N. These initial fertilizer ratios were shown to be inadequate for sustained production and stand maintenance of bermudagrass. Taliaferro et al. (2004) cited several studies that showed the importance of K and the N:K ratio for stand survival and DM production on specific soil types (Holt et al., 1951; Jackson et al., 1959; Adamson and Twershy, 1960; Adams et al., 1967; Woodhouse, 1968; Gilbert and Davis, 1971; Keisling et al., 1979; Nelson et al., 1983; Robinson et al., 1990). It was