Management Strategies for Sustainable Pastures and Beef Production

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For those of us who may ask, "I wonder what they meant when they said...?" we can always rely on the "authority" of Webster's Dictionary with definitions for current terminology in Agriculture and Corporate Business, including the following:

- **Management** - "Judicious use of means to accomplish an end; skillful treatment; to control and direct; executive skill."
- **Strategies** - "The large-scale planning and directing of operations in adjustment to combat area (climatic diversity)."
- **Sustainability** - "The ability to maintain or cause to continue in existence or a certain state, or in force or intensity."
- **Maintain –** "To continue or persevere in or with; to carry on; to hold or keep in any condition especially in a state of efficiency."

With respect to sustainability of forages and pastures for cattle production, management strategies provide guidance and set expectations and objectives for the overall property enterprises which focus on pastures and cattle production goals. From the perspective to "maintain," promote, or enhance sustainable pastures, managers should implement stocking strategies based on relevant, comparative data from Research and/or Extension publications. In addition, managers use on-site, visual assessments and mental integration of cause-and-effect impact on pasture-animal performance. Thus, management strategies include an array of input-output decisions with potential objectives to "match" forage-animal requirements for production and economic rewards (Rouquette, 2015).

Some of the input information that owners and managers may seek includes some of the following questions: 1) What forages are present on my property, and which forages are best adapted to my vegetation-climatic area? 2) What is the soil fertility status of my pastures, and how much, if any, fertilizer is required for my desired level of forage production? 3) What is the best stocking rate for my operation, and what visual or measured "indicator" shows an optimum stocking rate strategy for sustainable cattle production? 4) Should I produce or purchase hay, and how do I know if a supplemental protein or energy feed may be needed? 5) What breedtype of cattle are best adapted to my vegetation zone, and what season(s) should they calve? and 6) How can I plan a forage-cattle operation system that includes a sustainable ecosystem which encourages wildlife food and habitat? (Rouquette & Aiken, 2019).

Stocking strategies should be characterized within a specific vegetation zone and combined with the Art and Management of efficient forage utilization and sustainability for the desired or optimum pasture-animal production. Figure 1 is a schematic that shows Inputs, driven primarily by climate, soil, and forage, and Outputs, driven primarily by production per unit land area. In-between the Inputs and Outputs are the management Decisions, which include stocking strategies, of which stocking rate has the primary influence (Rouquette, 2015).

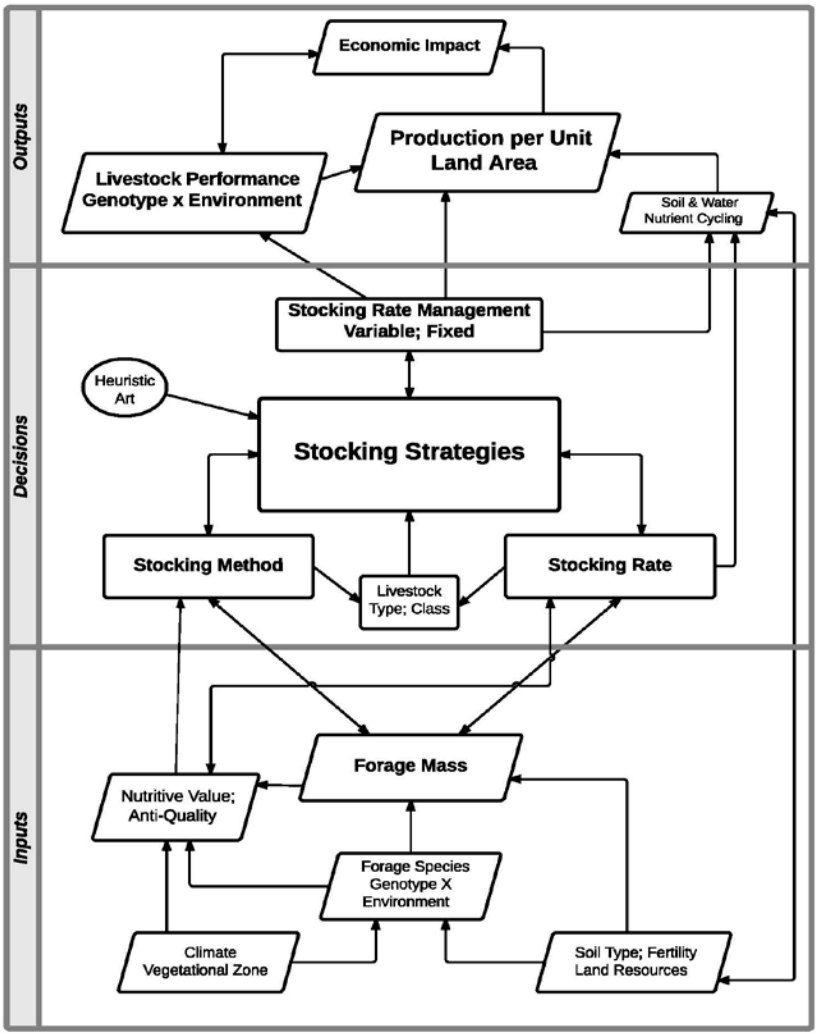

Figure 1. Inputs and outputs of pasture-animal systems as directed by stocking strategy decisions. (Adapted from F.M. Rouquette, Jr., 2015 Crop Sci. 55:2513-2530.)

Sustainability of pastures and cow-calf production in the US has received increased attention during the past few years. The increasing land values and ownership scenarios, redirected agricultural production objectives, and financial requirements for new (novice) ownership affect land use, livestock enterprises, and sustainability of the beef industry (Rouquette, 2017). Like many business enterprises, agriculture has similar concerns of sustainability with livestock products and production. The US Roundtable for Sustainable Beef (USRSB) is a multi-stakeholder initiative that was developed to support sustainability of the US beef value chain (USRSB, 2016). The USRSB has worked in collaboration with the Global Roundtable for Sustainable Beef (GRSB, 2016) to meet goals for beef value. Consequently, the GRSB has defined "sustainable beef" as a socially responsible, environmentally sound, and economical product. And, this product prioritizes natural resources, efficiency and innovation, people and the community, animal health and welfare, and food. Socially responsible is a synonym for "Management." The primary definition of sustainable beef is dependent and controlled by management strategies and practices for environmental stability and economic returns. Some of the primary components of sustainable beef are illustrated in Figure 2. Site-specific vegetation zones, pasture ecosystems, management, and stocking strategies are the main components that influence sustainability of pastures and livestock production. The overall intensity of the operation is management specific. Thus, beef production and the beef value chain are controlled by biological-economic risks and stewardship-legacy objectives (Rouquette, 2017).

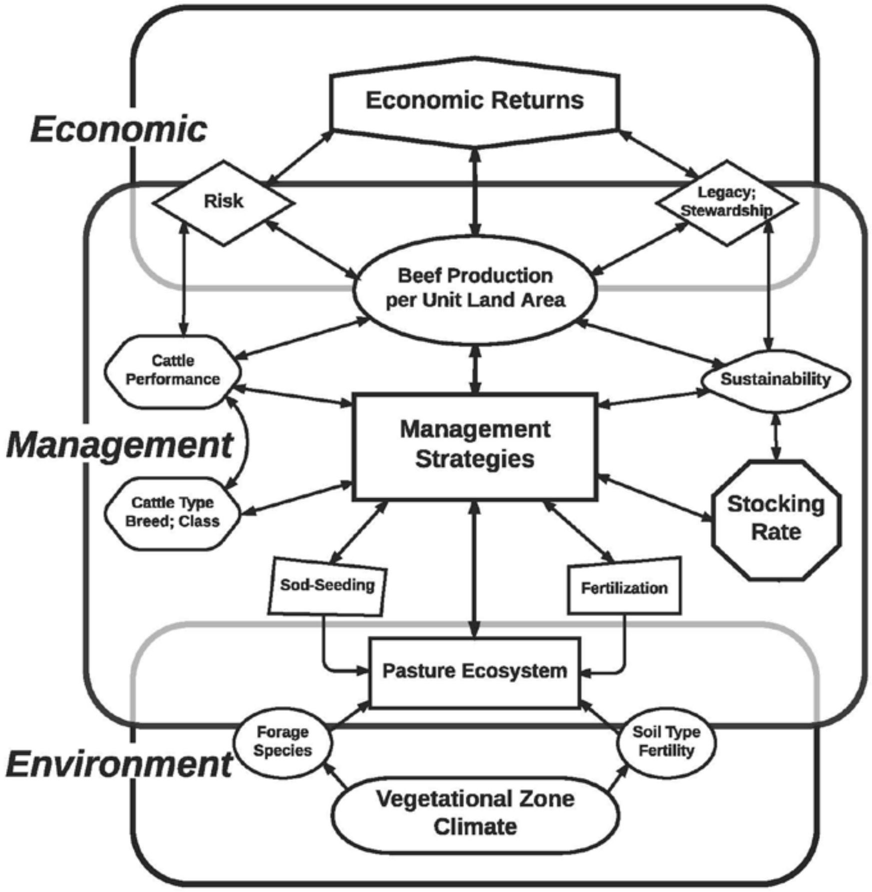

Figure 2. Sustainability of cow-calf production controlled by environment, management, and economic considerations. (Adapted from F.M. Rouquette, Jr., 2015 Crop Sci. 55:2513-2530.)

Production per animal and per unit land dictates the economic effect of the system, and is influenced primarily by stocking rate and secondarily by stocking method. Many stocking strategies have been proposed and incorporated to implement forage-animal production systems with outcomes that seek to optimize animal gains without the destruction of the forage resource. In other words, strategies that will "maintain" and "sustain" the plant-animal ecosystem are desired. In some of the early grazing research studies from the 1950s, management and stocking strategies for optimum forage utilization and animal performance introduced the concept of Flexible Grazing Management which was led by Dr. Roy E. Blaser (Blaser et al., 1962). Some of the management strategies evaluated from 1956 to 1982 by Blaser and coworkers included: a) fattening steers on pastures; b) first and last rotational grazers; c) top and bottom grazers; and d) creep or forward-creep grazing.

Stockers and Warm-Season Perennial Grasses

Numerous grazing experimentation using weaned, stocker calves on warm-season perennial grass pastures were targeted at forage utilization and animal performance to document sustainable management principles. Figure 3 illustrates the general forage production of warm-season grasses during the active growing period. Some stocking strategies used to enhance stocker gains from pastures included the following:

- **Animal Breedtype, Age, and Weight.** Young (< 6 mo), lightweight (< 450 lb), non-Brahman crossbred stockers grazing in the Gulf-Coast and southeastern US region have much lower ADG than older, heavier calves. Optimum to maximum ADG for steers stocked on bermudagrass, for example, may be achieved with long-yearlings weighing >650 lb, with a body condition score of ≤4, and having Brahman influence (Oliver, 1972, 1978; Rouquette et al., 2005).
- **Forage Variety or Cultivar.** The ADG of stockers is directly related to nutritive value (TDN, Crude Protein) and available forage mass. Among warm-season perennial grasses, 'Tifton 85' bermudagrass has produced greater stocker gains than other grasses (Hill et al., 1993). Tifton 85 bermudagrass has some of the highest digestibility and the best potential for optimum or maximum ADG from bermudagrass pastures.
- **Stocking Rate.** Adequate forage mass availability that allows stockers to selectively graze high percent leaf components results in optimum to maximum ADG. Results from grazing research have shown that optimum stocker gain is related to the amount of forage available for consumption. Expressing stocking rate as Forage Allowance (lb DM forage : lb Body Weight) shows that forage allowance > 1.0 : 1.5 is necessary for optimum ADG and gain per acre.
- **Stocking Method.** Continuous stocking and numerous "types" of rotational stocking approaches have been used to enhance stocker gains. The subject of continuous vs. rotational stocking has led to an active debate between scientists and among stakeholders. One of the primary strategies that results in reduced to no ADG from a rotational stocking venture is that of forcing stockers to have a high percent utilization of forage in the resident paddock. This "forced consumption" results in intake of low nutritive value stem portions before moving to another paddock. Regardless of any data that may provide an alternative or equal advantage for continuous vs. rotational stocking, the method of choice selected by a manager or stakeholder does not have to be scientifically assessed to be the "best method." Rather, the stocking method used must provide a "comfort zone" that has reduced risk and the perception of being the "best method" for the stakeholder's objectives (Bransby 1988, 1991).

  Alternative stocking strategies using a first-last rotational method (Blaser, et al., 1986), and which may incorporate a two-herd (Rouquette et al., 1992) or a three-herd system (Rouquette et al., 1994) on bermudagrass pastures significantly enhanced ADG of the first herd. In this scheme, the first grazers consumed only the top third of the forage available which had much higher nutritive value than the lower two-thirds remaining for the next herd.
- **Supplementation.** Numerous supplementation grazing experiments have been evaluated by scientists as a method of enhancing ADG compared to pasture-only stockers. Depending upon the objectives, the foci of these experiments ranged from: 1) using levels and nutrient concentration of supplement to increase stocking rate and gain per acre; to 2)

substituting supplements for reduced forage available in pasture; to 3) using supplements to increase ADG for a niche market; to 4) achieving the most cost-effective method of supplementation. In general, daily supplementation of 0.2% to 0.3% of animal Body Weight has shown the best biological efficiencies of supplement to extra gain ratio. The cost of the additional gain is most always the primary objective of a supplementation program for stockers.

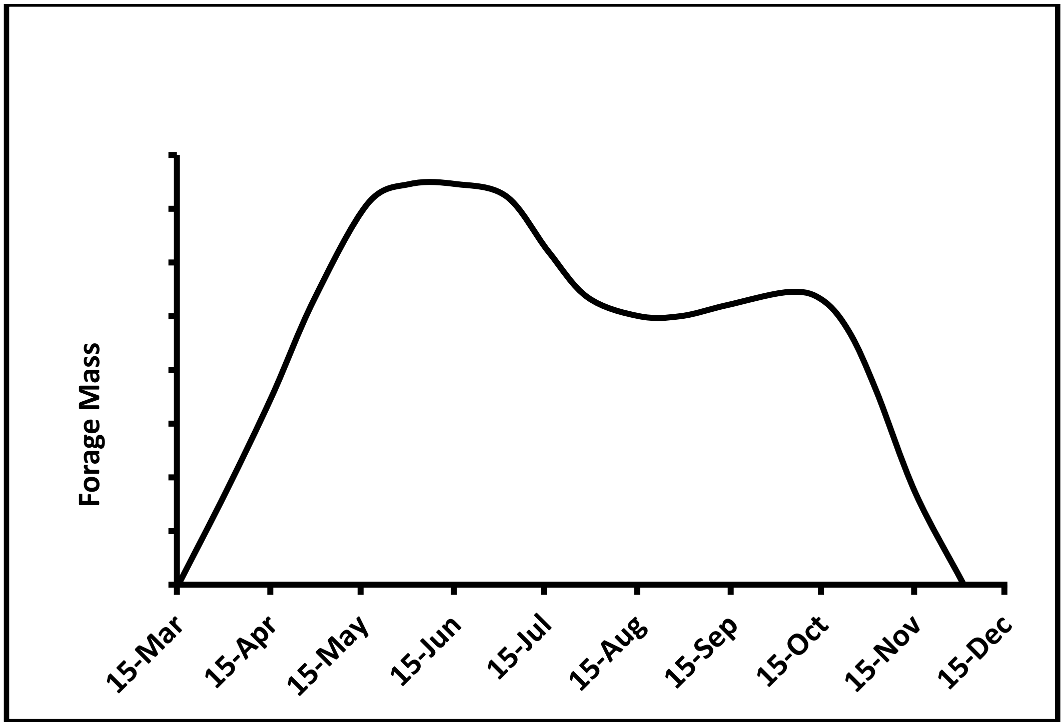

Figure 3. Illustration of forage dry matter mass variations of warm-season perennial grass during growth season.

Stockers and Cow-Calf on Winter Annual Forages

Active grazing can be extended into the fall, winter, and early spring using cool-season annual grasses or grass-clover management options (Mullenix & Rouquette, 2018). Small grains that are adapted to the Southern US include cereal rye, wheat, oats, and triticale. Rye has shown the best tolerance to low pH (acidic) soils. These small grains when combined with annual ryegrass have a bimodal forage DM accumulation trait (Figure 4). With a stocker operation, stocking strategies present challenges that are primarily related to fertilization with N and climatic diversity. With the major forage production occurring in the late-winter to early spring months, stocking rates have to be flexible to allow for proper utilization. Stocking strategies and stocking rates that are appropriate at initiation of grazing in November to December may be too high in December to January, and these initial stocking rates maybe too low in February to April (Rouquette, 2015). Thus, the stocking strategy for stocker cattle in which optimum to near-maximum gain per animal (ADG) and gain per acre are achieved must incorporate a flexible stocking rate that may be two times greater in the spring than in the fall (Rouquette et al., 2013).

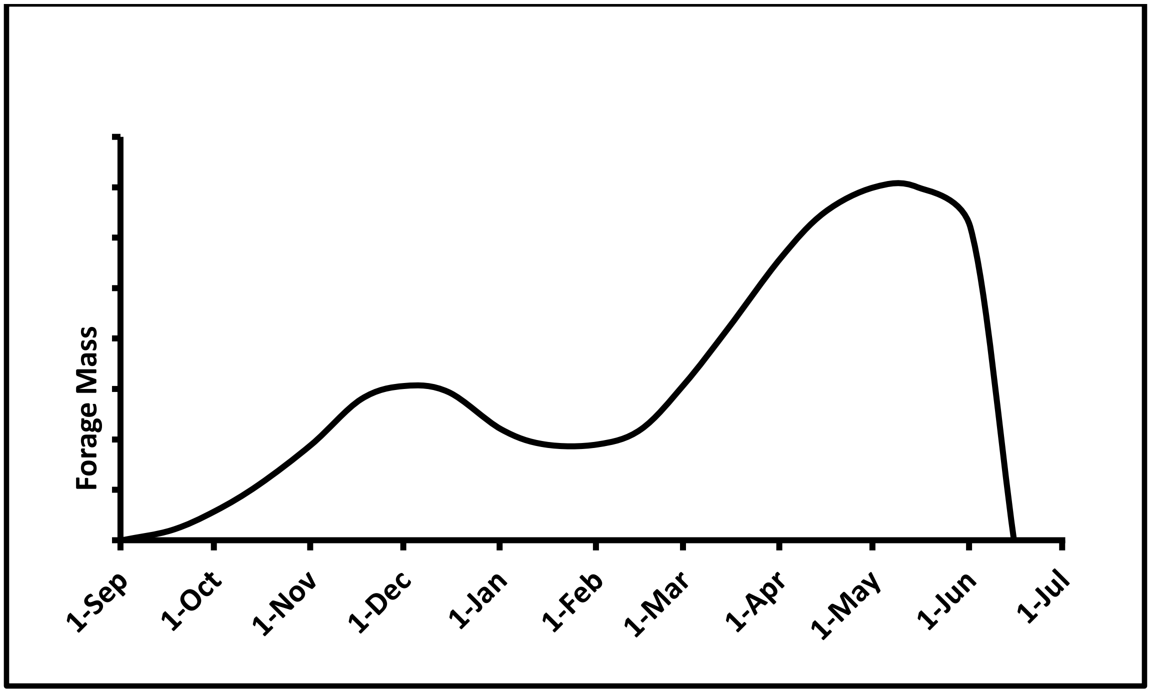

Figure 4. Bimodal forage mass and growth attributes of small grain and annual ryegrass pastures.

Perhaps one of the most recommended stocking strategies for small grain + ryegrass pastures is that of using cows and calves to assist with desired grazing pressure or forage availability. A commonly used stocking strategy to match forage production with utilization has been that of using limit-grazing of cows and calves or stockers (Altom, 1978). Some of these limit grazing strategies may involve grazing 2 to 3 days per week, 2 to 3 hours per day, or other combinations that allow managers to have a daily or weekly appraisal of forage produced and utilized.

For cows and calves, annual ryegrass and/or clovers have long been used to extend the grazing season on warm-season perennial grass pastures. The magnitude of stocking rate effects on cow-calf performance during a 29-year period has shown the relationship of forage mass and performance (Rouquette, 2017), and the impact on stand maintenance (Rouquette et al., 2011).

Cow-Calf

With respect to cows and calves, there are several management options that may be used for sustainable pasture and beef production. In the southeastern states from Interstate 20 to the Gulf of Mexico, warm-season perennial grasses are the basic forages for pastures. Figure 3 shows the general forage growth of these grasses during the year, from time of emergence from winter dormancy in the spring to time of active growth after the first killing frost in the fall. Cow-calf systems are therefore managed over a 365-day period with the basic pasture grass becoming dormant during the winter. Thus, to provide a constant source of forage for daily consumption, an array of strategies may be implemented that includes winter-annual forages and/or hay with stockpiled warm-season, perennial grasses with or without supplementation (Figure 5) (Rouquette, 2018).

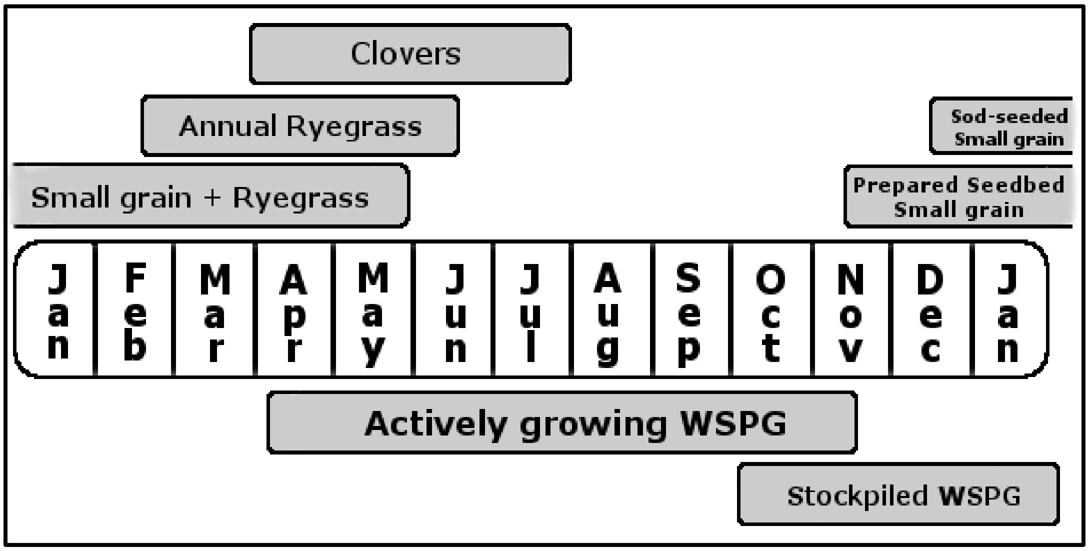

Figure 5. Forage combinations with warm-season perennial grasses (WSPG) for 365-day grazing in Hardiness Zone 8.

Time of calving is a management decision with considerations given for pastures within a specific vegetation zone. The choice and selection of a calving season offers challenges for management to match forage production traits and subsequent nutritive value of pastures with the opportunities for rebreeding the cow herd. Management objectives for calving season include desired weaning percent, weaning weight, and percent rebreeding. One of the most important considerations for rebreeding the cow herd is that of body condition score (BCS) of the cow at time of calving (Rouquette et al., 2018). Although there are always some differing circumstances, cows should have a BCS of 5 or greater at time of calving for successful rebreeding in the designated season.

The most appropriate strategies to attain acceptable BCS and reliable, sustained 12-month calving intervals are related to the forage and pasture conditions during the dry cow period from time of weaning to the next calf. Thus, much if not all of the success of a 12-month calving system is due to the management of dry cows and pastures during the 3 to 4 months pre-calving (Rouquette, 2018).

To decide on the best calving season for a specific property, some of the following objectives and decisions should be considered and explored by management (Rouquette et al., 2019):

- A warm-season perennial grass pasture that allows for overseeding with cool-season annual forages such as small grain, ryegrass, and clover.
- The calving season that offers the best opportunity to wean heavy-weight calves.
- The calving season that offers appropriate forage-pastures for dry cows to meet nutritional requirements for weight gain and with reduced costs for supplementation and labor.
- The calving season that offers the best opportunities for merchandizing/selling calves and cull cows.

- Pasture availability for retained ownership from time of weaning for an additional 100 to 200 days of grazing.

Forage and pasture options for the more humid regions that include bermudagrass and cool-season annual forages, and which fit calving seasons for Fall (Table 1), Winter (Table 2), and Spring (Table 3), are provided as examples of management strategies (Rouquette et al., 2019). The long-term, 29-year relationship of lactating cow and suckling calf weight gain with stocking rate, expressed as Forage Allowance, on bermudagrass pastures overseeded with ryegrass or clover, is shown in Figure 5.

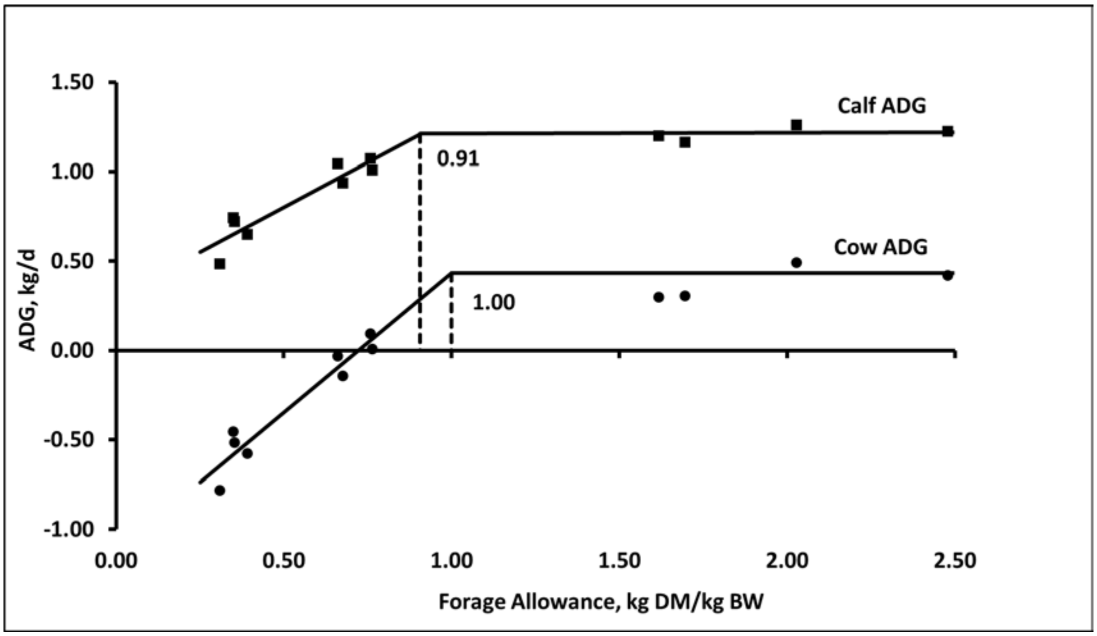

Figure 6. Relationship of cow and suckling calf ADG with forage allowance using a 29-yr stocking rate data set.

Table 1. Forage and pasture options for fall-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
AUG	Dry Cow	Warm season perennial grass (WSPG) pasture[1]
SEP	Calve	WSPG pasture
OCT	Calve; Suckling Calf	WSPG pasture
NOV	Calve; Suckling Calf	Stockpiled forage; WSPG pasture; Hay and/or supplement
DEC	Cow-calf; Suckling Calf **Dec1**: Initiate Breeding	Stockpiled forage; Hay and/or supplement; Limit-graze small grain[2] + annual ryegrass (option)
JAN	Cow-calf; Suckling Calf; Breeding Continues	Limit-graze small grain + annual ryegrass (option); Hay and/or supplement
FEB	Cow-calf; Suckling Calf **Feb15**: Terminate Breeding	Full-time graze small grain + annual ryegrass (option); Ryegrass and/or clover
MAR	Cow-calf; Suckling Calf	Full-time graze small grain + annual ryegrass (option); Ryegrass and/or clover
APR	Cow-calf; Suckling Calf	Ryegrass and/or clover; WSPG
MAY	Cow-calf; Suckling Calf	Ryegrass and/or clover; WSPG
JUN	**Jun15**: Initiate Weaning Cow-calf; Dry Cow	WSPG
JUL	**Jul15**: Finalize Weaning Dry Cow	WSPG

[1]Bermudagrass, Bahiagrass; native grasses
[2]Rye, oats, wheat

Table 2. Forage and pasture options for winter-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
DEC	Dry cow	Warm season perennial grass (WSPG)[1]; Stockpiled forage; Hay and/or supplement;
JAN	Calve	Hay and/or supplement
FEB	Calve; Suckling Calf	Ryegrass and/or clover
MAR	Calve; Suckling Calf	Ryegrass and/or clover
APR	Cow-calf; Suckling Calf **Apr15**: Initiate Breeding	Ryegrass and/or clover
MAY	Cow-calf; Suckling Calf; Breeding Continues	Ryegrass and/or clover; WSPG
JUN	Cow-calf; Suckling Calf; Breeding Continues	WSPG
JUL	Cow-calf; Suckling Calf **Jul1**: Terminate Breeding	WSPG
AUG	Cow-calf; Suckling Calf	WSPG
SEP	Cow-calf; Suckling Calf **Late-Sep**: Initiate Weaning	WSPG
OCT	**Late-Oct**: Finalize Weaning Dry Cow	WSPG; Stockpiled forage
NOV	Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement

[1]Bermudagrass, Bahiagrass; native grasses

Table 3. Forage and pasture options for spring-calving cows.

MONTH	ANIMAL ACTIVITY	FORAGES AND PASTURES
FEB	Dry Cow	Hay and/or supplement
MAR	Calve; Suckling Calf	Ryegrass and/or clover
APR	Calve; Suckling Calf	Ryegrass and/or clover
MAY	Calve; Cow-calf; Suckling Calf	Ryegrass and/or clover; Warm season perennial grass (WSPG)[1]
JUN	**Jun1**: Initiate breeding Cow-calf; Suckling Calf	WSPG
JUL	Cow-calf; Suckling Calf; Breeding Continues	WSPG
AUG	**Aug15**: Terminate breeding Cow-calf; Suckling Calf	WSPG
SEP	Cow-calf; Suckling Calf	WSPG
OCT	**Oct15**: Initiate weaning	WSPG
NOV	**Nov15**: Finalize weaning Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement
DEC	Dry Cow	WSPG; Stockpiled forage; Hay and/or supplement
JAN	Dry Cow	Hay and/or supplement

[1]Bermudagrass, Bahiagrass; native grasses

Prolonged, high stocking rates and resultant low herbage mass (HM) under continuous stocking can cause substantial stand loss of both Coastal and common bermudagrass pastures. However, with the aggressive and persistent nature of invasive bermudagrass ecotypes, bermudagrass species continued to provide nearly complete ground cover under N-fertilization regimens. Tables 4-7 show the impact of long-term stocking rates and N fertilization on stand maintenance of bermudagrass. In the absence of N fertilization for 20 years, bahiagrass was a significant invasive species on low HM pastures. Under high HM, the originally planted Coastal and common bermudagrass made up 70 to 75% of the bermudagrass present after 38 years of grazing management. The genetic similarity dendograns and cluster analyses provided profound identification differences among bermudagrass ecotypes. Further genetic analysis would be needed to determine whether these differences were due to contamination from common bermudagrass types in adjacent areas of from intercrossing of Coastal bermudagrass with common bermudagrass pollen. Under grazing strategies for animal performance and production per unit land area, stocking rates of 1 cow-calf pair per ac (1250 to 1300 lb BW/ac) were sufficiently low enough to allow for adequate HM to promote bermudagrass stand maintenance. Low HM created by stocking rates of 2 to 3 cow-calf pair/ac (3150 to 4700 lb BW/ac) did not eradicate bermudagrass ecotypes and other sod-forming grasses; however, these stocking rates substantially eliminated the originally planted Coastal and common bermudagrass (Rouquette, et al., 2011).

Table 4. Long-term stocking and fertility regimen effects on percent stand of forages in Coastal bermudagrass pastures (Rouquette, et al., 2011).

	Bermudagrass	Bahiagrass	Other‡
	------------------------	%	------------------------
Fertility Regimen			
N plus ryegrass	99.8 a†	0 b	0.24 a
No N plus clover	80.6 b	19.3 a	0.14 a

† Letters in a column grouping, followed by a different letter, differ at $p < 0.01$.
‡ Crabgrass and miscellaneous weeds.

Table 5. Long-term stocking and fertility regimen effects on percent stand of forages in common bermudagrass pastures (Rouquette, et al., 2011).

	Bermudagrass	Bahiagrass	Other‡
	------------------------	%	------------------------
Herbage Mass			
Low	87 a†	0 b	13 a
Medium	68 b	30 a	3 c
High	64 b	30 a	6 b
Fertility Regimen			
N plus ryegrass	97 a†	1 b	2 b
No N plus clover	49 b	39 a	12 a

† Letters in a column grouping, followed by a different letter, differ at $p < 0.01$.
‡ Crabgrass and miscellaneous weeds.

Table 6. Invasive bermudagrass ecotypes and bahiagrass in Coastal bermudagrass pastures under long-term stocking intensities and fertility regimens (Rouquette, et al., 2011).

Fertility regimen†	Herbage mass	Coastal bermudagrass	Invasive bermudagrass ecotypes	Bahiagrass
		------------------------	%	------------------------
N plus RYG	Low	14 b‡	86 a	0
N plus RYG	Medium	71 a	30 b	0
N + RYG	High	75 a	25 b	0
No N plus CLV	Low	21 b	73 a	7 b
No N plus CLV	Medium	24 b	45 b	31 a
No N plus CLV	High	78 a	22 c	0 b

†RYG, ryegrass; CLV, clover.
‡Means within a column and treatment not followed by the same letter differ at $p < 0.01$.

Table 7. Invasive bermudagrass ecotypes and bahiagrass in common bermudagrass pastures under long-term stocking intensities and fertility regimens (Rouquette, et al., 2011).

Fertility regimen†	Herbage mass	Common bermudagrass	Invasive bermudagrass ecotypes	Bahiagrass
		----------------------------	%	----------------------------
N plus RYG	Low	57 b‡	43 a	0 a
N plus RYG	Medium	60 a	41 a	0 a
N + RYG	High	66 a	34 a	0 a
No N plus CLV	Low	27 b	27 a	46 a
No N plus CLV	Medium	24 b	18 a	59 a
No N plus CLV	High	72 a	28 a	0 b

†RYG, ryegrass; CLV, clover.
‡Means within a column and treatment not followed by the same letter differ at $p < 0.01$.

Considerations for Management Strategies

The most reliable and predictable factor for indexing sustainability of cow-calf production is that of persistence and stand maintenance of forages in pastures of a vegetation zone. Stocking rate, intensity of defoliation regimens, and soil nutrient upkeep are the primary management strategies that control the desired level of pasture and cow-calf production. Management controls the degree of intensity of the cow-calf or stocker operations which are based on level of economic risk and desired environmental and stewardship options. These management strategies should be based on integrating relationships of pasture ecosystems and stand maintenance, environmental awareness, economic implications, and legacy-heritability objectives of property for strategic, sustainable forage-livestock production (Rouquette, 2017).

Management and stocking strategies are uniquely integrated with grazing pressure, stocking rates, deferment of pastures, and harvested forage. Stocking strategies should consider forage growth and nutritive value inputs and allow modifications on defoliation to match animal nutrient requirements in order to produce the desired level of production. The objectives of stocking strategies are targeted at matching stocking rates and stocking methods with climatic conditions for a specific ecoregion with the purpose of exploring optimum biological and economic impacts for a sustainable system (Rouquette, 2015). Stocking strategies should include economic goals and objectives in addition to risk awareness for sustainable pasture-animal production systems.

Successful managers should always have a multi-level "decision-indicator" that includes current, weekly, monthly, and seasonal expectations of forage growth and accumulation which are influenced by climatic conditions. Perhaps the "best strategy" is to "know" and "expect" the potential surplus or deficits in forage accumulation for the near future. Management should implement the "best approach" for optimum utilization via grazing, changes in stocking rate, altering the stocking method, and/or mechanical harvesting. Implementing management strategies requires a similar "mindset" as one preparing for a competitive event: The competitors for management are climatic diversities and appropriate timing to match soil-forage attributes with animal requirements for sustainable livestock production and an economically viable product (Rouquette & Aiken, 2019).

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