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# LONG-TERM COMPARISON OF THE NUTRITIVE VALUE OF FORAGE SPECIES GROWN IN THE SOUTHERN USA


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## ABSTRACT

Producers in Southeastern US use hay as a supplement to close the gap between warm-season perennial grazing in late October and cool-season annual grazing in early February. The nutrient value of stored hay depends upon its ability to meet the grazing animal's nutritional requirements during this period. Forage species nutritional values should be compared with the corresponding animal requirements for the animal's physiological status. The objective of this study was to determine the long-term nutritive value of different preserved forage types produced across Mississippi and their impact on livestock feeding systems. A dataset was compiled to quantify variation in forage plant nutritive values between-plant species. The data presented include a total of 2,396 forage samples of annual ryegrass (hay and baleage), bahiagrass, bermudagrass, mixed grass, and silage submitted by Mississippi's forage and livestock producers to the Louisiana State University Forage Quality Laboratory from 2006 to 2014. This dataset also revealed the capacity for variation in the nutrition provided by forage plants, which may drive producers to rethink their hay production strategies. Most of the forage species were in the form of dry hay and had CP values ranging from 8.3 to 10.6 % DM. The amount of fiber contained within plant material ranged from68.9 to 73.3%; this might impact animal daily forage intakes and the ability of rumen microbial population in digesting forage content and extracting nutrients. This information can be used to develop better hay production practices that could enhance livestock productivity and performance.


### ***INTRODUCTION***

Winter supplementation costs are usually the most expensive component of annual costs in a cow-calf operation across the southern USA. Hay production is the most common method of feed preservation for winter feeding in Mississippi. In 2019, there were over 610,000 acres harvested for hay production (dry hay, baleage, and silage) in Mississippi. Hay production was estimated to be 1.4 million tons with a production value of $151 M (MDAC, 2019). Most of the Mississippi's hay is marketed to the beef cattle industry; however, significant quantities are sold to the dairy and horse industry.

Forages are used to provide grazing and conserved feed for livestock. It has been estimated that grassland systems represent 26% of the global and 70% of the agricultural land area (Capstaff and Miller, 2018). There are a large number of forage species used in hay production in Mississippi which include annual ryegrass (*Lolium multiflorum*), bahiagrass (*Paspalum notatum*), bermudagrasss (*Cynodon dactylon*), tall fescue (*Schedonorus arundinaceous*), annual warm-season grasses [crabgrass (*Digitaria sanguinalis*), pearl millet (*Pennisetum glaucum*), forage sorghum (*Sorghum bicolor*), sorghum x sudan hybrid (*Sorghum × drummondii*)], corn silage (*Zea mays*), etc. Knowing the actual nutritive value of hay is very important to both the seller and buyer. High-quality hay brings a higher price for the grower, but can allow the beef cattle producer to require less commodity feed supplementation.

One of the keys to developing a successful winter supplementation program is knowing the nutritive value of the hay being, sold, or used in comparison to alternative feed commodities. Although hay should be sampled for nutritive value before starting a feeding program, it is a very uncommon practice in the cow-calf industry in the southern USA. Estimating hay value based on the nutritive value is a decision tool that allows for a more uniform comparison to other commodity feeds. These comparisons are usually based on crude protein content (CP) and the percent of total digestible nutrients (TDN).

Forage nutritive value impacts dry matter intake, diet energy density, dietary grain and protein supplementation, feed costs, and lactation performance (Cuddeford, 2013). For optimal production results, match forage quality to animal needs. Information that is useful when evaluating hay includes where species, fertilization, date of harvest, maturity at harvest, method of storage (uncovered, tarped, barn stored), and bale type and size. The nutritional needs of an animal depend on the type of animal, reproductive cycle, sex, age, and use. Forages with low nutritive value can result in reduced animal performance and increased supplemental feeding costs.

Plants vary in the quantities of different nutritive components that they could provide based on their stage of maturity (Lee, 2018). At the same time livestock species and classes vary in their requirements for these different nutritive components since their dietary requirement can change over time (Simpson et al. 2004). During the last 10 years, forage analysis has become a valuable tool for hay marketing mainly because of increased awareness and technology in the beef and dairy cattle industries. The objective of the analysis is to determine the overall nutritive value of different preserved forage types produced across Mississippi.

## *MATERIAL AND METHODS*

The data presented include a total of 2,396 forage samples of annual ryegrass (hay and baleage), bahiagrass, bermudagrass, mixed grass, and silage submitted by Mississippi's forage and livestock producers to the Louisiana State University Forage Quality Laboratory from 2006 to 2014 (Fig. 1). Samples submitted to the LSU laboratory were weighed and dried at 140 °F for 48 h to determine DM concentrations. Dried samples were ground to 2-mm particle size using a Thomas Wiley mill (Thomas Scientific, Swedesboro, NJ) and ground to 1-mm particle size using a cyclone mill. Samples were scanned using a 6500 NIR instrument (Foss North America, Eden Prairie, MN) using an in-house developed equation for forage analysis. Samples were analyzed for dry matter (DM), crude protein (CP), acid detergent fiber (ADF), and estimated total digestible nutrients (TDN) (Han and Tidwell, 2014).

Samples were analyzed by the forage category using Proc Means of SAS (SAS 9.3, 2014) to determine mean values. Mean values for CP and TDN were also used to develop GIS maps using a thematic map classification and using Jenks's natural brakes classification method to determine the best arrangement of values into four different classes (ArcGIS 10.3.1, Esri, Redlands, CA). Mean data for CP and TDN was also used to determine the percent of samples not meeting the nutrient requirements of two different livestock classes (dry and pregnant cows). A sensitivity analysis was performed using the Hay Value Calculator developed at Oklahoma State University to determine the nutritional value in a feed (Doye et al., 2020). Nutritive values present in Table 1 were used for the calculations along with commodity prices and nutritive values (CP and TDN) for corn and cottonseed meal. Mean commodity prices used in the sensitivity analysis were obtained from the USDA Agricultural Marketing Service for the southern USA (AMS-USDA, 2020a). Nutritive values for corn (88% DM, 10% CP and 88% TDN), and whole cottonseed (91% DM, 23% CP, and 95% TDN) were obtained from Lalman (2017). Good bermudagrass hay was used as base hay and price ($90/ton) for the analysis (AMS-USDA, 2020b). The analysis assumes that bales weight 1000 lb.

## RESULTS

Mixed grasses represented 32% of the total six groups of preserved forages that were submitted for analysis while bermudagrass represented 23% of the total samples (Fig. 1). Overall estimated nutritive value in different forage species indicated that annual ryegrass (hay and baleage) and bermudagrass hay had CP values above the overall mean (10.1%). On the other hand, annual ryegrass (hay and baleage) and silage had TDN values above the overall mean (56.2%) (Table 1). Annual ryegrass had similar ADF and NDF values to some of warm-season perennial grasses. This is an indication that annual ryegrass for hay was cut very late in the spring and was overmatured. Annual ryegrass baleage was harvested much earlier in the season than hay and indication of better CP and TDN percentages. Bahiagrass and mixed grass hay were the two major categories that did not meet the nutrient requirements for a 1,000-lb dry cow and a 1,000-lb pregnant cow in relation to CP and TDN (Karish and Parish, 2018) (Fig. 2 and 3).

**Table 1.** Mean values of forage parameters for different preserved forage categories submitted to LSU Forage Lab from 2006-2014. All values are expressed as percent dry matter bais (% DM). Values in parenthesis represent the standard deviation of the mean for each of the nutritive value parameters.

| Category | N | DM | CP | ADF | NDF | TDN |
|---|---|---|---|---|---|---|
| | | | | | | |
| A. Ryegrass | 185 | 86.2 (12.7) | 10.3 (3.4) | 40.4 (4.4) | 68.9 (7.3) | 57.1 (4.2) |
| Bahiagrass | 306 | 90.3 (6.0) | 8.3 (2.2) | 41.8 (3.1) | 73.2 (4.2) | 50.1 (2.9) |
| Baleage | 306 | 45.5 (11.3) | 13.4 (3.9) | 36.1 (5.1) | 57.2 (8.2) | 61.6 (5.3) |
| Bermudagrass | 594 | 90.3 (6.5) | 10.6 (3.4) | 37.6 (3.5) | 72.0 (4.0) | 54.4 (3.5) |
| Mixed Grass | 757 | 90.0 (6.5) | 9.0 (2.7) | 41.4 (3.7) | 72.0 (5.3) | 51.3 (4.1) |
| Silage | 146 | 34.0 (12.8) | 8.5 (2.0) | 30.2 (6.) | 49.3 (10.3) | 62.9 (12.1) |
| | | | | | | |

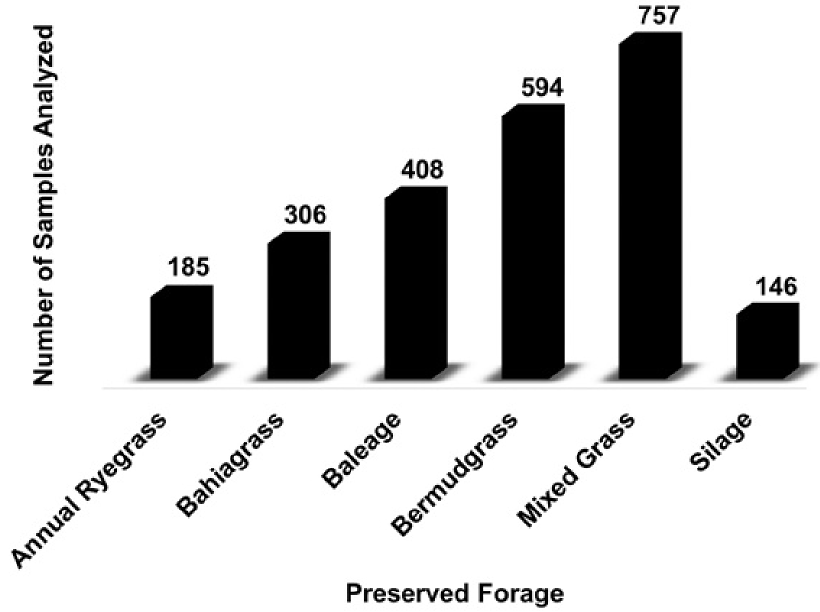



***Figure 1.*** *Total Mississippi hay samples by category submitted to the LSU Forage Lab from 2006 to 2014.*

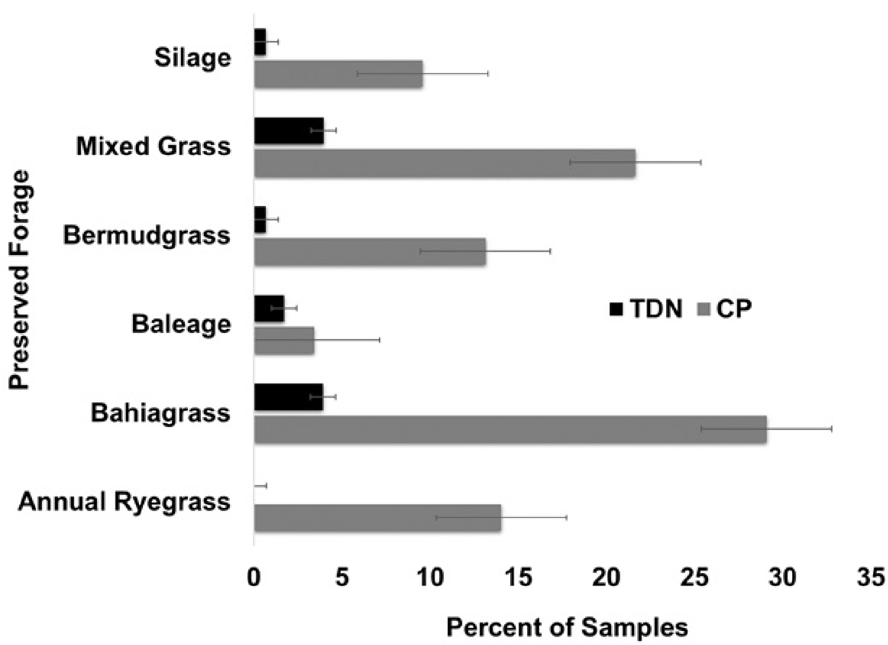



***Figure 2.*** *Percent of forage samples in each preserved forage category not meeting the nutrient requirements (CP and TDN) for a 1,000-lb dry beef cow with a 20-lb dry matter intake and a nutrient requirement of 7.0% CP and 45.0% TDN.*

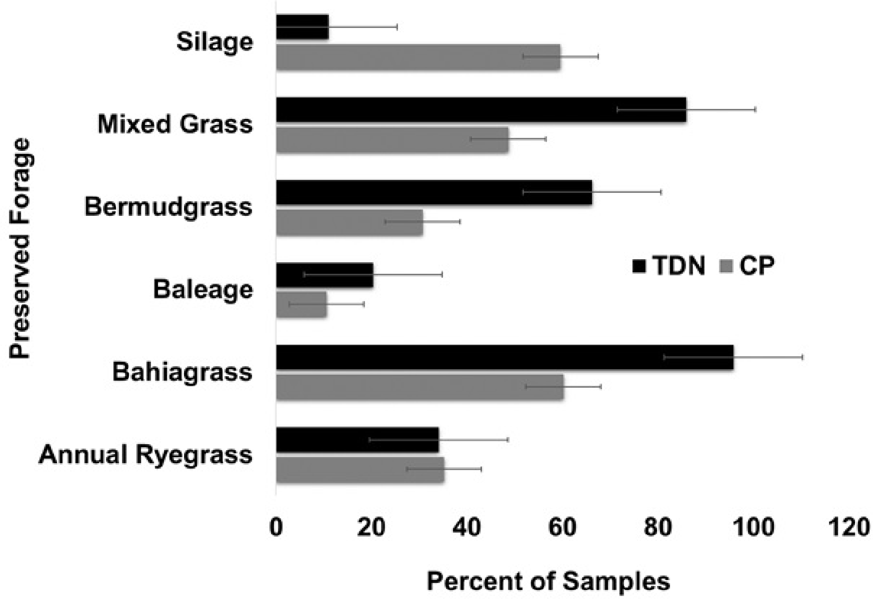



***Figure 3.*** *Percent of forage samples in each preserved forage category not meeting the nutrient requirements (CP and TDN) for a 1,000-lb pregnant beef cow with a 20-lb dry matter intake and a nutrient requirement of 8.7% CP and 55.7% TDN.*

Spatial variability in forage nutritive values indicated that fertilization and harvest management strategies impacted nutritive values. Crude protein distribution across the state based on county data had a tendency for higher values in the southern region and the NE region for all preserved forage categories (Fig. 4). Total digestible nutrient distribution across the state was quite variable with a tendency to lower levels in the central region (Fig. 5).

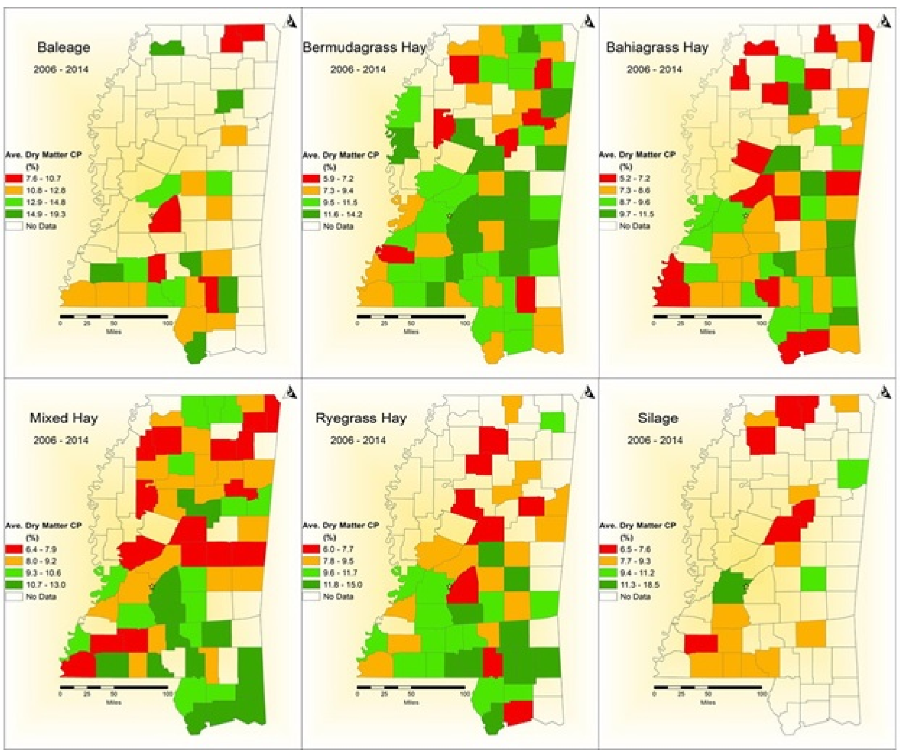



***Figure 4.*** *Percent crude protein (CP) distribution in dry matter basis by county for preserved forage samples submitted to the LSU Forage Lab from 2006 to 2014.*

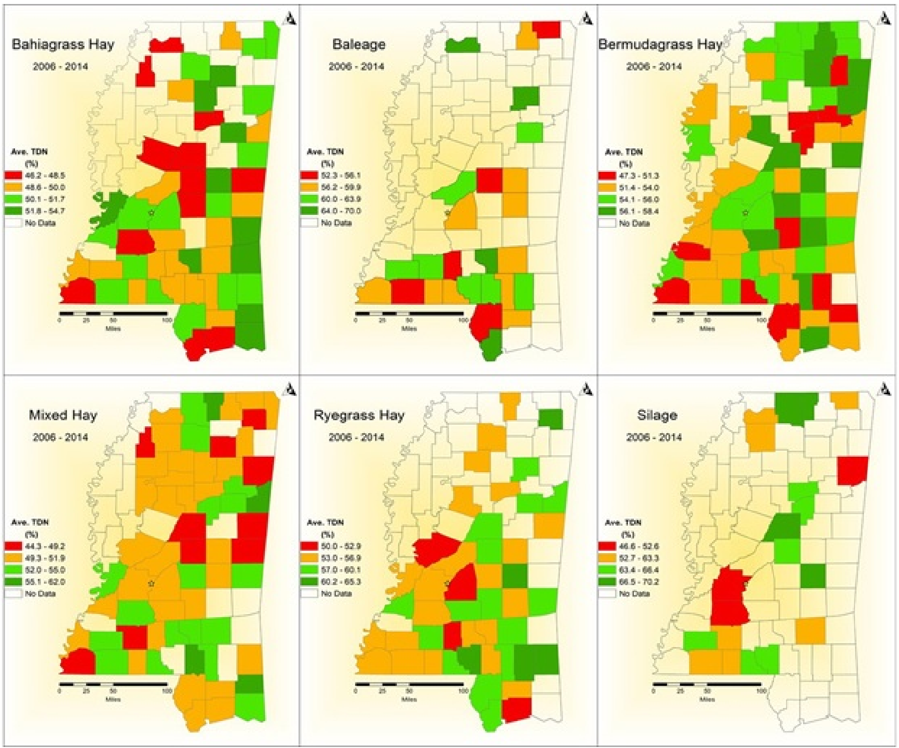



***Figure 5.*** *Percent total digestible nutrient (TDN) distribution in dry matter basis by county for preserved forage samples submitted to the LSU Forage Lab from 2006 to 2014.*

The economic sensitivity analysis was based on the percent CP and TDN of the different preserved forages and compared to bermudagrass as the base hay. The value of CP and TDN in the hay samples were calculated on the replacement cost from alternatives sources such whole cottonseed and corn. Annual ryegrass was very comparable to bermudagrass in hay prices based on nutrient analysis while balege and silage had much lower value (Fig. 6). It is important to keep in mind that these values are approximate values and do not account for hay biomass production, digestibility, intake, and storage and feeding losses. However, the analysis calculated the estimated hay value based on nutrients and the adjusted market value, where the differences in prices between bermudagrass hay (base hay) and the alternative preserve forage types can be useful in buying, selling, of feeding hay through the season. It is important to know the nutritive value and the relative cost of feed sources as hay with low or poor nutritive value is not a bargain. Figures 7 and 8 indicate the cost of feed based when comparing the bermudagrass (base hay) to other types of preserved forages. The cost of feed is 53 and 75% lower for baleage and silage, respectively, when compared to the base hay. On the other hand, the cost of protein is 11% higher with bahiagrass when compared to bermudagrass.

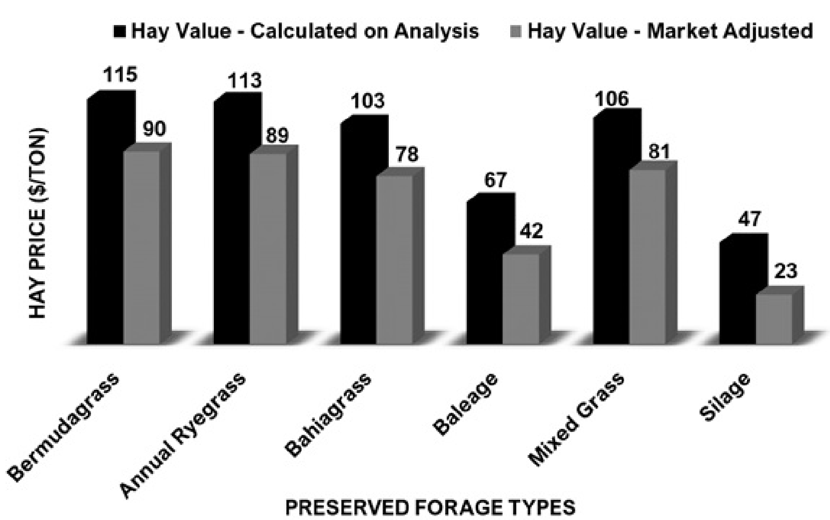



***Figure 6.*** *Approximate sensitive analysis comparing the economic value per ton of hay for bermudagrass as the base hay and other hay types using the hay nutritive analysis and the market adjusted price. These values do not account for any efficiency in hay, protein, or energy utilization and are guidelines for buying, selling, or feeding hay.*

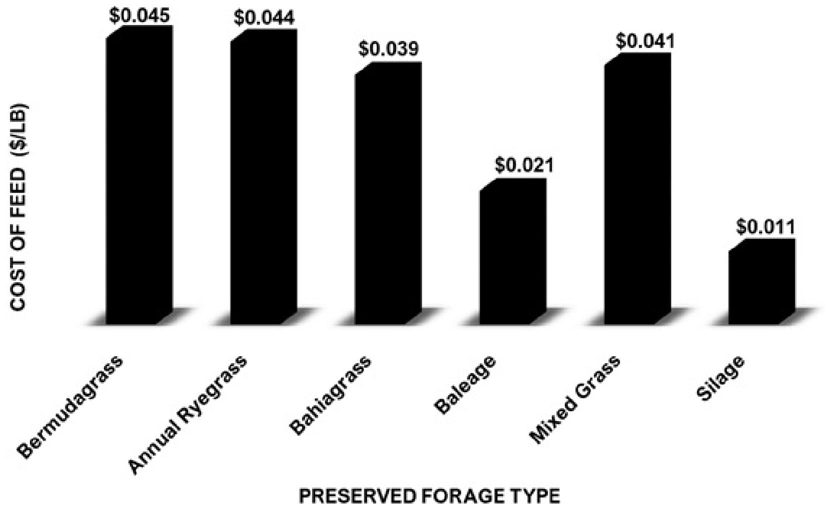
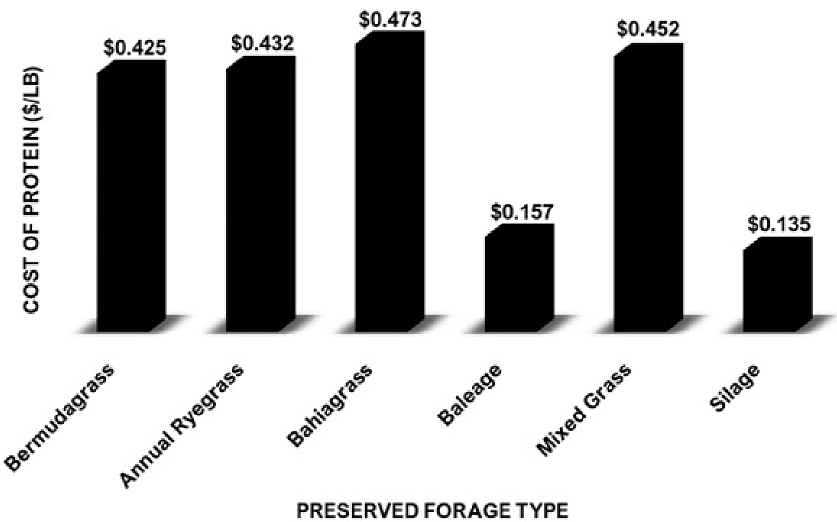



***Figure 7.*** *Cost of feed for different hay types produced in Mississippi. The value of bermudagrass as base hay and the other hay types was calculated using both the total digestible nutrients (TDN) and crude protein (CP) replacement feed sources necessary to replace the pounds of TDN and CP in a ton of hay.*




**CONCLUSIONS**

Beef cattle producers that purchase their forage should evaluate quality using nutritive value parameters; while for those that produce their own, hay quality and yield using the stage of maturity and fertilization practices should be used to compare their price to other commodities. Hay testing is useful for hay pricing/valuing and for targeting hay of varying quality to livestock groups according to their nutrient requirements as well as anticipating what forages are in demand in the state. Nutritive values are useful in forage variety selection programs and for evaluating hay management practices. With the volatility of the grain markets, beef cattle producers are starting to see the value of high-quality forages. Forages, whether hay, baleage, or silage, continues to be in high demand in Mississippi and the southern USA. There is a need to develop a better hay market in the region and to develop better marketing plans. Producers should have their hay analyzed for nutrient composition to make the necessary adjustment for buying, selling, or feeding and adjust the nutrient requirements accordingly using a planned supplementation strategy.

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