Nutrient Composition of Selected Warm-season Grasses:

Preliminary Report

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Introduction

Warm-season grasses are planted in North Dakota for mid to late summer pastures, hay land, wildlife habitat, roadside right-a-ways, and set aside acres. However, warm-season plantings are somewhat atypical in North Dakota due to dominating cool-season species. But, for many years, new varieties/cultivars of warm and cool-season grasses have been established and released by plant materials centers around the country. Grasses of the same species can take on different forms due to their point of origin. These ecotypical species have great potential for adding more diversity to a producer's forage supply. Whatever a producer desires from a grass species, evaluation of ecotypical species can have great importance to decision-making.

Meeting the nutritional requirements of domestic livestock is the key to optimizing performance on and off pasture. Crude protein (CP) content, acid detergent fiber (ADF), and total digestible nutrients (TDN) comprise the majority of values needed to develop feed requirements for domestic livestock (Nutrient Requirements of Beef Cattle 1996). It is generally known that as grasses mature, they decline in nutritional quality. Knowledge of the nutritional concentrations of these warm-season grasses can be used by livestock producers to obtain optimum performance through the addition of proper management and timely supplementation during the grazing season when nutritional requirements are deficient.

Many ranchers of the northern Great Plains have an overabundance of cool-season forage and would

benefit from the high quality forage that warm-season grasses produce in July and August (Tober and Chamrad 1992). Likewise, many cost cutting measures are focused on the mechanical side of ranching, when more attention should be directed towards cutting feed costs (Ricketts 1994). To best suit these needs, nutritional content of the grasses, production potential, and best use based on plant phenology and production are needed to address these concerns. With the advent of such knowledge and the potential to improve cattle performance on a regional basis, a need has developed to determine the nutrient content and forage production potential of selected warm-season grasses in the Northern Great Plains region.

The primary objectives of this study are to 1) determine and compare the nutrient content by date and phenological growth stage of the 16 warm-season grasses, 2) determine and compare forage production levels, and 3) develop management recommendations on proper use of these grasses.

Study Area

The two locations selected for this study are near Hettinger, ND and Pierre, SD. The Hettinger site is located on private land approximately 2 miles south of Hettinger, ND. It lies on the Verbar-Flasher-Parshall soil association, with a sandy loam soil texture (Ulmer and Conta 1987). The Pierre site is located north of Ft. Pierre, SD, on land managed by the U.S. Army Corps of Engineers. Soils on the Pierre site are a Promise clay with nearly level slope, a high shrink-swell potential, and restrictive root growth (Bismarck PMC, 1992).

Thirty-three different varieties or experimental lines were seeded in 3.5m by 15m plots on May 20-21, 1986 at the Pierre site. The Hettinger site had 16 tested varieties seeded in 2m by 8m plots on May 20, 1997. Seeding rate varied with species but followed recommended seeding rates as specified in the North Dakota NRCS Technical Guide. Species with no specified seeding rates were planted at 20-25 seeds/0.1m^2.

The climatic condition in both sites is a continental climate characterized by continuous air movement and large annual, daily, and day-to-day temperature changes. Relative humidity is low and precipitation tends to be irregular in time and cover (Jensen 1972).

Average annual precipitation in the Hettinger area is near 16 inches, and 14.7 to 18.7 inches in the Pierre area. Most precipitation occurs during the growing season. Seventy-seven percent of the annual precipitation falls during the summer months, with 50 percent falling during May, June, and July (Bavendick 1952). On average for the year, the temperature is 44 to 48 degrees F with a 130 to 160 day freeze-free period.

During the summer of 1999, temperatures were normal to above normal during clipping trials. From mid to late July, extreme temperatures occurred throughout much of the country, with temperatures

reaching 100+ degrees F in the Pierre area for many consecutive days. Precipitation was relatively normal throughout the summer at both locations.

Grasses Studied

Sixteen grasses were selected to be analyzed for nutrient and forage production in 1999. A total of eight grass species will be tested encompassing 16 cultivars (Table 1).

Table 1. List of grass species and cultivar of each warm-season grass tested near Hettinger, ND, and Pierre, SD 1999.

Grass Species	Common Name	Cultivar
Andropogon gerardii	Big bluestem	Bison
Andropogon gerardii	Big bluestem	Sunnyview
Andropogon hallii	Sand bluestem	Garden*
Andropogon hallii	Sand bluestem	Goldstike*
Bouteloua curitpendula	Sideoats grama	Butte
Bouteloua curtipendula	Sideoats grama	Pierre
Bouteloua gracillis	Blue grama	Bad River*
Bouteloua gracillis	Blue grama	Willis*
Calamovilfa longifolia	Prairie sandreed	Goshen
Calamovilfa longifolia	Prairie sandreed	ND-95
Panicum virgatum	Switchgrass	Dacotah
Panicum virgatum	Switchgrass	Forestburg
Schizachyrium scoparium	Little bluestem	Badlands*
Schizachyrium scoparium	Little bluestem	Camper
Sorghastrum nutans	Indiangrass	Holt
Sorghastrum nutans	Indiangrass	Tomahawk

* Grass cultivar was not sampled at Pierre, SD site.

Methods and Procedures

Nutritional quality and forage production were determined from ungrazed, non-mowed warm-season grass clippings at six time periods throughout the growing season beginning late June and ending early October. An array of 16 warm-season grass cultivars were seeded in 2m by 8m plots at the Hettinger site on May 20, 1997. Also, arrays of 33 warm-season cultivars were seeded in 3.5m by 15m plots at the Pierre site on May 20-21, 1986. Only 11 of these 33 cultivars will be analyzed in this study. Three replicated arrays were developed and each grass cultivar randomly seeded in each array to create a randomized complete block design (RCBD).

This nutritional quality and forage production trial began in June of 1999. Forage production was determined for the Pierre, SD site in 1999, while nutritional quality was determined for both sites. Each plot was subdivided into six quadrants of equal size that correlated to a clipping period. The six clipping periods were randomly selected for each plot. Samples were clipped in a similar random fashion at the Hettinger, ND site; however, sample sizes only had to be large enough for nutritional analysis. Each of the grass cultivars were tested for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), phosphorus, calcium, copper, zinc, magnesium, molybdenum, iron, potassium, and manganese. Forage production was determined for each of the grass cultivars at the Pierre site for each clipping period to determine peak herbage production and seasonal growth patterns. Crude protein and peak production will be summarized in this report.

The first clipping period was conducted June 21, 23 and 24, 1999. Six clipping periods occurred in 1999 at three-week intervals. Samples from the Pierre site were collected from each plot using a 0.5 m2 frame placed in its designated quadrant as randomly selected for each clipping period. Samples from Hettinger were taken using a random block approach; yet, frame size was not a factor. Grasses were clipped to a 1 cm stubble with tissue placed into a paper bag for future preparation. Clipping date and phenological growth stage was recorded for all grass cultivars at each clipping period.

All samples were oven dried at 60 degrees Celsius, ground through a 1 mm screen in a Wiley mill, and analyzed for dry matter, ash, CP, ADF, and NDF at the North Dakota State University, Animal and Range Sciences nutritional laboratory. Dry matter, ash, and ADF were determined following standardized procedures (AOAC 1990), NDF using procedures described by Robertson and Van Soest (1982), and CP using the Kjeldahl Auto System II (AOAC 1990).

Data will be analyzed to determine differences at the 0.10 percentile ($P<0.1$) between time periods and grass species cultivars. Analysis comparing differences in nutrient quality and forage production between time periods will be conducted using one-way analysis of variances as performed using Statistical Procedures for Social Sciences (1994). Analysis comparing differences in nutrient quality and herbage production between grass cultivars for each time period will be conducted using least square deviations as performed using Statistical Procedures for Social Sciences (1994).

Results and Discussions

The warm-season grass species differed in amount of forage production, timing of peak production, and levels of nutrient content. The results will be discussed in two sections, forage production and nutritional quality.

Forage Production

Although 13 warm-season grasses were selected for this trial in Pierre, 11 were tested for herbage production potential due to a loss in viable stands of Sand bluestem (Goldstrike and Garden). Herbage production was calculated by grass species. Herbage production alone should not be used to determine which grass species is a better choice for planting. Date of peak production (Table 2) and amount of time it remains at peak production (data not shown) must be looked at to best analyze a specific use of a grass species.

Table 2. Peak productivity (lb/ac) among 13 select warm-season grasses near Pierre, SD, 1999.

Grass species (cultivar)	Peak Production 1999	Date of Peak Production
Big bluestem (Bison)	5953	mid-summer
Big bluestem (Sunnyview)	5973	mid-summer
Sand bluestem (Garden)	NA	NA
Sand bluestem (Goldstrike)	NA	NA
Sideoats grama (Butte)	679	late summer-early fall
Sideoats grama (Pierre)	1274	late summer-early fall
Prairie sandreed (Goshen)	2559	mid to late summer
Prairie sandreed (ND-95)	5279	mid to late summer
Switchgrass (Dacotah)	5956	mid summer
Switchgrass (Forestburg)	6879	early August
Little bluestem (Camper)	4081	early August
Indiangrass (Holt)	4523	early August

NA indicates data not available

Nutritional Quality

Sixteen warm-season grasses were analyzed for nutritional quality in 1999. To optimize livestock performance, ranchers would like the nutrient content of the grass to remain high throughout the grazing season or harvest grass stands for hay at optimum time for quality and production. These goals can be achieved if knowledge of nutrient content is determined and correlated with the production perimeters.

All grass cultivars showed a steady decline in crude protein (CP) content from June to early fall (Table 3). Species that maintained a higher state of CP included blue grama and prairie sandreed. Switchgrass declined to the lowest levels among the species. The phenological stage contrast between cultivars of the same species indicated nutritional differences. Big bluestem (Sunnyview) maintained a vegetative state throughout the study; therefore, it tested slightly higher CP levels than big bluestem (Bison). All grass species initially met the minimum nutrient requirements of a 1200 lb lactating cow, but dropped below requirements in mid-summer.

When reviewing the nutritional quality results of these warm-season grasses, quality can only be assessed for hay quality and not actual grazing quality. Livestock can selectively graze for higher quality than shown in this data; however, hay quality should be accurate since clipping was conducted similar to a haying operation. Comparison among grass species can be conducted and selection for grazing or haying since all grass species were collected and analyzed the same.

Table 3. Crude protein (%) content by date for selected warm-season grasses in Hettinger, ND and Pierre, SD.

	Date					
Plant Species	6/21	7/12	8/4	8/23	9/14	10/5
Hettinger, ND						
Big bluestem (Bison)	13.27	9.97	7.79	6.59	5.90	3.41
Big bluestem (Sunnyview)	14.95	10.36	7.55	9.05	7.88	5.41
Sand bluestem (Garden)	14.07	10.81	8.09	8.24	7.32	5.82
Sand bluestem (Goldstrike)	14.59	10.87	8.54	8.55	7.63	6.05
Blue grama (Bad River)	15.49	12.07	8.92	9.34	8.75	6.89
Blue grama (Willis)	15.99	12.51	9.22	9.94	9.12	7.46
Sideoats grama (Butte)	14.85	11.18	8.68	7.73	6.30	4.84
Sideoats grama (Pierre)	15.12	10.97	7.78	7.48	6.57	4.75
Prairie sandreed (Goshen)	13.53	10.80	7.99	7.92	8.74	7.48

Prairie sandreed (ND-95)	14.90	11.56	9.44	9.02	9.77	8.07
Switchgrass (Dacotah)	15.89	10.49	7.05	6.71	5.61	4.24
Switchgrass (Forestburg)	15.88	11.42	7.84	7.77	6.88	3.92
Little bluestem (Badlands)	13.73	10.75	6.50	5.60	6.56	5.24
Little bluestem (Camper)	14.18	10.60	7.95	8.20	6.89	6.67
Indiangrass (Holt)	13.46	10.35	8.18	7.89	7.14	6.21
Indiangrass (Tomahawk)	14.27	9.84	7.14	5.81	5.05	4.22
Average for all cultivars	14.64	10.91	8.04	7.87	7.26	5.67
Pierre, SD						
Big bluestem (Bison)	9.58	5.95	5.24	3.85	3.64	3.38
Big bluestem (Sunnyview)	9.82	6.23	5.41	4.34	4.58	3.76
Sideoats grama (Butte)	12.09	8.83	7.48	6.42	7.41	7.28
Sideoats grama (Pierre)	11.06	9.02	6.75	5.51	6.45	5.87
Prairie sandreed (Goshen)	10.28	7.78	6.53	5.56	6.60	5.99
Prairie sandreed (ND-95)	10.46	7.72	6.07	4.96	6.23	5.50
Switchgrass (Dacotah)	8.31	5.17	4.17	2.83	3.27	2.29
Switchgrass (Forestburg)	11.16	6.74	4.95	4.20	3.47	2.95
Little bluestem (Camper)	8.94	6.25	5.22	4.41	4.43	4.25
Indiangrass (Holt)	11.05	6.42	5.58	4.88	5.13	5.03
Indiangrass (Tomahawk)	11.10	7.18	5.99	4.67	5.08	3.34
Average for all cultivars	10.35	7.03	5.76	4.69	5.12	4.51

Summary

It appears that forage production and nutrient content will differ between some of these warm-season grasses and even between cultivars of the same species. Grasses such as Prairie sandreed and Blue grama were able to maintain relatively high levels of crude protein throughout the growing season. However, grasses that produced the most biomass (i.e. Switchgrass) had the lower levels of crude protein. Phenological developmental differences between cultivars of big bluestem indicated an effect of morphology on nutritional characteristics. The least matured plants were most nutritious. A full report will be published at a later date showing mineral and statistical analysis for crude protein, ADF, and NDF among all grass species and cultivars.

Literature Cited

AOAC. 1990. Official Methods of Analysis (15th ed.). Association of Official Analytical Chemists, Arlington, VA.

Bavendick, F.J. 1952. Climate and weather in North Dakota. U.S. Weather Bureau Office, Bismarck.

Bismarck Plant Materials Center. 1992. Warm-season grass field evaluation plantings: Technical report.

Jensen, R.E. 1972. Climate of North Dakota. N.D. National Weather Serv., North Dakota State Univ., Fargo.

Nutrient Requirements of Beef Cattle. 1996. Nutrient requirements of beef cattle (7th ed.). Nat. Acad. of Sciences--NRC, Washington D.C.

Ricketts, M. 1994. Cutting ranching costs: Optimizing forage protein value. Rangelands. 16(6):260-264.

Robertson, J.B. and P.J. Van Soest. 1981. The detergent system of analysis and its application to human foods. In: W.P.T. James and O. Theander (Ed.). The Analysis of Dietary Fiber. P. 138. Marcell Dekker, New York.

Statistical Procedures for Social Sciences. 1994. Statistical Procedures for Social Science. Marketing Department. SPSS Inc. Chicago, Ill.

Tober, D.A. and A.D. Chamrad. 1992. Warm-season grasses in the Northern Great Plains. Rangelands. 14(4):227-230.

Ulmer, M.G. and Conta J.F. 1987. Soil Survey of Adams County,North Dakota. U.S.D.A., Natural Resource Conservation Service, Bismarck, ND.

Vallentine, J.F. 1990. Grazing Management. Aca. Press, Inc. San Diego, CA.