FORAGE INTAKE AND DIGESTIBILITY OF STEERS
GRAZING BURNED AND NONBURNED
FLINT HILLS NATIVE RANGE

by

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GENERAL INTRODUCTION

Cattle producers in the Flint Hills region of Kansas typically practice late spring burning of native range pastures. This practice has been shown to improve range condition and result in consistently greater steer weight gains over the summer grazing period. Information on the reasons for improved gains is limited. Some work has suggested burning improves nutrient content and digestibility, resulting in greater animal performance. This improved nutritional value of burned forage has not been consistent, however. This study was undertaken to examine the effect of burning on forage intake and digestibility as possible explanations of improved gain.

LITERATURE REVIEW

Effect of spring burning on Flint Hills native range

Kansas Flint Hills native vegetation is classified as true prairie. Big bluestem (Andropogon gerardi), little bluestem (Andropogon scoparius) and indiangrass (Sorghastrum nutans) predominate with lesser amounts of switchgrass (Panicum virgatum) and sideoats grama (Bouteloua curtipendula) also present (Anderson and Fly, 1955). Fire was likely the most important controlling factor in the development of this grassland climax (Sauer, 1950). Fire favors grassland by killing or suppressing species with growing points above ground (Anderson et al., 1970).

Many studies show that spring burning of Flint Hills native range can increase desirable warm season grasses while decreasing cool season grasses. McMurphy and Anderson (1965), in a trial comparing early, mid, and late spring burning to nonburned range, found mid and late spring burning resulted in an increase in big bluestem and a decrease in Kentucky bluegrass (Poa pratensis). Late spring burning also helped control Japanese brome (Bromus japonicus) and buckbrush (Symphoricarpos orbiculatus). The unburned pasture had an increase in bluegrass and brome which resulted in a decreased range condition rating. Owensby and Anderson

(1967) found that weed yields were significantly lowered by late spring burning. Anderson et al. (1970) showed an increase in perennial forbes in nonburned range as compared to late spring burning. Some increase in shrubby species occured on late spring burned range. The primary increase came from leadplant (Amorpha canescens) and smooth sumac (Rhus glabra) (McMurphy and Anderson, 1965; Owensby and Anderson, 1967; Anderson et al., 1970)

Forage yield of Flint Hills range was generally not affected by late spring burning. Owensby and Anderson (1967), and Anderson et al. (1970) found that late spring burning did not significantly reduce forage production over nonburned range. Early and mid spring burning did reduce forage yield (Anderson et al., 1970). McMurphy and Anderson (1965) indicated a long term trend of unburned range producing greatest yields and early spring burned producing the least. Decreases in production were attributed to decreased soil moisture (McMurphy and Anderson, 1965; Anderson et al., 1970). In high moisture areas, removing excess herbaceous litter by burning can sometimes increase yield (Owensby and Anderson, 1967).

Spring burning increases the quality of the available forage (Anderson et al., 1970; Smith and Young, 1959; Smith et al., 1960). Smith and Young (1959) found clipped samples of little bluestem to be higher in crude protein on burned pasture than on unburned. Burning increased digestibility of dry matter and of crude fiber in a study done by Smith *et al.* (1960). Rao *et al.* (1973) reported no significant difference in crude protein due to burning.

The economic advantage of late spring burning of Flint Hills true prairie is improved animal performance. Cattle gain more on burned range than nonburned (Anderson *et al.*, 1970; McMurphy and Anderson, 1965). Rao *et al.* (1973) reported steers grazing burned bluestem pastures gained 600 g/day compared to 350 g/day gains for steers on nonburned bluestem. In a 16 year study by Anderson *et al.* (1970), steers averaged 26 pounds more gain during a 5 month summer grazing period on late spring burned range as compared to unburned. Most of the improved performance occured during the early part of the grazing season. Anderson suggested that the higher gains for burned range might be due to increased nutritive value of the plants and/or increased palatability of the burned range.

Factors influencing voluntary intake

Voluntary food intake is the most important factor determining the total energy consumption by ruminants (Montgomery and Baumgardt, 1965), with capacity of the body cavity perhaps the most significant anatomical barrier to feed intake (Conrad, 1966). Campling and Balch (1961) reported that removal of swallowed food through a fistula induced cows to eat more while water-filled bladders placed in the rumen decreased intake. Body condition and pregnancy have also been shown to reduce the space for feed, thereby reducing feed intake (Conrad, 1966).

The effect of body capacity on forage intake is related to digestibility of the forage. In a study with lactating dairy cows, Conrad et al. (1964) found that with forage of low digestibility (52-66%), intake increased as digestibility increased. Voluntary intake was regulated by roughage capacity, rate of passage, and dry matter digestibility (DMD). For roughage of 67-80% DMD, intake decreased with increasing digestibility. At the higher digestibility intake was related to metabolic size and production.

Montgomery and Baumgardt (1965) reported that voluntary intake is related to the amount of digesta in the reticulo-rumen which is a function of rate of digestion and rate of passage. Voluntary consumption of a forage is limited primarily by the rate of digestion of its cellulose and hemicellulose rather than by the contained nutrients or the completeness of their utilization (Crampton, 1957; Fontenot and Blaser, 1965; Van Soest, 1965). Blaxter et al.

(1961) reported for mature wethers in metabolic crates, the rate of passage was slowest for poor quality hay and fastest for high quality hay. The estimated dry matter content of the digestive tracts was the same for all three fodder qualities, suggesting that the forage intake of sheep is determined by gut capacity.

At higher DMD, factors other than body capacity play a role in regulating voluntary intake. Other possible regulating factors may be thermostatic or chemostatic. Energy intake decreases slightly with increased environmental temperature. At a critical temperature, intake declines too low to sustain normal production (Conrad, 1966). Heat production may be a common denominator in thermostatic intake regulation. Montgomery and Baumgardt (1965) reported that Holstein heifers fed four different rations of alfalfa meal and corn decreased intake as the amount of corn in the ration increased, but found no significant differences in calculated heat increment. In other work, cooling preoptic areas of the hypothalamus increased intake in goats while warming other areas stopped eating (Conrad, 1966).

Chemostatic regulation of intake may occur on highly digestible diets through monitoring of volatile fatty acids. Acetic acid, propionic acid and sodium acetate decreased feed intake when added to the rumen at 12.5% of the caloric value of maintenance (Conrad, 1966). For lactating dairy cows, Dowden and Jacobsen (1960) found intravenous injection of acetic acid and sodium acetate decreased intake significantly, while other volatile fatty acids had no effect.

It is evident that regulation of voluntary feed intake is a complex process involving many variables. It is necessary to examine each situation to determine which factors are most important under the conditions to be studied.

Influence of selective grazing on diet quality and intake

Selective grazing is a critical problem in determining the amount and character of forage consumed by grazing animals (Weir *et al.*, 1959). Numerous studies have shown that given an opportunity for selection, animals will choose forage of a higher quality than the overall quality of forage available (Arnold, 1960; Weir and Torell, 1959; Lesperance *et al.*, 1960; Rao *et al.*, 1973; Weir *et al.* 1959). Weir and Torell (1959) found that esophageally fistulated sheep selected a diet 4.1% higher in crude protein and 3.5% lower in crude fiber than samples obtained by hand clipping. In a summary of 4 trials, Lesperance *et al.* (1960) found no agreement between the composition of fistula samples and samples harvested beneath cages the same day. He suggested that the chance for error is large with hand clipped samples. Rao et al. (1973) found forage samples collected with esophageally fistulated steers were higher in ash and crude protein while lower in crude fiber, nitrogen free extract, and acid detergent fiber than hand clipped samples. Esophageal fistula samples were also higher in in vitro dry matter digestibility and organic matter digestibility (Rao, 1972). Fistula samples were consistently higher in ash (Weir et al., 1959; Rao et al., 1973; Jefferies and Rice, 1969; Smith et al., 1959; Edelefsen et al., 1960). This is explained by salivary contamination and possibly ingestion of soil (Edelefsen et al., 1960). Ridley et al. (1963) found lignin to be 2 times higher in fistula samples than in hand clipped, but this could have been artifact lignin due to drying at high temperatures (Van Dyne and Torell, 1964). Smith et al. (1959) compared plot clipping to hand plucking by following steers. Hand plucked samples were higher in crude protein, ether extract, and ash while lower in crude fiber and nitrogen free extract than samples from clipped plots. Hand plucked samples may be adequate if one is careful to select forage similar to that being grazed and thereby avoid the salivary contamination of fistula samples (Edelefsen et al., 1960).

Selectivity in grazing depends on the opportunity for choice and the availability of forage. No significant differences were found in chemical composition of fistula samples and clipped samples when sheep were grazing previously grazed pasture (Weir and Torell, 1959). Arnold (1960) found little selectivity occurred when sheep grazed young, leafy alfalfa, but as herbage available increased in age and maturity, selectivity became more pronounced. Jefferies et al. (1969) reported no difference in crude protein between fistula and clipped samples in a dry year, but in a year with abundant early moisture, protein was higher in fistula samples due to the selection of annual forbs. In a study by Edelefsen et al. (1960), sheep grazing mixed stands of forage were able to maintain a more constant nutritional level in their diet than those grazing pure stands due to shifting grazing pressure from species to species. Blaser et al. (1960) felt the decreased selective grazing on heavily stocked pastures was due to decreased forage availability.

Forage availability may also influence the amount of dry matter consumed. As forage becomes sparse, animals spend more time grazing and intake decreases (Allden and Whittaker, 1970; Donnelly et al., 1974). Arnold and Dudzinski (1967) reported that 40% of the variability in digestible organic matter intake of grazing sheep was accounted for by total dry matter available per acre. Allden and Whittaker (1970) felt there was little relation between herbage yield and intake. They found rate of intake by grazing sheep to be closely associated with plant height. The size of bite increased with an increase in herbage height, while rate of biting decreased. Above 7.7 cm, size and rate of biting varied inversely to maintain a constant intake level. Heady and Torell (1959) stated that there was no basis for the conclusion that plant height affected selection on an ungrazed plot. They found a strong preference for species at certain times of the year, but felt where forage is scarce and plants tall, height may be a factor in preference.

Influence of plant maturity on diet quality and intake

As a plant matures, its chemical constituents change, resulting in a decline in forage quality. Most reseach indicates that forage quality is highest in early spring growth, with a steady decrease over the grazing season (Cook and Stoddart, 1961; Raleigh, 1970; Woolfolk et al., 1975; Streeter et al., 1974; Jefferies and Rice, 1969; Rosiere et al., 1975). This lowered quality was indicated by decreased protein and increased cellulose and lignin. A decline in digestibility of components usually accompanied increased maturity.

Cogswell and Kamstra (1976), studying four native range species, found that maturity was accompanied by a decrease in dry matter digestibility and protein, and by an increase in fiberous fractions and lignin. Crude protein decreased 6.8 percentage points (from 11.0 to 4.2%) during the period June through September while acid detergent fiber (ADF) increased from 33.1% to 42.3% during the same period. Cool season grasses responded to maturity similarly to warm season species.

Allen *et al.* (1976),studied the change in chemical composition of big and little bluestem in Kansas True Prairie from May through November. Dry matter increased from 22.5 to 75.0% during the period. On a dry matter basis, protein declined 14.8 percentage points (17.7% to 2.9%), crude fiber increased 9 points (25.9% to 34.9%), and lignin increased 3.8 points (4.7% to 8.5%).

Rao *et al.* (1973, 1974) also studied bluestem pasture. In one study, he found dry matter digestibility decreased from 50 to 41% between June and October. During this period lignin, cellulose, and ADF increased (Rao *et al.*, 1973). In the second study, hay was harvested at three stages of maturity, in June, July, and September. Dry matter digestibility decreased from 65% to 52% with increasing maturity. Digestibility coefficients of crude fiber, nitrogen free extract, neutral detergent fiber, hemicellulose, and cellulose also declined from June to September (Rao _et al._, 1974).

Consumption of forage was greater for immature forage than for mature forage. Holloway _et al._ (1979), compared dry matter intake for lactating beef cows grazing tall fescue. Cows on high quality fescue, kept immature by frequent clipping, consumed 1.7 kg/day more dry matter and 1.3 kg/day more digestible dry matter than cows grazing mature fescue. Steers fed hay of three levels of maturity had dry matter and organic matter intakes of 5.7 and 5.3 kg/day for early cut hay, while for late cut hay intake was 4.2 and 3.8 kg/day (Rao _et al._, 1974). Streeter _et al._ (1974) reported dry matter consumption for lactating cows declined 4.4 kg/day from mid June to mid October.

Determination of voluntary forage intake by grazing steers

In a grazing situation, voluntary consumption of forage cannot be measured directly. Indirect estimation of intake is accomplished by the relationship:

$$\text{herbage intake (g DM/day)} = \frac{\text{fecal output (g DM/day)}}{\text{indigestibility of DM (\%)}}$$

(Smith and Reid, 1955)

Daily fecal output can be measured through total collection. It requires a large input of time and may not be practical under grazing situation. Collection bags may alter normal grazing behavior (Hardison and Reid, 1953) or cause a reduction in live weight gains (Cordova et al., 1978).

Indirect estimation of fecal output can be accomplished with the use of indigestible external indicators and the following relationship.

$$\text{fecal output (g DM/day)} = \frac{\text{external indicator consumed (g/day)}}{\text{external indicator conc. of feces (g/g DM)}}$$

(Smith and Reid, 1955)

The most frequently used external indicator has been chromic oxide. A problem arises with sampling because of the diurnal excretion pattern for chromic oxide (Lambourne, 1957; Putnam et al., 1958; Nelson and Green, 1969; Hopper et al., 1978). Several workers have reported that twice daily fecal grab samples taken on a 12 hour or 9 and 18 hour basis and pooled daily gave unbiased estimates of fecal chromic oxide excretion (Lambourne, 1957; Hardison and Reid, 1953; Putnam et al., 1958; Hopper et al., 1978). Smith and Reid (1955) reported recovery rates of 97.5 to 101.2% when chromic oxide was administered and fecal samples taken at 6:00 am and 4:00 pm for seven consecutive days. Administration of the indicator impregnated in shredded paper gave no better recovery than other methods (Kiesling et al., 1969). Frequency of adminstration of chromic oxide has been shown to reduce the diurnal variation in excretion to the point that if equal boluses were given six times a day, representative fecal samples could be taked at any time (Hardison *et al.*, 1956). Lambourne (1963) reported estimated feces output of 102% over five to seven days when dosing Merino wethers two times a day.

The accuracy of the estimated intake increases at a decreasing rate as the number of days during which feces is collected increases (Smith and Reid, 1955). A collection period of seven days was typical for many studies but successful estimates have been reported for periods ranging from three to eleven days (Smith and Reid, 1955; Holechek *et al.*, 1982; Nelson and Green, 1969; Elam *et al.*, 1962; Hardison and Reid, 1953). Reid *et al.* (1952) reported that the results of a four day fecal collection period were comparable to those of a seven to ten day period and the shorted period minimized the effects of changing forage composition.

The per cent dry matter indigestibility of a forage (100-% digestibility) may be determined by one of several methods: ratio technique, fecal index, *in vitro* dry matter digestibility, or summative equation.

The ratio technique involves the use of an indigestible indicator naturally present in the forage. Dry matter digestibility is calculated from the ratio of grams of indicator present in the forage to grams present in the feces. Internal indicators used most often have been lignin, chromogen and silica.

Lignin has been used with variable success. Several investigators have reported apparent digestibility of lignin of up to 47.5%, particularly in immature forages (Lopez-Trujillo *et al.*, 1976; Streeter, 1969; Ridley *et al.*, 1963; Hill *et al.*, 1961; Cordova *et al.*, 1978). Part of this may be due to artifact lignin in esophageally collected forage samples dried at high temperatures (Cordova *et al.*, 1978; Van Dyne and Torell, 1964; Streeter, 1969). Chromogens have had some success, particularly with immature forage (Connor *et al.*, 1963). Ridley *et al.* (1963) found chromogen the only satisfactory indicator when studying rumen fistulated and intact cattle grazing tall fescue and orchardgrass. Cordova *et al.* (1978) suggested that each investigator must find the appropriate wavelength to use for chromogen determination in a given situation. The use of silica has been limited due to contamination problems from ingested soil (Streeter, 1969). Block *et al.* (1981) found acid insoluble ash was an acceptable natural marker for digestibility in limit-feeding situations, but variable recovery made it unreliable for *ad libitum* feeding. In general, the validity of ratio techniques depends on getting a representative forage and feces sample.

The use of fecal indeces first requires a conventional digestion trial to develop regression equations relating digestibility to fecal concentration of the indicators of interest. This necessitates use of clipped forage which many studies have shown to be often dissimilar to grazed forage (Arnold, 1960; Weir et al., 1959; Lesperance et al., 1960; Rao, 1972; Edelefsen et al., 1960). Fecal regression equations must be determined for the specific forage and time of year to be studied (Rosiere et al., 1980; Holechek et al., 1982; Streeter, 1969). Rao et al. (1975) found a fecal nitrogen-organic matter regression equation to provide valid estimates of in vivo organic matter digestion and intake. In other trials, error with fecal nitrogen index has been so large as to be useless except to detect very large intake differences (Cordova et al., 1978). Holechek et al. (1982) stated that fecal indeces are valuable especially when relative differences rather than absolute values are concerned.

Van Soest's (1967) summative equation is based on relating a forage's digestibility to its cell contents and cell walls. Forage samples are analyzed for neutral detergent fiber, acid detergent fiber and acid detergent lignin. Digestible organic matter (%) is calculated from an equation relating the three factors.

Several *in vitro* techniques have been used to estimate digestibility. Tilley and Terry (1963) two-stage procedure is simple and large numbers of samples can be analyzed quickly. Good agreement was obtained for Tilley and Terry *in vitro* and Van Soest *in vitro* cell wall digestibility (Wilson *et al.*, 1971). Gill *et al.* (1969) found relative rate of *in vitro* cellulose digestion to be a promising method for estimating digestibility of forages with a single species forage. *In vitro* digestibility was most reliable when innoculum was from the same animal providing the forage sample or from a steer fed "standard" grass hay (Streeter *et al.*, 1971). The major problem with *in vitro* procedures is that no allowance is made for individual animal variation (Rosiere *et al.*, 1980).

Wilson *et al.* (1971) reported that for sheep grazing forage of at least 60% digestibility there was good agreement between lignin ratio, two-stage *in vitro*, *in vitro* digestibility of cell walls, summative equation and fecal nitrogen index. For browse (40-60% digestibility), lignin ratio gave consistently low values while fecal nitrogen was repeatedly high. Rao *et al.* (1975) found that for steers fed native Flint Hills hay, fecal nitrogen-organic matter equation and Tilley and Terry two-stage *in vitro* digestibility provide valid estimates of *in vivo* organic matter digestibility and intake while lignin ratio was a poor indicator.

Near infrared reflectance spectroscopy is a technique showing promise to be a fast, easy way to evaluate forage quality and intake (Holechek *et al.*, 1982b). Holechek *et al.* (1982a) reported specific prediction equations developed for specific forage gave results comparable to conventional laboratory procedures for crude protein and *in vitro* dry matter digestibility. Accurate prediction depends on wavelength selection, the prediction equation developed, and proper calibration and data processing.

More extensive reviews of techniques to evaluate forage digestibility and intake are found elsewhere (Holechek *et al.*, 1982; Kartchner and Campbell, 1979; Wilson *et al.*, 1971; Streeter, 1969).

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FORAGE INTAKE AND DIGESTIBILITY FOR STEERS GRAZING BURNED AND NONBURNED FLINT HILLS NATIVE RANGE

SUMMARY

During the summer of 1981, one annually burned and one nonburned pasture were stocked at 1.3 hectares per steer from May 1 to September 30 to study the effect of burning on steer gains, forage digestibility and forage intake. The 31 cattle were weighed monthly and intake was estimated for 10 steers in each pasture for three periods: early June, mid July, and late August. Steers consisted of primarily Hereford and Angus, with average initial weight of 236 kg. Intake was estimated using chromic oxide as an external marker and *in vitro* dry matter digestibility as an estimator of forage digestibilty.

Steers grazing burned range gained more than those grazing nonburned range (110.2 vs 95.0 kg). Forage analysis suggested a higher crude protein and lower crude fiber for burned range, and higher digestibility for nonburned range. Apparent digestibility coefficients were not consistent. Estimated forage dry matter intake was higher for steers grazing nonburned range for all three sampling periods (8.3 vs 9.9, 11.0 vs 12.6, 9.4 vs 11.7). Forage analysis and calculated intakes were based on single composite samples per

pasture per sampling period.

INTRODUCTION

Spring burning of native range pastures has been a common practice in the Flint Hills region for many years. Properly timed burning has been shown to increase populations of desirable forage species, while reducing many "weed" species and brush (McMurphy and Anderson, 1965; Anderson _et al._, 1970; Owensby and Anderson, 1967). In addition weight gains have been consistantly greater for animals grazing burned range than for those grazing nonburned range (Smith _et al._, 1981; Rao _et al._, 1973; McMurphy and Anderson, 1965; Anderson _et al._, 1970). The basis for this improved performance has typically been attributed to increased nutrient content and digestibility of forage from burned range, but this increase has not been consistent (Smith _et al._, 1960; Rao _et al._, 1973; Smith and Young, 1959). This study was intended to examine the digestibility and dry matter intake of steers grazing burned and nonburned Flint Hills native range as possible explanations of performance differences.

MATERIALS AND METHODS

During the summer of 1981, 31 steers, primarily Hereford and Angus, were used to study the effect of long term annual burning of native range compared to non-burned range on steer gains, forage digestibility, and forage intake. Steers were maintained from May 1 to Sept. 30 on native Kansas tallgrass prairie consisting of big bluestem (*Andropogon gerardi*) and little bluestem (*Andropogon scoparius*) as the dominant warm season grasses with indiangrass (*Sorghastrum nutans*) and sideoats grama (*Bouteloua curtipendula*) as secondary species. Steers were randomly allotted to either one annually late spring burned pasture or to one pasture which had remained unburned for 32 years. The stocking rate for each pasture was 1.3 hectares per steer. Each pasture was provided salt free choice.

Forage intake of 10 steers in each treatment was measured using chromic oxide as an external indicator (Lambourne, 1957; Smith and Reid, 1955; Reid *et al.*, 1952). Intake was measured three times during the summer: early June, mid July, and late August. Chromic oxide (20g per head per day) was administered in gelatin capsules two times each day between 0730 and 0900 and between 1530 and 1700 for 5 days prior to and for the first 4 days of a 5 day collecting period. Rectal grab samples were taken twice a day at the same time during the last 5 days. The initial 5 day period was necessary for the chromic oxide to be distributed uniformly throughout the digestive tract. Fecal samples from each steer were stored frozen; dried at 55 C in a forced air oven; and ground in a Wiley mill (1 mm screen). Equal amounts were composited for the five day collection period for each steer. Crude protein, crude fiber, ether extract, ash (AOAC, 1975) and chromium (ppm) were determined for each sample.

During each collection period, range forage samples were obtained with an esophageally fistulated steer. The esophageally collected samples were dried in a forced air oven at 55 C, then ground in a Wiley mill (1 mm screen). *In vitro* dry matter disappearance (IVDMD; Tilley and Terry, 1963) was determined for each forage sample. Innocula for the *in vitro* procedure was obtained from a Jersey cow maintained on alfalfa hay and grain. Crude protein, crude fiber, ether extract, and ash (AOAC, 1975) were determined.

Range forage consumption was determined as follows:

1) $\text{g fecal dry matter/day} = \dfrac{\text{chromic oxide consumed (g/day)}}{\text{chromic oxide conc. (g/g DM)}}$

2) %total forage indigestibility = 100 - % IVDMD;

3) $\text{g forage DM intake/day} = \dfrac{\text{fecal dry matter/day (g)}}{\text{Indigestiblity of dry matter(\%)}}$

$$4)\ \text{digest. coefficient } (\%) = \frac{\text{nutrient in feed}}{\text{nutrient in feces}} \times (\%\ \text{indig.})$$

Data was analyzed by the SAS General Linear Model procedure (Barr _et al._,1976).

RESULTS AND DISCUSSION

The mean steer weight gains (kg) for each month and season-long are shown in Table 1. There was no significant difference (P=.88) between pastures in initial steer weights. Steers grazing burned range gained more season-long ($P<.05$) and every month ($P<.10$) except August and September. This is in agreement with previous studies indicating while most of the improvement in steer gains comes in the first part of the grazing season, burned pasture typically has greater season-long gains (Anderson et al., 1970; Rao et al., 1973; Owensby and Smith, 1979; Smith et al., 1981). Steers grazing nonburned range did gain significantly more ($P<.01$) than those on burned range for September. Since nonburned pastures generally have greater populations of cool season species (McMurphy and Anderson, 1965; Anderson et al., 1979; Owensby and Anderson, 1967), this greater gain may have been due to an increase in cool season forage with cooler weather and more precipitation.

Monthly forage quality is shown in Table 2. Only one composite forage sample was collected and analyzed each sampling period due to problems with the esophageally fistulated steer so no statistical comparisons can be made. It appears crude protein (CP) was higher in the first part of the season which is consistent with other studies (Smith and Young, 1959; Woolfolk et al., 1975; Allen et al., 1976), although it does not always occur (Rao et al., 1973; Smith et al., 1960). The values were higher than other work, but possibly this might have been due to the unusually wet summer causing the grass to stay vegetative longer. Crude fiber (CF) values were comparible to values reported elsewhere (Rao et al., 1973; Smith et al., 1960), but did not appear to be lowered by burning as has been reported (Smith et al., 1960) except in August. Ether extract (EE) and nitrogen-free extract (NFE) levels were similar to other work with Flint Hills range but no trends were evident. Work reported by Allen et al. (1976) and Smith et al. (1960) suggest that spring burning may increase EE and NFE levels in bluestem range. Ash values for the forage samples were a little high but that is typical for esophageal collection due to salivary contamination (Rao et al., 1973; Weir et al., 1959; Jefferies and Rice, 1969). More typical values for clipped or plucked range forage are 7-10% (Rao et al., 1974; Smith et al., 1960).

Calculated digestibility coefficients and Tilley and Terry (1963) two-stage in vitro dry matter digestibilities are reported in Table 3. While there was a tendency for CP digestibility to be greater for burned range, it was not a clear cut improvement. This is similar to the work reported by Smith et al. (1960) which showed a significant ($P<.05$) increase in protein digestibilities for burned pasture in only one year out of four. Crude fiber digestibility was significantly ($P<.05$) different all three months with burned range tending to have less digestible fiber. This differs from earlier work indicating an increase in CF digestibility with burning (Smith et al., 1960). Ether extract and NFE both tended to be less digestible for burned range than nonburned. This too disagreed with digestibility values for burned and nonburned range reported by Smith et al. (1960). *In vitro* dry matter digestibility (IVDMD) appeared lower for burned range all three months but no statistical significance could be determined due to the use of single composite forage samples. The values for IVDMD appeared comparable but slightly lower than dry matter digestibilities reported by others for Flint Hills native range and hay (Smith et al., 1960; Woolfolk et al., 1974). Crude fiber and protein digestibilities were similar to previous work while NFE and EE tended to be lower (Rao et al., 1974; Smith et al., 1960). Since calculation of individual nutrient digestibility coefficients depended on dry matter indigestibility, low IVDMD values would have resulted in lowering of all the digestion coefficients. No clear pattern was evident for season-long changes in digestibility, but it appeared that, regardless of treatment, digestibility of nutrients increased from June to July, then dropped to an overall low in August, suggesting maturation of the forage (Cook and Stoddart, 1961; Cogswell and Kamstra, 1976).

Forage dry matter intakes are shown in Table 4. Dry matter intake on burned range was significantly different ($P<.01$) from nonburned for all three periods, with steers grazing burned range consuming less than those on nonburned range. This is inconsistent with the higher gains and lower IVDMD for steers on burned range for each of the sampled periods. It is not reasonable that steers grazing burned range would eat less of a lower digestibility forage and yet gain more than comparable steers on nonburned range. Since the intake values and digestibilities are all functions of the IVDMD values, it would appear that the forage samples may not have been representative of what the steers actually consumed, or that the IVDMD procedure did not accurately reflect _in vivo_ digestiblity.

Since only one composite forage sample from each pasture was analyzed each period, it is quite possible that the samples may not have represented the actual forage consumed by the test steers. Rosiere _et al._ (1975) reported ten animals were needed to sample forage adequately for cattle grazing semi-desert range. Lesperance *et al.* (1960) stated that at least four samples were necessary to calculate protein for one day. In a review of the use of esophageally fistulated animals for forage collection, Van Dyne and Torell (1964) reported sampling on four or more consecutive days was more effective in adequately sampling grazed forage. In addition, while fasting the fistulated animals prior to sampling reduced contamination from regurgitation, it also decreased selectivity. Also, maintaining the fistulated animals in the test pastures with the unfistulated cattle allowed them to develop similar grazing patterns and collect a more representative forage sample. It was noted in this study that for at least the July samples, the fistulated steer refused to graze with the others steers and preferred forbs to grass.

In addition to the possibility of poorly representative forage samples, the *in vitro* dry matter digestibility values may not have accurately reflected the *in vivo* forage digestion. Rosiere *et al.* (1980) stated that while chromic oxide may estimate fecal output well, poor digestibility estimates from *in vitro* procedures may result in poor intake estimates. *In vitro* techniques do not allow for individual animal variation in digestibility due to level of intake, rate of passage, and physiological conditions.

In conclusion, steers grazing burned range gained significantly more ($P<.05$) than those grazing nonburned range as indicated in many previous studies. Greater forage intake and digestibility values for nonburned range than for burned were inconsistent with animal performance. The most likely sources of the discrepancy are nonrepresentative forage sampling and failure of _in vitro_ digestiblity to accurately predict _in vivo_ digestion.

Steers gained 110.2 and 95.0 kg for burned and nonburned range over the entire five month grazing season. Forage dry matter intake ranged from 2.7 to 4.3% of body weight with the highest intake occurring in July corresponding to the greatest forage digestibility and quality.

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Table 1. Weight Gains (kg) for Steers Grazing Burned or Nonburned Flint Hills Range

Period	Burned	Nonburned	P<
Initial Wt.	236	237	.88
May	33.1	26.4	.08
June	25.3	19.0	.07
July	18.1	7.6	.01
August	33.5	28.4	.14
September	0.2	13.7	.01
Season-long	110.2	95.0	.05

Table 2. Proximate Analysis of Burned and Nonburned Flint Hills Native Range

	June		July		August	
	Burn	Nonburn	Burn	Nonburn	Burn	Nonburn
CP	12.8	10.9	17.1	12.8	10.0	10.2
CF	28.9	30.7	20.5	14.0	33.6	40.5
EE	2.4	2.9	2.4	3.3	2.4	1.9
NFE	44.5	47.0	45.9	58.1	41.5	31.2
Ash	11.4	8.5	14.1	11.8	12.5	9.9

Table 3. Digestion Coefficients and *In Vitro* Digestibility of Burned and Nonburned Flint Hills Native Range

	June		July		August	
	Burn	Nonburn	Burn	Nonburn	Burn	Nonburn
CP	44.6	41.8 NS	64.3	62.8 NS	32.0	42.2 *
CF	56.7	63.1 *	47.1	36.4 *	62.4	73.8 *
EE	8.4	19.0 *	2.6	45.1 *	16.4	22.8 *
NFE	54.2	59.3 NS	57.8	72.6 *	49.3	32.8 *
IVDMD	47.8	49.7	51.6	59.7	45.8	51.6

*starred pairs are significantly different ($P<.05$)

Table 4. Forage Dry Matter Intake of Steers Grazing Burned or Nonburned Flint Hills Range
kg dry matter/day (per cent of body wt.)

Period	Burned	Nonburned	P<
June	8.3 (2.9)	9.9 (3.7)	.01
July	11.0 (3.5)	12.6 (4.3)	.01
August	9.4 (2.7)	11.7 (3.7)	.01

APPENDIX

Steer fecal data.

Burned
June

% Ash	% CP	% EE	% CF	% NFE	ppm Cr
20.030	13.681	4.179	23.635	38.475	4063.195
18.785	14.402	4.092	23.633	39.088	5845.613
19.978	12.444	4.061	24.780	38.737	3902.164
18.719	13.874	3.216	24.282	39.910	5213.118
19.677	14.072	4.054	22.892	39.305	3641.610
17.619	13.228	4.292	25.545	39.315	4790.498
20.727	14.479	4.402	22.788	37.604	7465.832
18.877	13.474	4.197	22.385	41.067	4123.983
17.486	12.959	4.468	26.396	38.690	4602.086
19.583	13.283	5.020	23.542	38.573	4524.212

July

% Ash	% CP	% EE	% CF	% NFE	ppm Cr
20.686	13.101	5.051	22.862	38.300	3250.157
20.371	12.839	5.612	21.626	39.552	4326.942
20.861	12.695	4.814	21.410	40.220	3173.898
20.092	12.574	4.674	22.855	39.805	3752.758
21.420	12.985	4.782	23.200	37.613	3600.858
19.145	12.455	4.637	23.803	39.960	3802.518
21.311	12.808	5.214	21.516	39.150	4553.953
19.162	12.512	4.262	22.618	41.446	4745.389
19.074	12.353	4.550	21.457	42.566	3598.620
19.265	11.670	4.633	22.666	41.765	3444.243

August

% Ash	% CP	% EE	% CF	% NFE	ppm Cr
22.056	11.850	3.479	23.118	39.497	3489.132
22.285	13.365	3.740	23.289	37.321	4894.398
23.353	10.753	3.512	23.429	38.953	3594.246
21.519	12.914	3.739	22.796	39.032	4797.863
21.369	12.878	4.067	22.815	38.871	3592.912
20.906	12.569	4.286	22.655	39.584	4273.695
21.322	13.339	4.033	23.500	37.806	4223.427
20.811	13.403	3.855	24.586	37.345	3700.495
21.286	11.650	3.546	23.573	39.945	3257.710
20.923	12.493	2.815	23.593	40.176	3934.595

Steer fecal data, cont.

Nonburned
June

% Ash	% CP	% EE	% CF	% NFE	ppm Cr
22.738	14.193	4.622	21.494	36.953	5185.199
17.704	11.205	4.095	20.753	46.244	2761.753
22.246	11.812	4.088	23.251	38.603	4448.390
19.611	12.994	4.581	24.330	38.484	3536.086
22.857	12.617	5.054	23.870	35.603	3940.004
23.010	12.578	4.902	21.978	37.532	4713.969
21.129	12.905	4.716	22.738	38.512	4306.178
23.755	13.247	4.967	20.988	37.023	3613.560
22.457	12.349	4.525	22.975	37.693	4270.386
25.826	12.292	5.143	23.078	33.661	4495.645

July

21.981	12.206	4.197	23.843	37.773	4507.718
21.494	12.471	4.352	25.705	35.979	3885.401
21.267	11.271	4.363	21.316	41.782	3454.443
20.297	12.668	5.109	20.115	41.811	4465.988
23.058	11.467	4.215	21.532	39.728	4364.793
21.949	11.276	4.600	22.519	39.657	4419.421
22.137	11.247	4.415	20.934	41.267	3754.630
24.700	11.217	4.330	21.283	38.470	3120.212
21.766	12.115	4.591	22.593	38.935	4192.994
22.404	12.254	4.693	21.059	39.590	4038.132

August

19.961	11.958	2.228	24.590	46.724	3547.372
20.624	12.144	2.343	23.182	41.689	2688.973
17.362	11.452	2.331	24.201	44.654	3784.170
20.353	13.234	3.174	21.805	41.434	3844.705
22.073	12.062	3.189	21.068	41.608	3785.888
21.500	12.316	3.364	20.113	42.707	4243.119
19.616	11.067	3.057	22.131	44.129	3364.235
19.577	11.951	3.045	21.796	43.631	3334.645
20.372	13.488	3.940	19.844	42.356	3778.389
19.859	11.982	3.724	20.441	43.994	3485.569

Steer weights, lbs

Nonburned

Date 4/30	6/2	7/1	8/4	9/2	9/30
555	610	645	650	700	745
480	550	580	625	700	715
580	645	735	730	795	830
555	600	630	655	750	750
515	560	605	615	680	725
535	610	630	660	725	775
510	585	630	650	700	725
565	600	655	635	680	705
450	550	605	625	675	725
500	560	625	640	700	740
460	515	585	590	670	690
500	535	545	600	650	685
505	580	620	625	690	735
620	645	680	700	785	790
505	565	590	595	635	680
610	680	725	750	840	830
490	545	575	600	650	700
505	550	585	600	650	675

Burned

535	630	710	765	835	835
510	600	655	700	800	775
630	705	785	810	845	890
535	605	665	710	785	775
480	570	630	675	730	785
505	530	585	630	690	680
525	565	595	645	695	680
475	550	575	600	700	670
510	555	595	615	725	720
525	625	680	725	810	810
510	610	685	725	800	800

FORAGE INTAKE AND DIGESTIBILITY OF STEERS
GRAZING BURNED AND NONBURNED
FLINT HILLS NATIVE RANGE

by

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AN ABSTRACT OF A MASTER'S THESIS

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Thirty one steers, primarily Hereford and Angus, were used to evaluate steer gains, forage digestibility and forage intake for burned and nonburned Flint Hills native range over a 5 month summer grazing period. The stocking rate for each pasture was 1.3 hectares per steer. Both pastures were provided with salt ad libitum.

Ten steers in each pasture were used to determine forage intake using the excretion-to-indigestibility ratio with chromium oxide as an external marker and in vitro dry matter digestibility of the grazed forage. Three intake estimates were made for the grazing season: early June, mid July, and late August. Steers were weighed monthly. Forage analysis and calculated intakes were based on single composite samples per pasture per sampling period.

Steers grazing burned range gained more season-long than those grazing nonburned range (110.2 vs 95.0 kg, $P<.05$). Monthly steer gains were greater ($P<.10$)on burned range for May, June, and July. For September steers on nonburned range gained more ($P<.01$).

Forage from burned range tended to be higher in crude protein and lower in crude fiber than forage from nonburned range. Dry matter digestibility appeared greater for nonburned range for all three sample periods. Digestibility coefficients for forage components were inconsistant.

Steers grazing nonburned range had higher dry matter intakes ($P<.01$) for all three sample periods. Dry matter intake for steers grazing burned range for June, July and August were 8.3, 11.0, 9.4 kg/day, corresponding to 2.9, 3.5, 2.7 per cent of body weight. For nonburned range, steer intake was 9.9, 12.6, 11.7 kg/day, corresponding to 3.7, 4.3, 3.7 per cent of body weight.