FEEDING VALUE OF MILO STOVER FOR GROWING BEEF HEIFERS AND LAMBS

BY

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B.S., Kansas State University, 1973

A MASTER'S THESIS

Submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1976

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ACKNOWLEDGMENTS

The author wishes to extend his graditude to Dr. Keith K. Bolsen, major professor, for his assistance, stimulation and friendship throughout his graduate program. Special gratitude is also extended to Clint VanWinkle and Steve Soderlund for assistance in the author's research project.

A special memory is given for Dr. Ross Mickelsen who passed away during the author's graduate program and was on his graduate committee.

Appreciation is expressed to Dr. Jack Riley and Dr. Draytford Richardson for serving on the author's graduate committee.

This manuscript is dedicated to the author's wife, Becky and his two sons, Todd and Troy, for their patience, love and encouragement throughout his graduate program. Also, a special sincere thanks to the author's dad and late mother Mr. and Mrs. Robert B. Grimes and his father and mother-in-law, Mr. and Mrs. Robert H. Joyce for their understanding and interest in his education.

LITERATURE REVIEW

Yield and Composition of Crop Residues

Dry matter yield of harvested crop residues are influenced by several factors including: stage of maturity, climatic conditions, amount of nitrogen applied, grain variety, harvest date and grain yield.

Sorghum stover was shown to yield more dry matter when nitrogen was applied (Burleson *et al.*, 1956).

Ward (1973) reported yields for grain sorghum and corn residues at several locations in Nebraska. Two-year average yields taken October through March from all locations were 1.9 tons per acre and 2.6 tons per acre for sorghum stover and corn stover, respectively. Greater differences in yields were observed between locations than between harvest dates. Vanderlip *et al.* (1974) reported yields of 1.5 to 2.5 tons of sorghum stover per acre from early and normal harvest dates. There was no significant decreases in stover tonage between the two harvest times but, in some cases, the normal harvest date had greater yields due to plant regrowth.

Martin and Wedin (1974) reported that maximum dry matter yields of stover occurred at approximately 16 days after grain harvest.

Perry (1973) concluded that corn plant residue yields were greater than sorghum plant residues. He observed that cultural practices used could alter both yield and composition of sorghum plant residues.

Norris Farms (Havana, Illinois) in coordination with Ralston Purina Company and John Deere Manufacturing Company reported dry matter yields from 1969 to 1972 for corn stover (Wurster, 1973). Yields (tons per acre) were 2.71, 3.15, 2.52 and 3.30, respectively, for the four years. The highest yield was stover left after harvesting ear corn silage. The other three yields were following high-moisture grain harvest.

Deinum (1973) reported that immature stems are just as digestible as the leaves but digestibility of both fractions decreases with advancing maturity, the stems more so than the leaves. Vetter (1973) found that nutrient composition was affected by changes in leaf content. He reported that corn stover showed a 50% leaf loss with each 5% decrease in kernel moisture. If wind or storm damage precedes harvest, even greater leaf loss could occur, particularly in the drier plant. Martin and Wedin (1973) observed that composition of the sorghum plant residue may be influenced more by fertilization and climatic factors than corn plant residues.

Feeding Value of Crop Residues

Crop residues have been ensiled since the early 1900's. Sherman and Beckdel (1918) reported that corn stover would ferment to a product quite similar to corn silage and cattle readily consumed this stover silage, preferring it to any dry roughages. Nevens and Harshbarger (1940) produced satisfactory silage from broomcorn stover and molasses. This silage was somewhat less palatable to dairy cows than normal corn silage.

Russell and Morrison (1920) estimated the feeding value of corn stover silage at 61% of corn silage when both were fed to dairy cows.

Baker (1943) reported that steer gains from two varieties of grain sorghum stover silages equaled gains from prairie hay but were less than gains from grain sorghum silage. Morrison et al. (1956) estimated that sorghum stover silage was worth 87% as much per ton as sorghum silage in dairy cattle rations and 74% as much in beef cattle rations.

Bolsen et al. (1975) estimated that milo stover silage had a feeding value of 63 to 67% that of forage sorghum silage in rations for growing heifers.

Balwani et al. (1969) compared corn, corn stover, high-grain forage sorghum and forage-type sorghum silages in digestion trials with sheep. Apparent dry matter digestibility was 68% for corn and 50% for corn stover silages; for the grain and forage-type sorghum, 51 and 55%, respectively.

Ward (1972) reported cornstalks can be used effectively as the energy source for cows during gestation, but they must be supplemented if fed to lactating cows. Albert (1971) reported that corn stover silage met the daily energy needs of dry beef cows, but required protein, phosphorus, calcium and vitamin A supplementation. Vetter (1973) reported that phosphorus supplementation was needed if crop residues were to be a major portion of a beef cow ration. Beef cows fed cornstalks ensiled with urea consumed 13.3 lbs. of dry matter daily and gained 11.2 lbs. in a 50-day trial (Albert et al., 1967c). Those fed cornstalk silage and biuret consumed 12.0 lbs. of dry matter daily and gained 10.0 pounds.

McKee _et al_. (1975) maintained mature, dry, pregnant beef cows with a supplemented milo stover silage ration during two winters. Two groups of cows were fed either milo stover silage or forage sorghum silage to meet their daily energy requirement from the 5th month of gestation to within 3 weeks of calving (N.R.C., 1970). Weight change, condition score and calving and re-breeding performance were similar for the two groups both years. They concluded that milo stover silage's feeding value for maintenance was 85 to 90% that of forage sorghum silage.

Cornstalks ensiled with urea, biuret and soybean meal supplements were fed to gestating ewes (Albert et al., 1967b). Ewes fed the urea or biuret silage maintained their body weight, while those fed stover ensiled with soybean meal gained an average of 5.0 lbs. during the 80-day trial. Percent dry matter digestibility was 48.6, 48.4 and 50.3 respectively, for the urea, biuret and soybean meal silages. All ewes were in positive nitrogen balance. Oh _et al_. (1971) fed sheep pelleted alfalfa, cornstalks, rice straw and barley straw supplemented with urea, sulfur and phosphorus. Although pelleted cornstalks had a lower apparent dry matter digestibility than pelleted alfalfa, its calculated digestible energy value was in the N.R.C. (1968) recommended range for maintenance of mature sheep.

Bolsen and Chyba (1972) fed pregnant ewes corn silage or milo stover silage. Ewes consumed sufficient amounts of milo stover silage to meet their energy requirements during gestation (N.R.C.).

Albert et al. (1967a) fed pregnant beef heifers rations of husklage (ensiled husk and cob), stalkage (ensiled stalks and leaves) or corn silage supplemented with soybean meal and vitamin A. Average daily gain (lbs.) and dry matter digestibility (%) were: 0.73, 60.0; 0.11, 55.40 and 1.24, 65.0 for the husklage, stalkage and corn silage, respectively. Ward (1972) reported gestating heifers gained an average of 41 lbs. in 60 days on corn stalkage supplemented with corn, natural protein, vitamin A and phosphorus. Stalkage-fed heifers, hay-fed heifers, and heifers grazing cornstalks had similar calf birth weights.

Vetter et al. (1971) reported that growing beef heifers grazing cornstalks gained 1.06 lbs. per day while mature cows gained 0.88 lb. per day.

Chyba and Bolsen (1973) fed lambs: (1) forage sorghum silage, (2) milo stover silage, (3) milo stover silage ensiled with grain, (4) milo stover silage ensiled with organic acids and (5) milo stover pellets. Lambs fed forage sorghum silage or milo stover pellets gained faster, were more efficient and consumed more feed than lambs fed the three milo stover silages. None of the milo stover silages supported satisfactory lamb performance.

Bolsen et al. (1975) fed feeder lambs milo stover silage or milo stover pellets and four supplemental nitrogen sources (soybean meal, urea, biuret or corn gluten meal-soybean meal-urea) in a 50-day growing trial. Lambs fed the stover pellet rations gained faster and more efficiently than lambs fed the silage rations. Gain per unit of feed was greater for lambs receiving soybean meal or corn gluten meal-soybean meal-urea than for those receiving biuret or urea.

Colenbrander _et al_. (1971a) noted that although their fermentation patterns were similar, corn stover silage was usually less desirable than whole plant corn silage, as indicated by higher pH and titratable acidity and lower lactic acid levels. Colenbrander _et al_. (1971b) also noted that addition of increasing increments of urea, and to lesser extent ammonium polyphosphate, produced a linear increase in crude protein content of corn stover silage. Additions of urea tended to improve _in vitro_ dry matter digestibility and structural composition of the stover as measured by cell wall constituents, acid detergent fiber and acid detergent lignin.

Colenbrander _et al_. (1971c) fed 0.81, 0.92, 1.03 and 1.14 Mcal estimated net energy (ENE) per kg of complete feed to Holstein heifers. Increasing ENE produced a significant linear increase in daily weight gains (0.34, 0.43, 0.58 and 0.68 kg for the four rations, respectively). They concluded that, if properly supplemented, corn stover can satisfactorily produce 100% of the recommended growth response for dairy heifers.

Brethour and Duitsman (1975) fed steer calves either forage sorghum silage or milo stover silage plus grain and supplement. Calves fed milo stover silage gained slower and were less efficient than those fed forage sorghum silage.

Components of Forage Quality

Raymond (1969) stated, "The nutritive value of forages can be usefully considered in terms of three components: voluntary intake, digestibility and the efficiency of utilization by the ruminant animal." Similarly, Crampton (1957) concluded "Nutritive value of a forage depends upon the quantity voluntarily consumed as well as its digestibility." These are major determinants of forage nutritive value which ultimately influence animal performance.

Blaser (1964) observed that as a forage matures, protein content (and, in some cases, soluble carhobydrate) decreases while structural carbohydrate and lignin content increase. Reid *et al*. (1959) concluded that the date first-growth forages are harvested is the major known determinant of intake and digestibility of forages by ruminants. Also, as plant growth approaches maturity, both amount and digestibility of protein decline but digestible dry matter value of aftermath forage declines more slowly than first-growth forage. Minson *et al*. (1960) fed many different forage species and varieties cut at different stages of maturity and showed that digestibility of each forage decreased as it matured. Minson *et al*. (1964) later indicated that intake was even more depressed by increasing maturity than digestibility.

Van Soest (1967) divided forage dry matter into two fractions: (1) cellular contents composed of lipids, soluble carbohydrates, proteins and other water-soluble matter and (2) cell-wall constituents, consisting largely of cellulose and smaller amounts of hemicellulose and lignin. Most of the first fraction is essentially available while availability of the cell-wall fraction is governed by lignin concentration.

Van Soest (1965a) states that the major factors governing forage dry matter digestibility are the proportion of cell contents and the extent of lignification.

Sullivan (1955) and Kamstra et al. (1958) observed that as forages matured, lignification increased and cellulose digestibility decreased. Van Soest (1962) suggested that the relationship of lignin to cellulose digestibility depends upon plant species. Tomlin et al. (1965) reported that lignin content of legumes had less effect on cellulose digestibility than lignin content of grasses. Pigden (1953) observed that the progress and site of lignification were not the same in all range grasses.

Hilston and Gifford (1946) reported a higher requirement of dry matter per unit of beef cattle gain when feeding Atlas sorghum silage cut at the mature stage compared to the soft-dough stage. Helm and Leighton (1960) and Leighton and Rupel (1959) reported lower total digestible nutrient values for mature Leacy sorghum silage than dough-stage silage. Owen and Kuhlman (1967) found that apparent dry matter digestibility of Atlas sorghum silage declined from 55 to 46% with advancing maturity, but dry matter digestibility of silage made from Rox, another sorghum variety, was not affected by maturity.

Baker and Harris (1947) found that lignin acts as a physical barrier to cellulose digestion by acting as an encrusting substance and preventing the enzymes of rumen microorganisms and intestinal juices from attacking plant nutrients. Lignin content has been shown by some workers to be negatively correlated with energy and organic matter digestibility (Forbes and Garrigus, 1950; Sullivan, 1955 and Meyer and Lofgreen, 1956); however, other researchers found little correlation (Crampton and Jackson, 1944 and Crampton, 1957). Negative correlations have also been obtained between crude fiber content and organic matter digestibility (Axelsson, 1950 and Meyer and Lofgreen, 1956) but not by other researchers (Crampton and Jackson, 1944).

Phillips and Loughlin (1949) and Sullivan (1959) observed that the inconsistancies may be due to specie differences.

Quicke and Bentley (1958); Quicke and Bentley (1959); Sullivan (1955); Tomlin et al. (1961) and Johnson et al. (1962) estimated forage quality by determining in vitro cellulose digestibility. Danley and Vetter (1973) reported that with advancing maturity, digestibility decreases and the ratio of cell-wall constituents to cell contents becomes larger. The effects of lignin are closely related to the lignin-cellulose ratio (Van Soest, 1968). The lignin content of the acid detergent fiber is essentially the lignin-cellulose ratio and results in a closer relationship of maturity to digestibility. As lignin content of the acid detergent fiber increases, digestibility decreases. This relationship exists for both corn and forage sorghum varieties.

Phillips et al. (1954) suggested that decreases in digestibility with advancing maturity are due to an increase in both crude fiber and lignin and a decrease in crude protein.

Van Soest and Marcus (1964) reported no significant relationship between cell-wall constituents and voluntary intake by sheep when cell-wall constituents made up less than 60% of the dry matter, but when cell-wall constituents made up more than 60% of the dry matter, there was a marked decrease in voluntary intake. Balch and Campling (1962) stated that intake varies inversely with the filling capacity of the forages in terms of fiber mass. Van Soest (1965b) reported that fibrous mass in the rumen inhibits intake particularly when cell-wall constituents exceed 50 to 60% of the forage dry matter.

McCullough and Russell (1962) reported that any influence of digestibility on intake declines when digestibility exceeds 65 percent.

Blaxter *et al*. (1961) concluded that within the limits of the quality of forage used, the amount of feed taken in by sheep is determined by the capacity of the digestive tract and other physical factors such as rate of passage. Other factors affecting intake, such as palatability and the consumption of digestible energy, will detract from the relationship between digestible and voluntary intake.

Some researchers have found intake more closely related to rate of digestion rather than total digestibility (Donefer *et al*., 1960 and Johnson *et al*., 1962. Conrad *et al*. (1964) reported voluntary intake by dairy cows was directly related to body weight and rate of passage when rations were low in digestibility. At higher digestibility, intake was related to metabolic size, milk production and digestibility. Moore and Winter

(1934) showed wide variation among individuals for rate of passage of undigested material. Stone et al. (1960) found that differences among individuals contributed more than one-half of the variation in forage voluntary intake by dairy cows.

Swingle and Waymack (1975) reported that a major factor limiting the intake and digestibility of low-quality forages was their low crude protein content. Raleigh and Wallace (1963); OH *et al*. (1969) and Bhattachara and Pervez (1973) indicated that supplementation of these forages with non-protein nitrogen increased dry matter intake and digestibility.

Blaxter *et al*. (1961) found that voluntary intake of forages was related to the apparent energy digestibility, increasing rapidly as digestibility increased from 38 to 70 percent. In forages over 70% digestible, voluntary intake varied with a fractional power of body weight close to 0.734 making it easier to determine forage quality when fed *ad libitum*. Montgomery and Baumgardt (1965) concluded that ruminants will adjust voluntary intake to satisfy their physiological demand for energy if physical capacities of the digestive tract do not limit consumption.

Balch and Campling (1962) reported that the rate of removal of undigested residue from the digestive tract influence intake and this may be influenced by particle size. When forage particle size was reduced by chopping, grinding or pelleting, consumption increased (Lloyd *et al*., 1960 and O'Dell., 1963). Owen and Kuhlman (1967) indicated that dry matter intake was increased by decreasing the particle size of silage. Meyer *et al*. (1959), Minson (1963), Beardsley (1964) and Moore (1964) reported that reduction of particle size may increase voluntary intake and decrease crude fiber digestibility.

McCullough (1959) summarized the problem of intake by saying, "At any stated level and stage of animal production, a forage may be defined as adequate when it is supplied in such a quantity, is of sufficient palatibility, and its per-unit concentration of usable nutrients is high enough to permit the animal to meet his nutritional requirements concurrent with the satiation by bulk."

Feeding Value of Alfalfa

Grinding or pelleting of dry forages often increases animal performance. This is especially true with rations containing large amounts of low-quality forage. Pelleting decreases apparent digestibility of forages but pelleting increases forage intake resulting in an increased intake of digestible nutrients.

Beardsley (1964) concluded that the value of forage to an animal is influenced by the physical form in which it is fed and, measured in terms of animal performance, long or chopped hay is improved by grinding or pelleting.

Brethour and Duitsman (1966) and Ely *et al*. (1967) fed steers a full-feed of sorghum silage plus fixed amounts of long, chopped or pelleted alfalfa. The highest consumption and fastest gain occurred with the pelleted alfalfa. They concluded that the response to pelleting was related to differences in physical form rather than any better conservation of nutrients by the dehydrating process.

Meyer et al. (1959) fed sheep chopped or pelleted alfalfa and observed that digestibility of lignin and holocellulose were not greatly affected, but nitrogen digestibility was higher for pelleted hay.

Johnson et al. (1964) reported faster gains by steers fed pelleted or ground hay than by those fed long hay, when hay constituted the entire ration. As ground corn was added to the rations, long and pelleted hay supported faster gains than ground hay.

Cate et al. (1955) fed lambs either pelleted or ground high-quality alfalfa hay or pelleted or ground low-quality timothy hay with ground corn. Pelleting did not affect performance of lambs fed alfalfa hay, but pelleting of the timothy hay increased rate and efficiency of gain compared to grinding.

Neale (1955) concluded that self-feeding 50 to 60% low-quality alfalfa hay with 50 and 40% sorghum grain as pellets to lambs saved feed when compared to hand-feeding high-quality alfalfa hay and sorghum grain. Kolsterman et al. (1961) found the only advantage of feeding pelleted hay over long hay, when a concentrate was self-fed, was in saving amounts of hay wasted.

Esplin et al. (1957) showed that improved performance of lambs fed a pelleted ration was due to increased intake. Meyer et al. (1959) suggested an increased rate of digestion of pelleted hay was responsible for increased consumption.

Conflicting reports have been published concerning the nutritive value of alfalfa hay and alfalfa silage.

Thomas et al. (1961) fed dairy heifers alfalfa as hay, wilted silage or direct-cut silage and obtained greater gains from hay than either silage. They suggest that dry matter content at ensiling and differences in resulting fermentation influence the nutritive value and acceptability of ensiled alfalfa.

Hinds et al. (1966) conducted studies over two years comparing alfalfa hay and haylage fed to beef cattle. First year gains were not different, although dry matter digestibility was higher for hay compared to haylage. In the second year, gain, dry matter intake and digestibility were higher for the hay.

Gordon et al. (1961) fed dairy cattle either low-moisture alfalfa silage or high-moisture alfalfa silage and obtained greater dry matter intake with the low-moisture silage but decreased nitrogen digestibility and weight gain.

Bolsen et al. (1974) fed steers three alfalfa treatments: (1) direct-cut ensiled with dry milo, (2) field-wilted ensiled, milo added at feeding and (3) baled, milo added at feeding. Steers fed baled alfalfa consumed more dry matter but were less efficient than those fed the other alfalfa rations. Direct-cut alfalfa produced the most efficient gains.

Sutton and Vetter (1971) evaluated alfalfa nitrogen utilization in lambs fed long hay, low-moisture silage or high-moisture silage. Lambs fed hay showed greatest utilization of nitrogen. The authors concluded that lower available energy in the silages prevented efficient nitrogen use.

Sutton and Vetter (1968) suggested that considerable protein nitrogen in high-moisture alfalfa silage is converted to water soluble compounds during fermentation.

Roeffler et al. (1967) and Hawkins et al. (1970) reported that as dry matter and digestible energy increased in alfalfa silages, nitrogen retention in sheep also increased. Waldo et al. (1965) found that, when feeding dairy cattle alfalfa as direct-cut silage, wilted silage or long hay, nitrogen retention increased as dry matter content increased.

Relationship between energy and protein is critical in explaining observed differences in nitrogen utilization among silages of different dry matters.

Hawkins et al. (1970) tested four dry matter levels of alfalfa silage: 22, 40, 45 and 80 percent. Daily nitrogen retention in lambs was: -0.89, 1.04, 1.97 and 2.94 g, respectively. It was suggested that fermentation was more extensive and continued longer for the high-dry matter silages.

Conrad et al. (1961) and Gordon et al. (1961) concluded that inadequate available energy in high-moisture alfalfa silage resulted in low nitrogen balance in dairy cattle when compared to alfalfa hay and low-moisture alfalfa silage.

Associative Effect of Feedstuffs

When a combination of feeds yields a digestibility value higher than that given when either is fed alone, this is an associative effect. Reid (1958) states that this effect seldom exceeds 10% of the digested energy, indicating that the digestible dry matter or energy of individual feeds is not strictly additive and that digestibility of a ration can not be predicted accurately from the digestibility of individual components.

Mitchell (1942) emphasized the importance of associative effects in digestion for ruminants, showing that most of these may be traced to changes in the ratio of sugar and starch to nitrogen-containing compounds in the ration. He further suggested that these effects are brought about by modification of the rumen microorganisms.

Blaxter (1956) reports that associative digestibility does not account for all of the associative net energy effects. Forbes et al. (1933) indicates that net availability of metabolized energy is not constant for an individual feed and that feed express their characteristic net energy values only as components of nutritively complete rations.

LITERATURE CITED

Albert, W. W., L. D. Ferrell and U. S. Garrigus. 1967a Husklage, stalkage and corn silage for wintering pregnant beef heifers. Ill. Beef Cattle Day. P. 13.

Albert, W. W., D. L. Cox and E. E. Hatfield. 1967b. Urea, biuret and soybean meal ensiled with cornstalk forage for wintering pregnant ewes. Ill. Beef Cattle Day. p. 25.

Albert, W. W., D. L. Cox and E. E. Hatfield. 1967c. Stalkage ensiled with urea or biuret for wintering beef cows. Ill. Beef Cattle Day. p. 24.

Albert, W. W. 1971. Cow-calf information roundup: Utilizing corn field wastes. Univ. of Ill., Urbana-Champaign.

Axelsson, J. 1950. Connections between contents of nutrients and digestibioity of grassland crops. Kungl. Lantbruks Hogskol Ann. 17:320.

Baker, M. L. 1943. Wintering steer calves. Nebr. Agr. Exp. Sta. Bull. 350.

Baker, F. and S. T. Harriss. 1947. The role of the microflora of the alimentary tract of herbivora with special reference to ruminants. II. Microbial digestion in the rumen (and caesum), with special reference to the decomposition of structural cellulose. Nutr. Abstr. Rev. 17:3.

Balch, C. C. and R. C. Campling. 1962. Regulation of voluntary food intake in ruminants. Nutr. Abstr. Rev. 32:669.

Balwani, T. L., R. R. Johnson, K. E. McClure and B. A. Dehority. 1969. Evaluation of green chop and ensiled sorghums, corn silage and perennial forages using digestion trials and VFA production in sheep. J. Anim. Sci. 28:90.

Beardsley, D. W. 1964. Symposium on forage utilization: Nutritive value of forage as affected by physical form. Part II. Beef cattle and sheep studies. J. Animal Sci. 23:239.

Bhattacharya, A. N. and E. Pervez. 1973. Effect of urea supplementation on intake and utilization of diets containing low quality roughages in sheep. J. Animal Sci. 36:976.

Blaser, R. E. 1964. Symposium on forage utilization: Effect of fertility levels and stage of maturity on forage nutritive value. J. Animal Sci. 23:264.

Blaxter, K. L. 1956. The nutritive value of feeds as cources of energy: A review. J. Dairy Sci. 39:1396.

Blaxter, K. L., F. W. Wainman and R. S. Wilson. 1961. The regulation of food intake by sheep. Animal Prod. 3:51.

Bolsen, K. K., G. Q. Boyett and J. G. Riley. 1975. Milo stover and sources of supplemental nitrogen for growing beef heifers and lambs. J. Animal Sci. 40:306.

Bolsen, K. K. and L. T. Chyba. 1972. Grain sorghum stubble silage for gestating ewes. Sheep Day Kan. Agr. Exp. Sta. Prog. Rpt. 189.

Bolsen, K. K., J. G. Riley and L. L. Berger. 1974. Influence of alfalfa harvesting and storing methods on steer performance. Cattlemen's Day Kan. Agr. Exp. Sta. Prog. Rpt. 210.

Bolsen, K. K., J. G. Riley and G. Boyett. 1975. Milo stover and sources of supplemental nitrogen for growing heifers. Cattlemen's Day Kan. Agr. Exp. Sta. Prog. Rpt. 230.

Brethour, J. R. and W. W. Duitsman. 1966. Baled, chopped, or pelleted alfalfa to supplement sorghum silage in a wintering ration for steer calves. Bull. 492. Ft. Hays Branch, Kan. Agr. Exp. Sta.

Brethour, J. R. and W. W. Duitsman. 1975. Forage sorghum silage and milo stover silage compared. Rpt. of Prog. 236. Ft. Hays Branch, Kan. Agr. Exp. Sta.

Burleson, C. A., W. R. Cowley and G. Otey. 1956. Effect of nitrogen on yield and protein content of grain sorghum in the lower Rio Grande Valley of Texas. Agron. J. 48:524.

Cate, H. A., J. M. Lewis, R. J. Webb, M. E. Mansfield and U. S. Garrigus. 1955. The effect of pelleting rations of varied quality on feed utilization by lambs. J. Animal Sci. 14:137.

Chyba, L. J. and K. K. Bolsen. 1973. Milo stubble for growing lambs. Sheep Res. Rpt. 198.

Colenbrander, V. F., L. D. Muller and M. D. Cunningham. 1971b. Effects of added urea and ammonium polyphosphate on fermentation of corn stover silages. J. Animal Sci. 33:1097.

Colenbrander, V. F., L. D. Muller, J. A. Wasson and M. D. Cunningham. 1971a. Effects of added urea and ammonium polyphosphate to corn stover silages on animal performance. J. Animal Sci. 33:1091.

Colenbrander, V. F., L. D. Muller, J. A. Wasson and M. D. Cunningham. 1971c. Corn stover silage supplemented with varying increments of energy for growing dairy heifers. J. Animal Sci. 33:1306.

Conrad, H. R., J. W. Hibbs, A. D. Pratt and R. R. Davis. 1961. Nitrogen metabolism in dairy cattle. I. The influence of grain and meadow crops harvested as hay, silage or soilage on efficiency of nitrogen utilization. J. Dairy Sci. 44:85.

Conrad, H. R., A. D. Pratt and J. W. Hibbs. 1964. Regulation of feed intake in dairy cows. I. Change in importance of physical and physiological factors with increasing digestibility. J. Animal Sci. 47:54.

Crampton, E. W. and I. C. Jackson. 1944. Seasonal variation in chemical composition of pasture herbage and the relation to its digestibility by steers and sheep. J. Animal Sci. 3:333.

Crampton, E. W. 1957. Interrelations between digestible nutrients and energy content, voluntary dry matter intake and the overall feeding value of forages. J. Animal Sci. 16:546.

Danley, M. M. and R. L. Vetter. 1973. Changes in carbohydrate and nitrogen fractions and digestibility of forages: maturity and ensiling. J. Animal Sci. 37:994.

Deinum, B. 1973. Structural inhibitors of quality in forage. Neth. J. Agric. Sci. 28:42.

Donefer, E., E. W. Crampton and L. E. Lloyd. 1960. Prediction of the Nutritive Value Index of a forage from <u>in vitro</u> rumen fermentation data. J. Animal Sci. 19:545.

Ely, G. G. and W. W. Duitsman. 1967. Three methods of processing alfalfa to supplement sorghum silage rations for wintering steer calves. Rpt. of Prog. 214. Ft. Hays Branch, Kan. Agr. Exp. Sta.

Esplin, A. L., U. S. Garrigus, E. E. Hatfield and R. M. Forbes. 1957. Some effects of pelleting a ground mixed ration on feed utilization by fattening lambs. J. Animal Sci. 16:863.

Forbes, E. B., W. W. Braman, M. Kriss, and R. W. Swift, with collaboration of A. Black, D. E. Frear, O. J. Kahlenberg, F. J. McClure and L. Voris. 1933. The associative effects of feeds in relation to the utilization of feed energy. J. Agr. Research. 46:753.

Forbes, R. M. and W. P. Garrigus. 1950. Some relationships between chemical composition, nutritive value and intake of forages grazed by steers and wethers. J. Animal Sci. 9:354.

Gordon, C. H., J. C. Derbyshire, H. G. Wiseman, E. A. Kane and C. G. Melin. 1961. Preservation and feeding value of alfalfa stored as hay, haylage and direct-cut silage. J. Dairy Sci. 44:1299.

Hawkins, D. R., H. E. Henderson and D. B. Purser. 1970. Effect of dry matter levels of alfalfa silage on intake and metabolism in the ruminant. J. Animal Sci. 31:617.

Helm, R. E. and R. E. Leighton. 1960. Relationship of stage of maturity at harvest to the feeding value of sorghum silage for dairy cows. J. Dairy Sci. 43:868.

Hilston, N. W. and W. Gifford. 1946. Comparative values of various roughages for wintering feeder calves. Arkansas Agr. Exp. Sta., Bull. 463.

Hinds, R. C., P. E. Lamb, B. E. Bremer, R. Almendinger and U. S. Garrigus. 1966. Study of hay and haylage made from the same field for beef cattle. Agr. Exp. Sta. and Coop Ext. Ser., Univ. of Ill. Ruminant Division AS-645d.

Johnson, R R., B. A. Dehority, J. L. Parsons and H. W. Scott. 1962. Descrepancies between grasses and alfalfa when estimating nutritive value from _in vitro_ cellulose digestibility by rumen microorganisms. J. Animal Sci. 21:892.

Johnson, R. R., G. E. Richetts, E. W. Klosterman and A. L. Moxon. 1964. Studies on the utilization and digestion of long, ground and pelleted alfalfa and mixed hay. J. Animal Sci. 23:94.

Kamstra, L. D., A. L. Moxon and O. G. Bentley. 1958. The effect of stage of maturity and lignification on the digestion of cellulose in forage plants by rumen microorganisms _in vitro_. J. Animal Sci. 17:199.

Klosterman, E. W., A. L. Moxon and L. E. Kunkle. 1961. Methods of feeding beef calves. Ohio Agr. Exp. Sta. Res. Circ. 84.

Leighton, R. E. and L. W. Rupel. 1959. Value of Tracy sorghum silage at two stages of maturity for feeding producing dairy cows. J. Dairy Sci. 42:393.

Lloyd, L. E., E. W. Crampton, E. Donefer and S. E. Beacon. 1960. The effect of chopping versus late cut Red Clover and Timothy hays. J. Animal Sci. 19:859.

Martin, N. P. and W. F. Wedin. 1974. Effects of fall weathering on yield and composition of grain sorghum stover. Agron. J. 66:669.

McCullough, M. E. 1959. Conditions influencing forage acceptability and rate of intake. J. Dairy Sci. 42:571.

McCullough, M. E. and J. R. Russell. 1962. Forages and nutritional factors influencing potential and economic use of forage for dairy cattle. J. Animal Sci. 21:1036 (Abstr.).

McKee, M., K. K. Bolsen and J. G. Riley. 1975. Unpublished data. Kansas State University, Manhattan, Kansas.

Meyer, J. H. and G. P. Lofgreen. 1956. The estimation of the total digestible nutrients in alfalfa from its lignin and crude fiber content. J. Animal Sci. 15:543.

Meyer, J. H., R. L. Gaskill, G. S. Stoeusand and W. C. Weir. 1959. Influence of pelleting on the utilization of alfalfa. J. Animal Sci. 18:336.

Minson, D. J., W. F. Raymond and C. E. Harris. 1960. Studies in the digestibilities of herbage. J. Brit. Grassl. Soc. 15:174.

Minson, D. J. 1963. The effect of pelleting and wafering on feeding value of roughage--a review. J. Brit. Grassl. Soc. 18:39.

Minson, D. J., C. E. Harris, W. F. Raymond and R. Milford. 1964. The digestibility and voluntary intake of S22 and H1 ryegrass, S170 tall fescue, S48 timothy, S215 meadow fescue and Germinal cocksfoot. J. Brit. Grassl. Soc. 19:298.

Mitchell, H. H. 1942. The evaluation of feeds on the basis of digestible and metabolizable nutrients. J. Animal Sci. 1:156.

Montgomery, M. J. and B. R. Baumgardt. 1965. 1. Pelleted rations varying in energy concentration. J. Dairy Sci.

Moore, L. A. and O. L. Winter. 1934. The rate of passage of undigested material through the digestive tract of the bovine. J. Dairy Sci. 17:296.

Moore, L. A. 1964. Symposium on forage utilization: Nutritive value of forages as affected by physical form. Part 1. General principles involved with ruminants and effect of feeding pelleted or wafered forage to dairy cattle. J. Animal Sci. 23:230.

Morrison, F. B. 1956. Feeds and Feeding. 22nd ed. Morrison Publ. Co., Ithaca, N.Y.

Neale, P. E. 1955. Alfalfa cube mixtures for fattening lambs. New Mex. Agr. Exp. Sta. Bull. 398.

Nevens, W. B. and K. E. Harshbarger. 1940. Broomcorn silage for dairy cattle. J. Dairy Sci. 23:1023.

N.R.C. 1968. Nutrient requirements of domestic animals. No. 5. Nutrient requirements of beef cattle. National Research Council, Washington, D.C.

N.R.C. 1970. Nutrient requirements of domestic animals. No. 4. Nutrient requirements of beef cattle. National Research Council, Washington, D.C.

O'Dell, G. D., W. A. King, W. C. Cook and S. L. Moore. 1963. Effect of physical state of coastal bermuda grass hay on passage through digestive tract of dairy heifers. J. Dairy Sci. 46:38.

Oh, H. K., W. M. Longhurst and M. B. Jones. 1969. Relation of nitrogen intake to rumen microbial activity and consumption of low-quality roughage by sheep. J. Animal Sci. 28:272.

Oh, J. H., W. C. Weir and W. M. Longhurst. 1971. Feed value for sheep of corn stalks, rice straw and barley straw as compared with alfalfa. J. Animal Sci. 32:343.

Owen, F. G. and J. W. Kuhlman. 1967. Effect of maturity on digestibility of forage sorghum silages. J. Dairy Sci. 50:527.

Perry, L. J., Jr. 1973. Comparative crop residue values as forage and agronomic management considerations. Univ. of Nebr., Lincoln.

Phillips, T. G. and M. E. Loughlin. 1949. Composition and digestible energy of hays fed to cattle. J. Agr. Res. 78:389.

Phillips, T. G., J. T. Sullivan, M. E. Loughlin and V. G. Sprague. 1954. Chemical composition of some forage grasses. I. Changes with plant maturity. Agron. J. 46:361.

Pigden, W. J. 1953. The relation of lignin, cellulose, protein, starch and ether extract to the "curing" of range grasses. Canadian J. Agr. Sci. 33:364.

Quicke, G. V. and O. G. Bentley. 1958. Lignin and methoxyl groups as related to the decreased digestibility of mature forages. J. Animal Sci. 17:1206

Quicke, G. V. and O. G. Bentley. 1959. Lignin and methoxyl groups as related to the decreased digestibility of mature forages. J. Animal Sci. 18:365.

Raleigh, R. J. and J. D. Wallace. 1963. Effect of urea at different nitrogen levels on digestibility and on performance of growing steers fed low quality flood meadow roughage. J. Animal Sci. 22:330.

Raymond, W. F. 1969. The nutritive value of forage crops. Adv. Agronomy. 21:1.

Reid, J. J. 1958. A personal communication as cited by W. A. Hardison. 1959. Evaluating the nutritive quality of forage on the basis of energy. A review. J. Dairy Sci. 42: 489.

Reid, J. J. 1959. Effect of growth stage, chemical composition and physical properties upon the nutritive value of forages. J. Dairy Sci. 42:567.

Roeffler, R. E., R. P. Niedermeier and B. R. Baumgardt. 1967. Evaluation of silage-brome forage stored as wilted silage, low-moisture silage and hay. J. Dairy Sci. 50:1805.

Russell, H. L. and E. B. Morrison. 1920. Corn stover silage for milk production. Wisconsin Agr. Exp. Sta. Bull. 323.

Sherman, J. M. and S. I. Beckdel. 1918. Corn stover silage. J. Agr. Res. 12:589.

Stone, J. B., G. W. Trimberger, C. R. Henderson. J. J. Reid, K. L. Turk and J. K. Loosli. 1960. Forage intake and efficiency of feed utilization in dairy cattle. J. Dairy Sci. 43:1275.

Sullivan, J. T. 1955. Cellulose and lignin in forage grasses and their digestion coefficients. J. Animal Sci. 14:710.

Sullivan, J. T. 1959. A rapid method for the determination of acid insoluble lignin in forages and its relation to dry matter digestibility. Unpublished data.

Sutton, A. L. and R. L. Vetter. 1968. Nitrogen utilization in lambs fed alfalfa hay, haylage and silage. J. Animal Sci. 27:1177.

Sutton, A. L. and R. L. Vetter. 1971. Nitrogen studies with lambs fed alfalfa (Medicago sativa) as hay, low-moisture and high-moisture silages. J. Animal Sci. 32:1256.

Swingle, R. S. and L. B. Waymack. 1975. Digestibility of grain sorghum stover and wheat straw supplemented with NPN. J. Animal Sci. 26:125 (abstr.).

Thomas, J. W., L. A. Moore and J. K. Sykes. 1961. Further comparisons of alfalfa hay and alfalfa silage for growing dairy heifers. J. Dairy Sci. 44:862.

Tomlin, D. C., B. A. Dehority and R. R. Johnson. 1961. Differential effect of lignification in grasses and legumes on in vitro cellulose digestibility. J. Animal Sci. 20:963 (abstr.).

Tomlin, D. C., R. R. Johnson and B. A. Dehority. 1965. Relationship of lignification to an in vitro cellulose digestibility of grasses and legumes. J. Animal Sci. 24:161.

Vanderlip, R. L., L. R. Schneider and K. K. Bolsen. 1974. Yield and composition of grain sorghum stover. Kansas Cattleman's Day. p. 46.

Van Soest, P. J. 1962. Annual report to the NE-24 Technical Committee: Nutritive evaluation of forages. U.S.D.A., Beltsville, Md.

Van Soest, P. J. 1965a. Comparison of two different equations for the prediction of digestibility from cell contents, cell wall constituents and lignin content of acid-detergent fiber. J. Dairy Sci. 48:815.

Van Soest, P. J. 1965b. Symposium on factors influencing the voluntary intake of herbage by ruminants: Voluntary intake in relation to chemical composition and digestibility. J. Animal Sci. 24:834.

Van Soest, P. J. 1967. Development of a comprehensive system of feed analysis and its application to forages. J. Animal Sci. 26:119.

Van Soest, P. J. 1968. Structural and chemical characteristics which limit the nutritive value of forages. p. 63. In C. M. Harrison (Ed.) Forage-Economics-Quality. Amer. Soc. Agron. Spec. Pub. No. 13.

Van Soest, P. J. and W. C. Marcus. 1964. Method for the determination of cell wall constituents in forages using detergent and the relationship between this fraction and voluntary intake and digestibility. J. Dairy Sci. 47:704.

Vetter, R. L., D. W. Weber and N. Gay. 1971. Corn plant forage for beef cows. Presented at the 1971 winter meeting Amer. Soc. of Agr. Eng. Sherman House, Chicago, Illinois. No. 71-666.

Vetter, R. L. 1973. Crop residue symposium: Evaluation of chemical and nutritional properties of crop residues. Univ. of Nebr., Lincoln.

Waldo, D. R., R. W. Miller, M. Okamoto and L. P. Moore. 1965. Utilization of silage in relation to hay, pellets and hay plus grain. 1. Composition, digestion, nitrogen balance, intake and growth. J. Dairy Sci. 48:910.

Ward, J. 1972. Feeding value of crop residues. Nebr. Beef Cattle Rpt. 30.

Ward J. 1973. Crop residue symposium: Supplementation of crop residues. Univ. of Neb., Lincoln.

Wurster, M. 1973. The stover concept. From Profits in Stalks Handbook. p. 15. Research Division, Ralston Purina, St. Louis, Missouri.

INTRODUCTION

Recent research has measured the feeding value of milo and corn stover in heifer and lamb growing rations (Colenbrander _et al._, 1971a, b; Chyba and Bolsen 1973; Bolsen _et al._, 1975). However, no information is available showing associative effects resulting when crop residues are fed in combination with higher quality forages.

We conducted two heifer trials to measure the feeding value of milo stover silage fed in combination with forage sorghum and alfalfa silages. Lamb growth and digestion trials were used to determine feeding values of milo stover (silage or pellets) in rations containing alfalfa (hay or pellets).

SUMMARY

Three growth trials and one digestion trial were conducted to measure the feeding value of milo stover when fed with higher quality forages. Performance of heifers fed the 100% forage sorghum silage ration in growth trials I and II or the 33% milo stover silage and 67% forage sorghum silage ration in growth trial II was significantly greater than that of heifers fed any of the other milo stover silage rations. When milo stover silage and forage sorghum silage were fed in combination, observed daily gain and feed efficiency were greater than predicted gains and efficiencies by 10.7 and 13.0%, respectively.

In growth trial III, lambs fed forage sorghum silage or milo stover pellets gained faster and more efficiently than those fed milo stover silage. Lambs fed milo stover pellets consumed more dry matter than those fed forage sorghum or milo stover silages (1.60, 1.28 and .96 kg/day, respectively). Lambs fed dehydrated alfalfa pellets consumed more dry matter and were less efficient than lambs fed ground alfalfa hay.

In the digestion trial, lambs fed milo stover pellets consumed the largest amount of dry matter. Dry matter digestibility and total digestible nutrients were highest for the forage sorghum silage and ground alfalfa hay ration. Digestion coefficients were higher for rations containing ground alfalfa hay than for those containing dehydrated alfalfa pellets. The milo stover pellet and dehydrated alfalfa pellet ration had the highest nitrogen retention and % of absorbed nitrogen

retained. Digestibilities of dry matter, crude fiber and crude protein and total digestible nutrients decreased but nitrogen retention increased as dry matter intake increased.

EXPERIMENTAL PROCEDURE

Milo stover and forage sorghum for growth trial I were harvested in the fall of 1974; stover, sorghum and alfalfa for growth trials II and III and digestion trial I were harvested in the summer and fall of 1975. The milo stover and forage sorghum were from high grain yielding varieties and were harvested after a killing frost. All forages were harvested using a 5.06 cm recutter screen and ensiled in covered, upright concrete silos (3.1 x 15.2 m). Milo stover and dehydrated alfalfa pellets (.66 cm) were prepared by a commercial dehydrator. All rations were formulated on a fixed-percentage basis to supply equal amounts of crude protein, minerals, vitamins and additives and all were mixed and fed *ad libitum* twice daily. In all growth trials, silages and supplements were sampled weekly and dry matter determined. When silage dry matter changed more than one percentage unit, adjustments were made in amounts of wet silage fed to maintain constant fixed-percentage rations. At the end of each trial, weekly samples were composited and proximate analysis determined by A.O.A.C. (1970) methods. Heifers in growth trials I and II came from the same cow herd and were of Angus, Hereford, Angus-Hereford and Simmental-Hereford breeding. Heifers and lambs in all growth trials were fed their respective rations at a dry matter intake equal to 2% of body weight for 5 days prior to initial weighing and 2 days prior to final weighing. All weights were taken after animals had gone 15 hr without feed or water.

Growth Trial I. Ninety-six heifer calves were allotted by breed and weight into 16 pens of six heifers each. Four pens (two light-weight, averaging 195 kg and two heavy-weight, averaging 262 kg) were assigned to each of the four forage sorghum silage (FSS) and milo stover silage (MSS) rations shown in table 1. Composition of the supplements is shown in table 2; supplements A through D were fed with rations 1 through 4, respectively. The heifers were fed in partially sheltered, concrete-floor pens during the 88-day trial (winter, 1974-1975). Twenty-eight day intermediate weights were taken full prior to the morning feeding.

Growth Trial II. Ninety heifer calves weighing an average of 202 kg were randomly allotted by weight and breed into 18 pens of five heifers each. Three pens were assigned to each of the six FSS, MSS and alfalfa haylage (haylage) rations shown in table 1. Composition of the supplements is shown in table 3; supplements A through F were fed with rations 1 through 6, respectively. Pen facilities and intermediate weighings were similar to those described in growth trial I. The heifers were fed for 96 days during the winter of 1975-1976.

Growth Trial III. Fifty-four crossbred wether and ewe lambs averaging 26 kg were allotted by sex and weight to 18 pens of three lambs each. Three pens of lambs were randomly assigned

Table 1. Composition of the Rations Fed In Growth Trials I and II (%, dry matter basis)

	Growth Trial I					
	Growth Trial II					
Ingredient	1 100% MSS	2 67% MSS 33% FSS	3 33% MSS 67% FSS	4 100% FSS	5 67% MSS 33% Haylage	6 33% MSS 67% Haylage
MSS	73.0	48.9	24.1	-	48.9	24.1
FSS	-	24.1	48.9	73.0	-	-
Haylage	-	-	-	-	24.1	48.9
Milo	7.0	7.0	7.0	12.0	12.0	12.0
Soybean meal (SBM)	5.0	5.0[a]	5.0[a]	-	-	-
Supplement	15.0	15.0	15.0	15.0	15.0	15.0

[a]SBM was replaced by rolled milo in Growth Trial II.

Table 2. Composition Of Supplements Fed In Growth Trial I (%, dry matter basis).

Ingredient	Supplements A	B	C	D
SBM	89.70	76.28	63.23	84.79
Milo	4.35	18.07	32.02	10.45
Dicalcium Phosphate	1.80	2.25	.65	1.51
Limestone	1.40	.65	1.35	.50
Salt	1.50	1.50	1.50	1.50
Fat	.90	.90	.90	.90
Chlortetracycline[1]	.30	.30	.30	.30
Trace mineral premix	.05	.05	.05	.05
Vitamin A premix[2]	+	+	+	+

[1]Formulated to supply 70 mg per heifer per day.

[2]Formulated to supply 30,000 IU per heifer per day.

Table 3. Composition Of Supplements Fed In Growth Trial II (%, dry matter basis)

Ingredient	Supplement A	B	C	D	E	F
SBM	66.92	91.81	82.28	73.00	51.42	3.47
Milo, rolled	25.55	.86	10.72	20.34	41.90	37.83
Dicalcium phosphate	2.11	2.14	2.48	2.03	2.49	4.58
Limestone	1.19	1.02	.35	.40	-	-
Salt	1.59	1.60	1.60	1.59	1.57	1.54
Molasses	2.07	2.00	2.00	2.07	2.05	2.01
Trace mineral premix	.22	.22	.22	.22	.22	.22
Vitamin A[1]	+	+	+	+	+	+
Chlortetracycline[2]	.35	.35	.35	.35	.35	.35

[1]Formulated to supply 30,000 IU per heifer per day.

[2]Formulated to supply 70 mg per heifer per day.

to each of these six forage and alfalfa treatments: (1) FSS and dehydrated alfalfa pellets (dehy), (2) FSS and ground alfalfa hay (gr. hay), (3) MSS and dehy, (4) MSS and gr. hay, (5) MSP and dehy and (6) MSP and gr. hay. All rations contained 47% of the appropriate forage, 47% of the appropriate alfalfa and 6% supplement (dry matter basis). Composition of the supplements is shown in table 4; supplement A was fed with treatments 1, 2, 3, and 5 and supplement B was fed with treatments 4 and 6. The lambs were housed in sheltered, concrete-floor pens and an intermediate weight was taken at 21 days during the 50-day trial (spring, 1976).

Digestion Trial I. The six forage and alfalfa treatments previously described in growth trial III were evaluated in two consecutive collection periods. Eighteen lambs were randomly allotted by weight into three weight groups (light, medium and heavy) and one lamb from each group assigned to each of the six treatments. All rations were fed *ad libitum*. In both collection periods a 13 day crate and feed-adjustment time was followed immediately by a 6-day collection period. Ration components, feces and urine were collected, sampled and analyzed as described by Bolsen *et al*. (1975).

RESULTS

Growth Trial I. Heifers fed the 100% FSS ration gained faster ($P<.05$) and more efficiently ($P<.05$) than heifers fed any of the other three rations (table 5). Heifers receiving the 100% MSS ration had the slowest ($P<.05$) and least efficient

Table 4. Composition of Supplements Fed in Growth Trial III and Digestion Trial I (% dry matter basis)[1]

	Supplement	
Ingredients	A	B
Milo, rolled	81.96	25.95
SBM	-	55.53
Sodium phosphate	8.76	9.21
Salt	5.13	5.31
Trace mineral premix	.44	.44
Molasses	2.12	2.12
Chlortetracycline[2]	1.59	1.59
Vitamin A, D and E[3]	+	+

[1]Fed as a .48 cm pellet

[2]Formulated to supply 20 mg per lamb per day.

[3]Formulated to supply 3,000 IU of vitamin A; 300 IU of vitamin D and 3 IU of vitamin E per lamb per day.

Table 5. Performance Of Heifers Fed MSS and FSS In Growth Trial I

Item	Ration no. and silage treatment			
	1 100% MSS	2 67% MSS 33% FSS	3 33% MSS 67% FSS	4 100% FSS
No. heifers	24	24	24	24
Initial wt, kg	227.9	228.4	229.3	227.9
Final wt, kg	268.3	288.3	295.6	302.8
Daily gain, kg	.46[d]	.68[c]	.75[b]	.85[a]
Daily feed, kg[1]				
MSS	4.04	2.67	1.43	-
FSS	-	1.43	2.91	4.28
Milo	.38	.39	.39	.40
SBM	.27	.29	.28	.30
Supplement	.81	.84	.86	.89
Daily dry matter intake, kg	5.50[b]	5.62[a,b]	5.87[a]	5.87[a]
Feed/kg gain, kg[1]	12.08[c]	8.35[b]	7.85[b]	6.88[a]

[a,b,c,d]Means on the same line with different superscripts differ significantly ($P<.05$).

[1]100% dry matter basis

($P<.05$) gain. As FSS increased and MSS decreased in the ration, rate of gain increased ($P<.05$) and feed required per kg of gain decreased. Dry matter consumption tended to increase as FSS replaced MSS.

Growth Trial II. Heifers fed 100% FSS or 33% MSS and 67% FSS (rations 3 and 4) had similar performance (table 6). Calves receiving 100% MSS or 67% MSS and 33% haylage (rations 1 and 5) gained slower, ($P<.05$) and tended to consume less feed than heifers fed any of the other rations. As FSS or haylage replaced MSS, rate of gain and feed consumption increased ($P<.05$) and feed required per kg of gain decreased ($P<.05$).

Growth Trial III. Lambs receiving FSS or MSP rations gained faster ($P<.05$), consumed more dry matter ($P<.05$) and were more efficient ($P<.05$) than lambs receiving MSS rations (table 7 and 8). Lambs fed MSP rations consumed more feed ($P<.05$) than those fed FSS rations, but rate and efficiency of gains were similar.

On the average lambs receiving dehy rations had greater ($P<.05$) dry matter intake and required more ($P<.05$) feed per kg of gain than those receiving gr. hay rations.

No significant ($P<.05$) interactions were observed between forage and alfalfa treatments.

Digestion Trial I. Results from periods one and two were averaged (table 9). Forage and alfalfa treatment significantly affected voluntary intake and dry matter digestibility. Lambs receiving MSP rations consumed the most ($P<.05$) dry matter; those fed MSS, the least, ($P<.05$). Lambs consumed more ($P<.05$)

Table 6. Performance of Heifers Fed MSS, FSS and Haylage In Growth Trial II.

Item	Ration no. and silage treatment					
	1 100% MSS	2 67% MSS 33% FSS	3 33% MSS 67% FSS	4 100% FSS	5 67% MSS 33% Haylage	6 33% MSS 67% Haylage
No. heifers	15	15	15	15	15	15
Initial wt, kg	202.5	203.4	198.4	203.8	200.2	200.1
Final wt, kg	249.2	267.0	271.9	281.0	253.3	262.4
Daily gain, kg	$.49^{c}$	$.66^{b}$	$.76^{a}$	$.80^{a}$	$.55^{c}$	$.64^{b}$
Daily feed, kg^{1}						
MSS	3.82	2.81	1.43	-	2.60	1.44
FSS	-	1.32	2.80	4.45	-	-
Haylage	-	-	-	-	1.30	2.90
Milo	.41	.73	.75	.80	.68	.76
SBM	.27	-	-	-	-	-
Supplement	.81	.88	1.01	.95	.82	.91
Daily dry matter intake, kg	5.31^{d}	$5.74^{b,c}$	$5.99^{a,b}$	6.20^{a}	$5.40^{c,d}$	$6.01^{a,b}$
Feed/unit gain, kg^{1}	11.01^{d}	8.71^{b}	7.86^{a}	7.72^{a}	9.74^{c}	$9.47^{b,c}$

^{a,b,c,d}Means on the same line with different superscripts differ significantly ($P<.05$)

^{1}100% dry matter basis

Table 7. Performance Of Lambs Fed FSS, MSS or MSP And Dehy or Gr. Hay In Growth Trial III.

	Forage and alfalfa treatments					
Item	FSS + dehy	FSS + gr. hay	MSS + dehy	MSS + gr. hay	MSP + dehy	MSP + gr. hay
No. lambs	9	9	9	9	9	9
Initial wt, kg	26.3	26.8	26.3	26.3	25.9	25.4
Final wt, kg	34.1	35.0	28.6	29.5	34.5	33.6
Daily gain, kg	$.15^{a}$	$.16^{a}$	$.05^{b}$	$.06^{b}$	$.17^{a}$	$.16^{a}$
Daily feed, kg[1]						
FSS	.62	.58	-	-	-	-
MSS	-	-	.45	.45	-	-
MSP	-	-	-	-	.83	.67
Dehy	.62	-	.46		.84	
Gr. hay	-	.56	-	.43	-	.65
Supplement	.09	.08	.06	.06	.11	.09
Daily dry matter intake, kg	1.33^{b}	1.21^{b}	$.97^{c}$	$.94^{c}$	1.78^{a}	1.41^{a}
Feed/kg gain, kg[1]	8.69^{a}	7.62^{a}	20.98^{b}	16.34^{b}	10.47^{a}	9.04^{a}

[a,b,c]Means on the same line with different superscripts differ significantly ($P<.05$).

[1]100% dry matter basis

Table 8. Effects of Forage and Alfalfa Treatments on Lamb Performance In Growth Trial III.

Item	Forage treatment			Alfalfa treatment	
	FSS	MSS	MSP	Dehy	Gr. hay
No. of lambs	18	18	18	27	27
Daily gain, kg	$.16^{a}$	$.16^{b}$	$.17^{a}$	.12	.13
Daily dry matter intake, kg	1.28^{b}	$.96^{c}$	1.60^{a}	1.36^{d}	1.19^{e}
Feed/kg gain, kg	8.16^{a}	18.66^{b}	9.76^{a}	13.38^{d}	11.00^{e}

[a,b,c]Means on the same line with different superscripts differ significantly (P<.05)

[d,e]Means on the same line with different superscripts differ significantly (P<.05)

[1]100% dry matter basis

Table 9. Least Square Means Analysis Of Forage and Alfalfa Treatments And Forage Alfalfa On Ration Dry Matter Intake, Ration Digestibility And Nitrogen Rentention In The Lamb Digestion Trial[1]

Item	Dry matter intake	Apparent digestion coefficients, %					Nitrogen retention	
	g/day[2]	Dry matter	Crude fiber	Crude protein	Nitrogen-free extract	TDN	N retained g/day	% absorbed N retained
Forage Treatment[3]								
FSS	1020.2^{b}	60.3^{a}	47.2	56.5	69.2^{a}	55.6^{a}	5.0^{a}	39.2^{b}
MSS	759.8^{c}	53.5^{b}	50.5	54.6	59.3^{c}	47.8^{b}	3.4^{b}	25.7^{c}
MSP	1407.7^{a}	52.6^{b}	42.6	57.9	61.9^{b}	47.6^{b}	5.7^{a}	46.1^{a}
Alfalfa Treatment[4]								
Dehy	1135.4^{e}	51.8^{f}	42.6^{f}	47.2^{f}	61.2^{f}	47.3^{f}	4.8	44.6^{e}
Gr. hay	989.7^{f}	59.1^{e}	50.9^{e}	65.5^{e}	65.8^{e}	53.4^{e}	4.6	29.4^{f}

[a,b,c] Means in the same column with different superscripts differ significantly ($P<.05$)

[e,f] Means in the same column with different superscripts differ significantly ($P<.05$)

[1] Average for periods one and two

[2] Mean dry matter intake during collection periods

[3] Twelve observations per treatment mean

[4] Eighteen observations per treatment mean

Table 9 (cont.) Least Square Means Analysis Of Forage And Alfalfa Treatments And Forage Alfalfa On Ration Dry Matter Intake, Ration Digestibility And Nitrogen Retention In The Lamb Digestion Trial[1]

	Dry matter intake	Apparent digestion coefficients, %					Nitrogen retention	
Item	g/day[2]	Dry matter	Crude fiber	Crude protein	Nitrogen-free extract	TDN	N retained g/day	% absorbed N retained
Forage alfalfa[5]								
FSS + dehy	1069.3^{l}	$54.2^{k,l}$	39.2	45.5^{k}	65.4	50.4^{k}	$4.6^{k,l}$	$44.0^{k,l}$
FSS + gr. hay	971.0^{l}	66.4^{j}	55.3^{j}	67.6^{j}	73.0	60.8^{j}	$5.3^{k,l}$	34.5^{l}
MSS + dehy	777.0^{m}	50.8^{l}	48.4^{k}	45.8^{k}	57.4	45.6^{l}	3.4^{l}	31.4^{l}
MSS + gr. hay	742.7^{m}	56.2^{k}	52.6^{j}	63.3^{j}	61.2	50.0^{k}	3.3^{l}	$20.0^{l,m}$
MSP + dehy	1560.0^{j}	50.6^{l}	$40.3^{k,l}$	50.3^{k}	60.6	45.9^{l}	6.4^{j}	58.4^{j}
MSP + gr. hay	1255.3^{k}	54.6^{k}	44.9^{k}	65.5^{j}	63.2	[illegible]9.4^{k}	$5.1^{j,k}$	33.7^{l}
Regression Coefficient	-	$-.36^{s}$	$-.16^{s}$	$-.91^{s}$	$-.51^{s}$	$-.45^{s}$	$.36^{t}$	1.0^{t}
Level of Probability	-	.29	.71	.04	.14	.18	.03	.44

^{j,k,l,m}Means in the same column with different superscripts differ significantly ($P<.05$)

^{s}Change in digestibility (%) with each 100 g increase in dry matter intake

^{t}Change in nitrogen retention (g or %) with each 100 g increase in dry matter intake

[1]Average for periods one and two

[2]Mean dry matter intake during collection periods

[5]Six observations per treatment mean

of the dehy rations than gr. hay rations. Lambs fed the MSP and dehy ration consumed more ($P<.05$) dry matter than those fed any of the other five rations. FSS rations had the highest ($P<.05$) dry matter digestibility. Gr. hay rations had a higher ($P<.05$) dry matter digestibility than dehy rations. The FSS and gr. hay ration had the highest ($P<.05$) dry matter digestibility. Alfalfa treatment affected ($P<.05$) crude fiber and crude protein digestibilities with gr. hay rations having higher ($P<.05$) digestibilities than dehy rations. Nitrogen free-extract digestibility and total digestibile nutrients (TDN) were affected ($P<.05$) by forage and alfalfa treatments. The FSS and gr. hay ration had the highest nitrogen free-extract digestibilities and TDN.

Grams of nitrogen retained was affected by forage treatment with MSS rations having the lowest ($P<.05$) nitrogen retention. Percent of absorbed nitrogen retained was affected ($P<.05$) by forage and alfalfa treatment with the MSP and dehy ration having the highest % of absorbed nitrogen retained.

Regression coefficients show the effect of ration dry matter intake on digestibility and nitrogen retention. Nitrogen retention (g/day) and % of absorbed nitrogen retained increased as intake increased. Only changes in crude protein digestibility and grams of nitrogen retained were significant at the .05 level of probability.

For each 100 g increase in intake, dry matter, crude fiber, crude protein and nitrogen free-extract digestibilities decreased .36, .16, .91 and .51 percentage units, respectively, and TDN decreased .45 percentage units.

DISCUSSION

Proximate analyses of forages fed in all trials are shown in table 10.

In both heifer growth trials, those fed 100% FSS had greater performance than those fed 100% MSS. This agrees with previous research by Bolsen et al. (1975) who showed that MSS had 63 to 67% the feeding value of FSS in similar rations for growing heifers. Brethour and Duitsman (1975) observed that steer calves receiving milo stover silage gained slower and less efficiently than those receiving forage sorghum silage. Colenbrander et al. (1971 b) found that dairy heifers fed corn stover silage gained slower than those fed whole plant corn silage.

When MSS and FSS were fed in combination, a positive associative effect on performance was observed in the heifer growth trials. Daily gain and feed intake from the 100% MSS and FSS rations were used to calculate predicted gains and feed efficiencies for the 67% and 33% MSS rations. In trial I, actual gains exceeded predicted gains by 16.3 and 5.1% for the 67 and 33% MSS rations, respectively; in trial II, these values were 12.3 and 9.1%, respectively. In trial I, actual feed efficiencies by 19.3 and 8.8% for the 67 and 33% MSS rations, respectively; in trial II, these values were 12.1 and 10.9%, respectively. Using corn silage and whole shelled corn, Byers et al. (1975) showed a negative associative affect when steers were fed at maintenance and ad libitum intakes. Dry matter and energy digestibilities of the rations that contained both silage and corn were lower than values predicted from the 100% corn rations.

Table 10. Proximate Analyses Of Silages Fed In Growth Trials I and II and Silage and Forages Fed In Growth Trial III and Digestion Trial I.

Item	Dry matter	Ash	Crude protein	Crude fiber	Ether extract
	%	%, dry matter basis			
Growth Trial I					
FSS	29.1	6.9	7.1	24.9	2.3
MSS	33.5	12.3	4.5	30.6	2.9
Growth Trial II					
FSS	29.0	8.1	7.6	25.0	1.9
MSS	29.7	14.2	5.2	29.6	1.4
Haylage	42.1	13.3	15.6	32.7	1.7
Growth Trial III					
FSS	33.1	7.7	7.5	23.5	2.7
MSS	33.9	14.5	4.6	30.9	1.9
MSP	92.5	16.8	5.9	27.3	1.5
Dehy	93.2	11.1	19.6	25.3	2.3
Gr. hay	87.5	10.5	14.3	29.9	1.9
Digestion Trial I					
FSS	32.5	7.0	7.8	21.7	2.8
MSS	28.8	13.5	5.8	30.0	1.7
MSP	89.4	16.6	5.9	26.0	1.7
Dehy	90.2	10.5	19.2	25.5	2.5
Gr. hay	85.9	12.9	19.2	23.8	2.4

In the lamb growth trial, rations containing 47% FSS supported greater performance than 47% MSS rations. This agrees with results of Chyba and Bolsen (1973) who fed lambs 71% FSS or MSS rations. Our results and results of Chyba and Bolsen (1973) showed that lambs receiving MSP rations consumed more dry matter but were less efficient than lambs receiving FSS rations.

Lambs fed MSP rations gained faster and more efficiently than lambs fed MSS rations. Similar results were reported by Chyba and Bolsen (1973) and Bolsen et al. (1975). However, in another trial, Bolsen et al. (1975) found that beef heifers fed MSP rations gained only slightly faster and were 25% less efficient than heifers fed MSS rations. These differences between lambs and heifers result, in part, from differences in dry matter intake. As an average for all trials, lambs consumed 94% more MSP dry matter than MSS dry matter; heifers consumed only 48% more MSP dry matter.

In the lamb digestion trial, digestibility of the three forages and two alfalfas tended to decrease as intake increased. Digestibility of the MSP rations was lower than that of the MSS rations. However, the lower digestibility was compensated for by an increased intake of the MSP rations. This agrees with results of Bolsen et al. (1975). These results indicate that rate and efficiency of gain were influenced more by ration intake than by ration digestibility.

LITERATURE CITED

A.O.A.C. 1970. Official Methods of Analysis (11th Ed.) Association of Official Agricultural Chemists. Washington, D.C.

Bolsen, K. K., J. G. Riley and G. Boyett. 1975. Milo stover and sources of supplemental nitrogen for growing heifers. Cattlemen's Day Kan. Agr. Exp. Sta. Prog. Rpt. 230.

Brethour, J. R. and W. W. Duitsman. 1975. Forage sorghum silage and milo stover silage compared. Rpt. of Prog. 236. Ft. Hays Branch, Kan. Agr. Exp. Sta.

Byers, F. M. J. K. Matsushima and D. E. Johnson. 1975. Associative effects of corn net energy values. J. Anim. Sci. 41:394 (Abstr.).

Chyba, L. J. and K. K. Bolsen. 1973. Milo stubble for growing lambs. Sheep Res. Rpt. 198.

Colenbrander, V. F., L. D. Muller, J. A. Wasson and M. D. Cunningham. 1971a. Effects of added urea and ammonium polyphosphate to corn stover silages on animal performance. J. Animal Sci. 33:1091

Colenbrander, V. F., L. D. Muller, J. A. Wasson and M. D. Cunningham. 1971b. Corn stover silage supplemented with varying increments of energy for growing dairy heifers. J. Animal Sci. 33:1306.

Harvey, W. R. 1960. Least-squares analysis of data with unequal subclass numbers. ARS 20-8.

Steele, R. G. and H. J. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.

FEEDING VALUE OF MILO STOVER FOR GROWING BEEF HEIFERS AND LAMBS

by

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B.S., Kansas State University, 1973

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1976

Two heifer growth trials were conducted to measure the feeding value of milo stover silage when fed in combination with higher quality forages (forage sorghum silage or alfalfa haylage). Influence of type of forage (forage sorghum silage, milo stover silage or milo stover pellets) and alfalfa treatment (ground or dehydrated) on lamb performance, ration digestibility and nitrogen was determined in lamb growth and digestion trials.

Heifers fed the 100% forage sorghum silage ration in growth trials I and II or the 33% milo stover silage and 67% forage sorghum silage ration in growth trial II had greater performance than heifers receiving any of the other milo stover silage rations. When milo stover silage and forage sorghum silage were fed in combination, observed daily gains and feed efficiencies were greater than predicted gains and efficiencies by 10.7 and 13.0%, respectively.

In the lamb growth trial, those fed forage sorghum silage or milo stover pellets gained faster and more efficiently than lambs receiving milo stover silage. Lambs fed milo stover pellets consumed more dry matter than those fed forage sorghum or milo stover silages. Lambs fed dehydrated alfalfa pellets consumed more dry matter and were less efficient than lambs fed ground alfalfa hay.

In the lamb digestion trial, lambs fed milo stover pellets consumed the largest amount of dry matter. Dry matter digestibility and total digestible nutrients were highest for the forage sorghum silage and ground alfalfa hay ration. Both type of forage and alfalfa treatment affected dry matter digestibility, total digestible nutrients and percent of absorbed nitrogen retained. Digestion coefficients were higher for rations containing ground alfalfa hay than for those containing dehydrated alfalfa pellets. Lambs fed the milo stover pellet and dehydrated alfalfa pellet ration had the highest grams of nitrogen retention and percent of absorbed nitrogen retained. As dry matter intake increased, nitrogen retention increased, but digestibilities of dry matter, crude fiber and crude protein and total digestible nutrients decreased.

These results and previous research show 100% milo stover silage rations do not support acceptable performance for growing heifers; however, feeding milo stover silage in combination with higher quality forages supported satisfactory rate and efficiency of gain.