EFFECTS OF CATTLE AGE AND LENGTH OF GRAZING ON SUBSEQUENT FEEDLOT PERFORMANCE WITH EITHER A DRY ROLLED OR STEAM FLAKED CORN RATION

By

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TABLE OF CONTENTS

LIST OF TABLES

FORMAT OF THESIS

This Thesis is presented in the Journal of Animal Science style and format, as outlined by the Oklahoma State University graduate college style manual. The use of this format allows for the independent chapters to be suitable for submission to scientific journals. One paper has been prepared from the data collected for research to partly fulfill the requirements for the M.S. degree. The paper is complete in itself with an abstract, introduction, materials and methods, results and discussion, implications and literature cited section.

CHAPTER I

INTRODUCTION

Beef production in the United States is a very complex business. Unlike other meat animal producers, cattlemen have little ability to control the environment in which their product is produced. This can be viewed as a curse or a blessing. The positive aspect is that cattle derive most of their nourishment from plant and more specifically grass species. Because of this cattle can be raised in a variety of locations across the world and utilize a resource that in many cases would have no other productive use. However, because of the vast differences in the environment in which cattle are raised a great deal of diversification in cattle breeds has evolved. Negatively associated with a large number of breeds is a great amount of variation in size, type, color, maternal milking ability, marbling ability and growth potential, to mention a few. But the meat packing industry, and ultimately the public, demand a certain product of consistent quality. To combat this problem cattlemen have employed various management schemes in an attempt to minimize variation in the end product. Some of these programs have involved the use grazing or growing programs commonly referred to as backgrounding which dependent on geographic location vary both in length and vegetation type. These programs are well suited for cattle smaller in stature and muscle which require some amount of growing before being fed a high concentrate feedlot ration to produce carcasses.

of acceptable weight without excessive fat. While larger more heavily muscled cattle are placed in feedlots earlier to avoid exceeding ideal carcass weights. Because of these different programs feedlot managers are receiving similar looking cattle differing in age and backgrounding. This creates a unique problem in that these cattle will not necessarily have similar performance, carcass traits or profitability in the feedlot.

Oklahoma's rangeland and pasturelands are dominated by warm season grasses which during the growing season can be effectively used for growing cattle prior to entry into the feedlot (stockers). Two popular management schemes for utilizing this forage are Season long stocking (SLS) and Intensive early stocking (IES). SLS refers to placing cattle on grass in April or at the start of the growing season and removing them in September or October at the end of the growing season. IES refers to placing approximately twice the number cattle as would be on a SLS program on grass at the beginning of the season but removing them in July or approximately half of the grazing season. As a result, cattle from these progams enter the feedlot at different ages, different lengths of grazing and are fed at different seasons of the year. Previous research has consistently shown the SLS cattle to be inferior in feedlot efficiency when fed dry rolled corn rations (Gill et al., 1991; Gill et al., 1992; Gill et al., 1993a).

The objective of the current research was to determine the factor or factors responsible for depressed feed efficiency in the feedlot, be it length of grazing, or age, and then evaluate whether steam flaking the corn in the ration could correct this problem. The results of this research should enable producers and feedlot managers to better understand the interactions associated with some of the commonly used management systems and feedlot performance and carcass traits. Additionally, it should provide information on how to better manage cattle differing in age and background in the feedlot to improve profitability and efficiency of production.

CHAPTER II

LITERATURE REVIEW

Factors affecting feedlot performance

Backgrounding effects on feedlot performance

The climatic and environmental variation that exists in the United States coupled with hobby ranchers has resulted in an explosion in the number of beef cattle breeds and types varying in size, growth potential, milking ability and carcass characteristics. However, the fed cattle market has a narrow window in what it deems an acceptable product with the optimum carcass weighing between 650 and 750 lbs, grading choice and a yield grade less than 4, with non- compliance resulting in sometimes severe economic penalties. Lack of consistency in product is by far the biggest fault the beef industry suffers. Backgrounding cattle prior to entry into the feedlot is one way to narrow the variation in cattle. However, the end result of backgrounding is cattle differing in age and previous nutritional regime and requiring different amounts of time on feed. These effects need to be further studied to better understand the optimal program for different types of cattle to decrease the amount of variation in the end product and maximize economic returns.

The effects of pasture supplementation. One popular backgrounding program is to graze cattle on warm or cool season forages before entry into the feedlot. Due to the size of the beef cattle industry most producers will specialize in one area of production. Some may retain cattle through two phases but few will retain ownership through all phases. The goal is to maximize profit which usually means maximizing weight gains. To accomplish this in a stocker program supplemental energy or protein may by fed. Edwards et al. (1968), Wise et al. (1967), Suman and Woods (1966), and Duncan (1958) showed that as level of grain fed on pasture increased average daily gain (ADG) increased. However, Dowe et al. (1957) showed as gain on pasture increased, as result of grain feeding, the subsequent feedlot performance was depressed; which is consistent with the work of Perry et al. (1971) and Denham (1977). Contrary to this, Lake et al. (1974) improved grazing performance with grain supplementation and showed no negative effects on the subsequent feedlot performance. In a unique design Coleman et al., (1976) supplemented cattle on pasture to a constant body weight instead of a constant number of days in other studies. They reported no effect of pasture supplementation level on subsequent feedlot performance. This study suggested that much of the observed depressions in feedlot performance reported in previous studies may be due to a heavier weight and thereby an increased maintenance energy requirement and not simply some inherent effect of grain feeding or lack of compensatory gain.

The effect of winter weight gain. Production systems which graze cattle on summer pastures require holding calves over the winter. The effects of different levels of winter weight gain on the subsequent pasture and feedlot gain have been investigated. In general as winter weight gain increases subsequent pasture performance decreases with no net affect on feedlot performance or carcass characteristics (Lewis et al., 1990; White et al., 1987).

The effect of various backgrounding systems. Ridenour et al. (1982) compared five management schemes and evaluated their effect on subsequent feedlot and total performance. Treatments were as follows: (1) high concentrate (HC) throughout growing to 600 lb and finishing; (2) 50% concentrate diet to 600 lb (50C-600) and then HC; (3) 50% concentrate to 800 lb (50c-800) and then HC; (4) irrigated wheat pasture to 600 lb (WP-600) and then HC and (5) irrigated wheat pasture to 800 lb (WP-800) and then HC. HC made the fastest growing and overall gains and had the best feed to gain ratios with the exception of 50C-600 which had numerically but nonsignificantly superior feed to gain ratios in the finishing period 7.69 vs 7.78 for the 50C-600 and HC respectively. Carcass quality grade tended to be higher for steers grown on treatments HC, 50C-600 and WP-600 than for the other treatments. No significant differences were noted at slaughter for carcass weight, fat thickness, skeletal maturity, lean maturity, conformation or USDA yield grade. Steers grown on HC had higher dressing percentages, larger ribeye areas and more kidney, pelvic and heart fat than those in the other treatment groups. The authors concluded that even though desirable carcass characteristics were achieved, cattle should not be maintained on either wheat pasture or a 50% concentrate diet to 364 kg to produce maximum weight gain during the finishing phase and to reduce the overall length of a feeding program. However, the cattle used in this trial were no. 1 and 2 medium to large frame, had smaller lighter muscled cattle been used the results could have been different. In agreement with these findings White et al. (1987) reported Hereford Angus cross steers placed directly the feedlot had heavier carcass weights, higher quality grades and greater fat thickness's than cattle previously grazed on summer pasture before entering the feedlot.

A Florida study compared direct feeding with backgrounding for approximately 135 days on a limited intake concentrate ration and backgrounding on pasture before entering the feedlot. They reported steers backgrounded on pasture before finishing had significantly heavier carcasses and lower yield grades than the other two treatments. Steers that directly entered the feedlot with no backgrounding had higher marbling scores and although requiring more days on a high concentrate ration required less total days than either of the backgrounded groups (Baker et al., 1988). Other carcass characteristics were not consistently affected by feeding system, and feeding system had little effect on palatability traits (Johnson et al., 1988).

A summary of three research trials conducted at Nebraska and Florida comparing the effects of backgrounding calves vs placing them directly in the feedlot revealed the following results: ADG decreased (Sindt et al., 1988; Lewis et al., 1989), ADG increased (Bertrand et al., 1988), feed efficiency improved (Bertrand et al., 1988; Sindt et al., 1988; Lewis et al., 1989), average daily feed intake decreased (Bertrand et al., 1988; Sindt et al., 1988; Lewis et al., 1989), increased marbling score (Bertrand et al., 1988; Sindt et al., 1988) for unbackgrounded calves sent to the feedlot vs calves backgrounded before feedlot, respectively.

Intensive early stocking vs season long stocking. A common backgrounding program in Oklahoma is to graze cattle during the late spring and summer months on warm season native range predominated by tall grass prairie. Two commonly used grazing regimes are to graze the season long (SLS) for 150-180 days or stocking twice the number of cattle for only 75 to 80 days referred to as intensive early stocking (IES). A series of studies were conducted by the Oklahoma Agriculture Experiment Station to determine the effects of IES vs SLS on the subsequent feedlot performance and carcass characteristics. Results were as follows: ADG increased (Gill et al., 1992; Gill et al., 1993a), no differences (Gill et al., 1991), feed intake decreased (Gill et al., 1991; Gill et al., 1992), no differences (Gill et al., 1993a) for IES vs SLS, respectively. In summary, results consistently showed a depressed feed efficiency for SLS compared to IES cattle with no consistently significant effects on carcass characteristics (Gill et al., 1991; Gill et al., 1992; Gill et al., 1993a).

When comparing cattle backgrounded on pasture before entry into the feedlot to cattle sent directly to the feedlot and short grazed to long grazed cattle, the results are not totally consistent but some generalizations can be made. ADG is the most inconsistent trait measured but is usually increased for unbackgrounded and short grazed cattle compared to backgrounded and longer grazed cattle. Feed intake increases with length of backgrounding. Feed efficiency is consistently depressed with pasture backgrounding and longer grazing periods. A likely explanation for observed depression in feedlot feed efficiency was offered by Gill et al. (1993b); body composition was measured on steers prior to entry into the feedlot after their respective backgrounding program. The results of body compostition analysis revealed that long grazed steers had a higher proportion of empty body protein and this was inversely correlated (r^2=.66) to the efficiency of feed use in the feedlot. It therefore can be concluded that any backgrounding or growing program which increases the proportion of empty body protein will result in depressed feed efficiency during the subsequent feeding period. Similarly, a Nebraska study showed that calves from dams with an increased milking ability tended to have depressed feedlot efficiency due to increased maintenance requirements (Lewis et al., 1989).

Backgrounding and length of grazing appear to have little if any effect on carcass characteristics except for marbling score and fat thickness which increases with days on feed, and unbackgrounded or short grazed steers are usually fed longer. Additionally, cattle started on feed at younger ages or lighter weights require longer amounts of time on feed and will usually have lighter carcass weights at an acceptable degree of finish.

The effect of preweaning gain. The only production phase which has not been discussed in relation to its effects on the subsequent feedlot performance is preweaning gain. Drouillard et al. (1990) reported that increased preweaning gain improved feedlot performance and concluded that " finishing gain and efficiency were greatly affected by preweaning gain, indicating a genetic predisposition for growth, or an influence of early postnatal development on subsequent performance".

The effect of age. While the effects of grazing and backgrounding on subsequent feedlot performance have been explored it can not be concluded that results are solely an effect of the backgrounding per se. A very key difference other than backgrounding history is the cattle enter into the feedlot differing in chronoligical age. Age plays a key role in the efficiency of feed use by cattle. Younger cattle will be at an earlier stage on the growth curve and depositing more lean tissue relative to fat. Energetic efficiency expressed as calories consumed to calories deposited may not differ between lean and fat deposition and may, in fact, favor the deposition of fat due to differences in the maintenance requirements associated with different relative rates of turnover. However, Efficiency expressed as a feed to gain ratio will always favor cattle depositing more lean or protein relative to fat because lean tissue contains much more water which requires little energy expense. When comparing cattle differing in chronological age, usually referred to as calves and yearlings, the results are very consistent. Calves will require more days on feed, be finished at a younger chronological age, have lower feedlot gains, lower feed intakes, superior feed efficiencies, higher marbling scores, more backfat, and higher numerical yield grades (Lunt et al., 1986; Sindt et al., 1991; Hickok et al., 1992).

<u>The effect of environment.</u> The final point to consider in assessing the effects of cattle age and previous backgrounding regime is that, depending on the particular backgrounding program and the length there of, cattle will be entering the feedlot at different times of the year. Environment can play a profound role on the performance of feedlot cattle. It has been reported that cattle perform best when entering the feedlot in the summer, winter, spring or fall depending on where the study was conducted. The reason for these discrepancies is primarily one of different types of environment. In the colder northern environments such as Iowa and Colorado it has been reported that cattle perform the best during the warmer summer months (Birkelo et al., 1991; Muhamad et al., 1983; Pusillo et al., 1991). While in the desert southwest, gain and efficiency of feed use was depressed by as much as 25% under the hot summer conditions (Ray et al., 1969). In a summary of ten years of close outs for cattle placed in feedlots in western Kansas, cattle started in the spring months of March, April and May produced the highest and most efficient gains (Schroeder et al., 1991).

Environment plays a profound role on the performance of feedlot cattle and should not be overlooked. It can be generalized that the average or long term effect the environment plays will be consistent and dictated by geographic location, however, the short term effects of variation in weather conditions are not predictable.

The Effect of Trenbolone Acetate On Decreasing Maintenance Requirements

The use of synthetic anabolic steroids for increasing live weight gain and feed efficiency with beef cattle is widespread. Two major classifications of anabolics, estrogenic and androgenic, are used for growth promotion. Several commercial products are available with different active ingredients and dose rates. For this discussion, the only distinction made will be in regard to either estrogenic or androgenic activity. The emphasis will be on trenbolone acetate (TBA), an androgen, and its effect on maintenance energy requirements.

Trenbolone acetate is a synthetic androgen which binds to muscle cell receptors with higher affinities than testosterone (Meyer and Rapp, 1985). Ion pumping and protein turnover are two metabolic processes that are main contributors to the cost of basal metabolism. Research suggests that the cost of pumping Na^+ and K^+ ions across cell membranes accounts for 20 % or more of the total energy expenditure by skeletal muscle, gut and liver tissue (Milligan and McBride, 1985). The effect of anabolics on reducing the costs of pumping Na^+ and K^+ ions across cell membranes has not been examined but seems unlikely to have any effect. However, the energetic costs of protein turnover are recognized and the effect anabolics play in altering these costs has been studied (Hunter and Magner,1990; Hunter and Vercoe,1987; Sinnet-Smith,1983; Vernon and Buttery, 1976; 1978).

Urinary excretion of 3-methylhistidine has been used as an indicator of skeletal muscle turnover. Nishizawa (1979) showed 93.4% of the total 3-methylhistidine occurred in skeletal muscle protein and it was a valid method to estimate the skeletal muscle turnover in cattle. In rats (Vernon and Buttery, 1976, 1978) and sheep (Sinnet-Smith, 1983) in positive energy balance, TBA enhanced protein deposition by decreasing the rates of both protein synthesis and protein degradation in skeletal muscle, with the reduction in degradation being the greater resulting in a net increase in deposition. In cattle losing weight, Hunter and Magner (1990) found that treatment with 300 mg TBA had no effect on the rate of protein synthesis in skeletal muscle but, based on 3-methylhistidine excretion and rate of urea synthesis, rate of mucle degradation was reduced. Steers implanted with 300 mg TBA and on submaintenance diets lost less weight and excreted less 3-methylhistidine and urea in the urine, but rate of protein synthesis in the whole body was not effected (Hunter and Magner, 1990). Griffiths (1982) reported a significant reduction in urinary nitrogen excretion and increased nitrogen balance for steers implanted with TBA and resorcylic acid lactone vs controls. Additionally, a consistent but nonsignificant decrease in urinary excretion of 3-methyl histidine was noted for implanted cattle. Hunter and Vercoe (1987) significantly reduced fasting metabolic rate, measured via respiration chambers, in adult steers either losing weight or gaining weight slowly by implanting 300 mg of TBA.

Hunter (1989) improved live weight gain and feed efficiency in steers receiving pharmacological doses of testosterone. However there were no beneficial effects of testosterone in steers losing weight. This contrasts the effect of TBA, which has been shown to decrease weight loss (Hunter 1990) and have no effect on live weight gain (Apple 1991). These observations suggest that although trenbolone acetate and testosterone are both androgenic compounds, they apparently have different modes of action possibly due to varying sensitivity at the receptor site.

Varying doses of TBA and TBA + estradiol-17β were studied as a means of reducing weight loss in cattle (Hunter, 1993). A dose of 300 mg TBA was required to decrease weight loss of cattle on a submaintenance diet. Regardless of dose, estrogen and TBA combined had little effect on weight loss . Implantation with estradiol-17β had negligible effects on the maintenance energy requirements of steers either losing weight or gaining weight at moderate rates (Hunter and Vercoe, 1988). Estrogenic growth promotants have increased both fasting metabolic rate (Rumsey et al., 1980) and the rate of live weight loss of cattle fed submaintenance diets (Rumsey and Hammond ,1990). Thus any effect of TBA on reducing maintenance requirements may be negated by estrogen acting to increase energy requirements. Lobley (1985) concluded that 140 mg TBA + 20 mg estradiol increased nitrogen retention in steers indicative of increased protein deposition or decreased protein degradation. Stafford et al. (1981) concluded that TBA + E2 stimulated growth by reducing the ME required for maintenance. Griffiths (1982) reported that steers implanted with TBA + Zeranol (Z) had better feed efficiency than non-implanted controls. He postulated that the increased efficiency of TBA + Z steers was due to a reduction in the ME requirements for gain. Hayden and et al. (1992) reported no significant effect of 300mg of TBA alone or in combination with estradiol-17β on the rate of skeletal muscle breakdown. In a study involving implantation with TBA + estradiol 17β, heat production, measured via respiration chambers, was not significantly affected in steers gaining weight rapidly (Lobley et al., 1985).

Based on the literature, TBA alone, at doses of 8 mg/kg BW or greater, consistently decreased weight loss presumably through a decrease in muscle turnover and an accompanying decrease in the maintenance energy requirements (Hunter and Magner,1990; Hunter and Vercoe,1987; Sinnet-Smith,1983; Vernon and Buttery, 1976, 1978).

The exact mode of action by which androgens decrease muscle turnover is not entirely clear. Mayer and Rosen (1975) suggested that androgens may displace corticosterones, which are catabolic, from receptor sites in the muscle and thereby slow protein turnover. More recently, Mayer and Rosen (1978) suggested that androgens may reduce the number of corticosterone receptor sites within the muscle cell.

The effects of a combination of TBA, at lower than 300 mg, and estrogen are not as clear. Donaldson et al. (1977) reported a decrease in thyroid function with a combination of androgens and estrogens, and suggested that energy requirements may be reduced via regulation of basal metabolism by the thyroid.

Biochemical transactions in the liver and gut account for about half of the maintenance energy requirements (Lindsay and Oddy, 1986). However, TBA had no significant effect on protein turnover in the liver (Vernon and Buttery, 1976; Sinnett-Smith, 1983). Based on these results, it seems likely that most of the TBA induced reduction in protein turnover is occurring in the skeletal muscle. But, data are limited, and the possibility of TBA influencing gut and organ protein turnover should not be ruled out. It is hard to make any definite conclusions about the effect of TBA alone or in combination with estradiol on maintenance energy requirements. The mode of action for TBA or estradiol when given alone seems to be different than when given in combination. TBA when given alone appears to reduce protein turnover but when administered in combination with estrogenic compounds the results are variable. Estradiol given alone increased the concentration of growth hormone (GH) and insulin (Trenkle, 1983) but when given in combination with TBA, GH and insulin were similar to non-implanted controls (Hayden et al., 1992). It is well recognized that in cattle gaining weight the combination of TBA and estradiol improves live weight gain and feed efficiency over either one given alone (Apple,1991; Heiztman, 1976). Therefore, it has been suggested that these compounds act independently and the effects are additive (Trenkle, 1983). Anderson (1993) postulated that anabolic agents may affect protein and energy nutrition via three routes: altered feed intake, altered composition of gain, and altered cellular and molecular efficiency. Androgens and estrogens exert opposing effects on maintenance, but the combination results in a net increase in energy use for maintenance (Anderson, 1993). Effects of sex steroids are energy dependent and the effects of estrogens are not positive at or near maintenance (Anderson, 1993)

Although there is not complete agreement in the literature, namely due to differences in compounds used, dose rates, physiological state, sex, and age of animals used, it appears that TBA alone administered to animals losing weight or a combination of TBA and estradiol in cattle in positive energy balance decreases maintenance energy requirements. This is partially mediated through a decrease in skeletal muscle and perhaps even GIT protein turnover rate, however there may additional factors involved that are not clear at this time.

The Effect of Corn Processing on Feedlot Cattle Performance

The narrow cattle margins that have typically and continue to exist have forced feedlot operators to maximize the efficiency of operating by decreasing cost of gains via grain processing. There are two main purposes for processing grain. The first purpose is to increase the digestibility of starch. All methods of processing grain involve increasing surface area rendering the starch more accessible to the rumen microorganisms, which enhances rate of fermentation and increases rumen as well as total tract digestibility. Steam flaking takes this further by increasing the solubility of the starch in rumen fluid, thus further increasing the availability of the starch to rumen fermentation. Generally speaking, the greater solubility, the faster the rate of fermentation and the greater the total digestibility up to a point. Because this point is not well defined, it leaves room for differing opinions as to how much processing is necessary.

The second purpose and most important reason for processing grain is to maximize net energy intake by the cattle. This of course, includes total digestibility but also takes into account processing effects on the acceptability of the grain in the finished feed and processing effects on rate of digestion.

The effect of particle size. Feedlot rations consist of 85 to 92% concentrate. The chief constituent of these diets is corn, milo, wheat or barly. Adeeb et al. (1971) showed that corn particle size affects site and extent of starch digestion. Particle size plays a major role in regulating the extent to which particulate matter is digested while in the rumen and the rate at which it passes from the rumen (Wilson et al., 1973; Galyean et al., 1979). Finely ground grains are more extensively digested in the rumen. Therefore, the supply of starch to the small intestine is decreased when grains are ground or processed (Owens et al., 1986). Enzymatic digestion of starch in the small intestine is more energetically efficient than digestion in the rumen. Factors other than particle size reduction affect utilization of starch in the ruminant. These factors include: heating of grain, level of intake and roughage level of the diet. In situ procedures have been employed to determine effects of particle size on site and extent of digestion of grain. Galyean et al. (1981) used nylon bags to investigate the effects of particle sizes on digestion rate. Corn was ground and sieved to separate particles into portions with mean particle sizes of 6000, 3000 , 1500 and 750 microns. Dry matter disappearance (DMD) was significantly greater for the smaller particles comparted to the larger particles at incubation times up to eight hours. Starch digestion at eight hours was greater for the smallest (750 micron) particle size. In a similar study Anzola (1987) used a mobile dacron bag technique to measure dry matter and starch disappearance. Bags were placed in the rumen and subsequently in the duodenum and recovered in the feces. Before being placed in bags the ground corn was sieved and separated into the following sizes: 1) 2000-1000 2)1000-500 3)500-250 4)250-125 5) <125 microns. The extent of DMD both in the rumen and the intestines increased as particle size decreased. Starch digestion mirrored DMD, increasing as particle size decreased. In a similar study, Thomas et al. (1988) separated corn particles by sieving and used particles retained on the 4 mm , 2 mm and 1 mm screens as the particle sizes to be tested. Rate of DMD and starch disappearance per hour were similar for the 3 particle size groups. Their results conflict with some previous studies but might suggest that corn particle sizes over 1,000 microns have similar DM and starch disappearance rates whereas only those < 1,000 microns show an increased digestion rate as particle size decreases. The method of sieving corn in all these experiments was similar. Unfortunately corn particles separated by sieving may differ in composition, which could affect digestion. Galyean et al. (1981) recognized that this problem could bias results. Research that grinds all the corn to a specific size would remove this potential for variation and be useful to reach a recommendation for optimal particle size. However, impact milling by hammer mills and crushing with roller mills typically results in a range in particle size.

Walker et al. (1973) conducted studies with ruminally cannulated steers on a high concentrate diet. Total tract digestion of sorghum grain particles increased as particle size decreased. Galyean et al. (1979) fed whole shell corn or corn ground to three relatively fine sizes (508-832 microns). No statistical differences in total tract DMD and organic matter digestion (OMD) were detected, but both DMD and OMD tended to increase as particle size decreased. Total tract starch digestion followed the same trend, with whole shell corn being different from the smallest particle size (88.2% vs. 94.5%). Yet, starch digestion in the small intestine was greater for whole shell corn (32.2%) than for the average of the other three grinds (13.8%). Molar percentages of VFA's and total VFA concentration were not influenced by particle size. Results of this study suggest that corn processing may not affect performance. However, the feeding strategy (limit fed 3X daily), may have altered the results. Results might differ with animals given ad libitum access to their diet.

Kim and Owens (1985) fed duodenal and ileal cannulated calves (250 kg) diets that differed in roughage level and intake. In this trial calves were fed diets of a single particle size, but particle size was measured at the duodenum, ileum and in the feces. Starch particles greater than 2,000 microns in diameter escaped intestinal digestion while particles under 1,000 microns were extensively digested in the rumen. Particles between 1,000 and 2,000 microns tended to escape ruminal digestion but were extensively digested in the intestine. Results indicate that particle size after mastication may be more important than feed particle size, yet with limited mastication, as with larger cattle, particle size may be quite important.

In a study using 350 kg cannulated steers, Brink et al. (1982) fed diets of whole corn, cracked corn and a 50:50 mix of cracked and whole corn. Mean particle size of the diets was not reported. Particle size did not statistically influence total DMD and OMD, but there was a trend for ruminal DMD and OMD to be greatest for the cracked treatment followed by the cracked/whole and whole corn diets. Post-ruminal DMD and OMD represented a greater percent of total tract digestion for the whole corn diet. This study demonstrates the increased importance of post-ruminal digestion for whole corn diets. The particle sizes represented here probably were relatively large. One would also expect these larger calves to masticate less thoroughly. This study is in agreement with Galyean et al. (1981) who noted that there was little difference in DMD for larger particle sizes.

In summary, the in vivo and in situ studies generally agree that as particle size is decreased, DMD, OMD and starch digestion are increased. The extent to which processing increases digestion may be related to mastication which is a function of the size of the animal being fed and the feed intake level. The optimum particle size has yet to be determined and appears dependent on the age of calves being fed and the roughage level in the diet. Though many questions remain, one can conclude that as grain particle size decreases, digestion rate increases. A medium grind (800 to 2,000 microns) may produce optimal digestion and performance of feedlot cattle. Further research is needed to more closely define the optimal grain particle size.

<u>The effect of site of digestion</u>. It is generally accepted that starch digestion in the small intestine is more energetically efficient than fermentation to VFA's in the rumen due to heat and methane loses in the rumen (Armstrong et al., 1960). However there has been considerable debate on the capacity of the small intestine to digest starch. Larson et al. (1956) and Huber et al. (1961) showed incomplete digestion of intestinal starch of cattle receiving daily abomasal infusions of starch at a rate of 2.2 g/kg body weight. Based on these and other studies by (Little et al., 1968) and (Orskov et al., 1969) several hypothesis for the observed depression in the intestinal starch depression were proposed. Specific factors suggested to be responsible are 1) limited activity,

production or presence of inhibitors to specific starch digesting enzymes; 2) limited absorption of released glucose from the small intestine; 3) insufficient time for complete starch hydrolysis and 4) inadequate access of enzymes to starch granules due to insolubility or impenetrability of the starch granule. Based on a review of 40 papers Owens et al. (1986) concluded the major factor limiting starch digestion is the physical size of particles containing starch. The incomplete digestion of starch in the intestine observed in the trials with large pulse doses is not likely to exist under normal feeding conditions. Processing of feedstuffs increases starch digestibility in both the rumen and small intestine by decreasing particle size and or increasing surface area leading to increased efficiency of feed use by cattle (Hale, 1973).

Because energetic efficiency favors digestion of starch in the small intestine, this erroneously leads people to the conclusion that less processed grains which escape ruminal fermentation would be advantageous. However, less processed feedstuffs that escape ruminal fermentation arrive at the small intestine in a form which makes digestion difficult due to the physical form and the amount of time in which the grain is present in the small intestine, less than 3 h (Zinn and Owens, 1980). The ideal situation would be to have a well processed grain arrive directly in the small intestine. However, this is not likely under practical feeding conditions, so the processing of feedstuffs to maximize rumen fermentation will also maximize small intestinal and total starch digestion lending to optimal animal performance and efficiency of feed use.

Description of processing methods. A variety of grain processing systems are available and each system will have different effects dependent on the grain being processed. In general, milo and corn respond more favorably in terms of animal performance to processing than wheat or barley with the former having the greatest improvement. The main reason grain responds to processing is due to an increase in the surface area available for ruminal microorganisms and intestinal enzymes to attack. Additionally corn and milo have a relatively tough pericarp composed of a protein matrix, which resists digestion. Processing, breaking or damaging this area allows access to the starch rich endosperm by ruminal microorganisms and/or intestinal enzymes. In a study by McAllister et al., (1993) differences in the properties of the protein matrix were the major factors responsible for differences in ruminal digestion of ground corn and barley

Processing methods can be classified as dry or wet. Dry processing includes grinding, dry rolling, pelleting, popping, micronizing, roasting and extruding. While steam flaking, exploding, high moisture harvesting and reconstituting are in the wet processing category. The best (most economic and animal efficient) method of processing will vary depending on grain type, grain cost and supply, animal age, energy cost and others. While there are a variety of processing methods and grain types, the focus of this discussion will be on dry-rolled and steam-flaked corn.

The effects of dry rolling. Dry rolling and grinding are often referred to as conventional methods of corn processing. Dry rolling, also referred to as cracking, is accomplished by passing the grain through rollers which are usually grooved on the surface. The final product may vary in particle size from very small to coarse, and is influenced by roller weight, pressure and spacing, moisture content of the grain and rate of grain flow (Wagner et al., 1973).

Henderson and Geasler (1971) in a summary of 13 cattle feeding trials at various experiment stations reported that feeding dry ground and rolled corn resulted in a 5 % improvement in both rate of gain and feed efficiency as compared to dry whole shelled corn when corn comprised less than 70% of the ration. When corn made up 70 to 80% of the ration, rate of gain and feed efficiency of whole shelled and dry ground or rolled corn were similar. However, whole shelled corn appeared to slightly improve rate of gain when fed as 80% or greater of the ration. Vance et al. (1971) observed improved rate of gain and feed efficiency in steers fed all concentrate whole shelled corn compared to crimped corn rations. However, when roughage level was increased to greater than 4.55 kg corn silage per day, crimped corn was superior to whole shelled. Thus, the differences between whole shelled and dry rolled or ground corn may be related to the roughage level in the ration.

In an Ohio study, Vance et al. (1970) compared whole shelled, dry ground, and steam flaked corn. No effect was observed on rate of gain due to processing. Steers fed steam flaked corn were more efficient than those fed dry ground or whole shelled which were similar. No advantage of processing was noted by Burkhardt et al. (1969) in a study comparing whole shelled, dry rolled, reconstituted and steam flaked corn. Rate of gain and efficiencies were similar on all treatments.

Turgeon et al. (1983) compared whole, cracked, finely ground and a 50:50 mixture of whole and cracked corn. The mixture produced faster and more efficient gains than either the whole or cracked alone.

The effect of steam flaking. Steam flaking by heat and moisture treatments is a more modern processing technique than dry rolling. Flaking is accomplished by subjecting the grain to steam at atmospheric pressure for 15 to 30 minutes prior to rolling. Large, heavy rollers are set to produce a very thin, flat flake with a bushel weight of 10 to 12.7 kg and a moisture level of 16 to 20%. Flaking results in a rupturing of starch molecule known as gelatinization. The level of gelatinization can be influenced by any variation in the above factors (Wagner et al., 1973).

Henderson and Geasler (1971) in a summary of 9 trials conducted throughout the country reported no apparent change in daily gain, but a 7.3% improvement in feed efficiency over grinding or cracking. Vance et al. (1970) reported improved feed efficiency on steam flaked corn compared to whole shelled and dry ground corn in all concentrate diets. Inclusion of 10% corn cobs or 4% artificial roughage to the diet did not alter the improvement in feed efficiency obtained from steam flaking. No difference was observed in rate of gain among treatments. In contrast, McLaren et al. (1970) compared whole shelled, extruded and steam flaked corn which comprised 85 to 95 % of the ration. No improvement in rate of gain or feed efficiency was observed for steam flaking. In a digestion and metabolism study, Johnson et al. (1968) compared 70 to 80 % concentrate rations composed of either dry rolled or steam flaked corn. Flaking resulted in disruption of the starch granule as measured by loss of birefringence; a 9 hour faster rate of passage and decreased energy losses in the form of methane gas.

Ramirez et al. (1985) compared whole corn (WC), steam-flaked corn (SFC) or steamed-whole corn (SWC) in a 67% corn diet. They found SWC consumed more dry matter per day than those fed WC or SFC. Average daily gain was greater for steers fed SFC and SWC than for those fed WC and feed efficiency was better for steers fed SFC than for those fed WC and SWC. Carcass characteristics were not different among the three groups. In digestibility trials starch digestibility was greater for SFC than for SWC and WC while, DM and protein digestibility were not different for any of the treatments.

Lee et al. (1982) compared varying combinations of whole shelled (W) and steam flaked (SF) corn with the following combinations: 100W : 0SF, 75W :

25SF, 50W : 50SF, 25W:75SF and 0W:100SF. In experiment 1, cattle fed 75W:25SF and 25W:75SF gained faster than those fed the 0W:100SF diet while the remaining treatments resulted in intermediate gains. Feed efficiency was not different among treatments but tended to be better for the 25W:75SF treatment. In experiment 2, cattle fed the 25W:75SF and 0W:100SF diets gained faster than those fed the 100W:0SF and 75W:25SF diets. Although not significant feed efficiency was improved with the 25W:75SF and 0W:100SF diets compared with other diets. Based on these two trials the authors concluded that SF corn was superior to W corn. However, 25% W corn substituted for SF corn resulted in no effect on cattle performance. Galyean et al. (1992) showed steers fed W corn gained slightly more during the first 56 days than did those fed SF corn. From days 0 to 112, however, gain was less with whole than steam-flaked corn. For the entire experiment, daily gain was the same for the two types of corn but, daily DM intake was greater for steers fed whole corn diets which resulted in a 12% greater feed to gain ratio. These results are consistent with Schaack et al. (1993).

Zinn et al. (1987) compared the feeding value of dry rolled corn (DR) and (SF) corn in one performance trial involving 180 crossbred steers and one digestion trial involving six steers with ruminal and proximal duodenum fistulas, consuming 50.64 % corn diets. Average daily gain was not affected by grain processing, but feed intake was decreased 5.4% and feed conversion was improved 6.8% by steam flaking. Steam flaking improved starch digestibility by 6.6 % and increased the estimated net energy value of the diet 7.7% and 8.5% for maintenance and gain, respectively.

In summary dry rolled corn appears to affected by particle size. In general feedlot performance is improved as the particle sized is decreased, up to a point. Whole corn, however, appears to be superior to cracked corn when the roughage levels decrease to below 8-10%. Steam flaking, in most cases, is superior in terms of feed efficiency over dry rolled or whole corn. However, it appears that combinations of SF corn and W or DR corn can be as effective in improving feed efficiency as SF corn fed alone.

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CHAPTER III

THE EFFECT OF AGE AND LENGTH OF GRAZING ON FEEDLOT PERFORMANCE WITH EITHER A DRY ROLLED OR STEAM FLAKED CORN RATION[1]

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ABSTRACT

Yearling steers (117 head) and fall born calves (112 head) were used to determine the effects of age, date on feed (July vs September) and ration (dry rolled vs steam-flaked) on feedlot performance, carcass characteristics, OM and starch digestibility and total profitability. Yearlings entering the feedlot in July had been grazed on tallgrass prairie for 100 days while calves entering in July had no grazing history. In September, yearlings had grazed for 156 days while calves had grazed for 56 days during late summer. Calves were fed on average 21 days longer than yearlings, but there was no difference (P>.90) in average daily gain. However, calves consumed less (P=.08) feed and were more (P<.05) efficient than yearlings, on average. Grazing from July to September resulted in greater (P<.05) feed intakes for calves during the feedlot phase

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otherwise did not affect performance. The extended grazing period had no effect on performance of the yearlings. Gain and efficiency from day 56 until slaughter and overall feed efficiencies were improved (P<.05) by Steam flaking. However, most of the advantage for steam flaking was due to an age x starting date interaction (P<.15). Steam flaking improved (P<.05) overall feed efficiency and gain during the first 56 days for the cattle started in July but had no effect for the cattle started in September. Calf carcasses had (P<.05) less backfat, smaller ribeyes and fewer graded choice compared to yearling carcasses. Ration alone had no effects on the measured carcass characteristics. However, due to a age x ration and starting date x ration interaction steam flaking increased (P<.05) backfat and yield grade for yearlings compared to calves and increased (P<.05) backfat for cattle started on feed in July compared to September. Calves tended (P<.10) to have higher OM digestibilities compared to yearlings. Cattle started on feed in July had higher (P<.05) OM digestibilities compared to cattle started on feed in September. Steam flaking improved (P<.05) OM and starch digestibility as well as the calculated NEg of ration. Additionally the calculated NEg was for steam flaked compared to dry rolled corn was greater for the cattle started in July, while there was no effect of processing for September cattle. Calves had higher (P<.05) feedlot costs and lower (P<.05) carcass values which resulted in (P<.05) negative profits.

Introduction

Many different backgrounding programs are used by the beef cattle industry. Warm season grasses are used routinely for growing cattle prior to entry into the feedlot. Much of the grazing land in north central Oklahoma is dominated by tall grass prairie, a vegetation type composed the warm-season species big bluestem (*Andropogon gerardii Vitman*), indian grass (*Sorghastrum nutans (L.) Nash*), switch grass (*Panicum virgatum L.*) and little bluestem (*Schizachyrium scoparuim (Michx.) Nash*). Common grazing programs practiced on this vegetation type are season long stocking (SLS) and intensive early stocking (IES). Season long stocking refers to pasturing cattle from the beginning of the growing season, approximately the middle of April, through the end of the growing season, approximately the first of October. Intensive early stocking refers to pasturing with approximately twice the density of cattle for only half this time (from April to July). As a result, IES and SLS cattle enter into the feedlot with 60 to 75d difference in the duration of grazing and chronological age and 35 to 50 Kg difference in body weight. Previous studies demonstrated that feed efficiency during the feedlot phase was inferior for SLS compared to IES cattle (Gill et al., 1991; Gill et al., 1992; Gill et al.1993a).

Studies comparing calves to yearlings have consistently shown that calves are superior to yearlings in feed efficiency (Lunt et al., 1986; Sindt et al., 1991; Hickok et al. 1992). The slightly older age (100d) of SLS cattle may partially explain the poorer feed efficiency. The first objective of this research was to determine whether age or grazing time was responsible for the depressed efficiency.

In previous trials comparing feedlot performance of calves and yearlings (Lunt et al., 1986; Sindt et al., 1991; Hickok et al. 1992) and IES compared to SLS (Gill et al., 1991; Gill et al., 1992) feed intake was increased for the older and longer grazed cattle. Additionally, all these trials fed corn grain in the dry rolled form. Henderson and Geasler (1971) and Zinn (1987) reported that feed efficiency is 7.3 % and a 5.4 % superior for steam flaked corn over dry rolled or ground corn, respectively. Additionally, they reported that flaking had no effect on average daily gain, and the improvement in feed efficiency was due to decreased feed intake. In light of these findings our second objective was to determine if steam flaking the corn would reduce the effect of age or grazing history on feed efficiency.

Materials and Methods

One hundred seventeen yearling steers and 112 fall born calves were used to determine the effects of age, date of entry into the feedlot (length of grazing), and corn processing method on feedlot performance and feed efficiency. Spring-born crossbred yearling steers (British and British x exotic) originating from western Kansas were received at the Pawhuska research station (Pawhuska, OK) in March 1993. The yearling had been on wheat pasture for 30 to 60 days prior to shipment. Upon arrival, cattle were weighed, ear tagged, treated with Ivermectin® (MSD Ag Vet Merck. Division of Merck & Co, Inc. Rahway, NJ) and vaccinated against Clostridial organisms (sc), IBR, PI3, BRSV and Leptospirosis (im). During the recieving period, cattle were limit fed
(.91 Kg/hd/d) a 38% CP supplement and had adlibitum access to prairie hay and water. After the 28 day receiving period, yearlings were re-vaccinated, implanted with Synovex S® (Syntex, West Des Moines, IA) and placed on tallgrass prairie pastures. While on pasture cattle had free access to a trace mineral supplement and starting approximately the middle of July were supplemented 3 times weekly with a 38% CP supplement at a rate of .91 Kg/hd/day. On July 27 after 100 d of grazing, the yearlings were re-weighed, re-implanted and randomly assigned either to continue grazing for the remainder of the season (SEPT) or to be placed in a feedlot (JULY). Yearlings returning to pasture were re-implanted with Synovex S® (Syntex, West Des Moines, IA) and

yearlings entering the feedlot were implanted with Revalor® (Hoechst-Roussel Agri-Vet, Somerville, NJ).

Fall-born weanling calves (exotic and exotic x brahman) were purchased in June from northern Texas. The 28 d backgrounding procedure was similar to the yearling program. After the receiving period, calves were randomly assigned to either graze with the remaining yearlings until September (SEPT) or to go directly to the feedlot (JULY) with no grazing history. All calves were implanted with Synovex S® (Syntex, West Des Moines, IA) at this time. On September 21, the remaining calves and yearlings on pasture were shipped to the feedlot. Calves were re-implanted with Revalor® (Hoechst-Roussel Agri-Vet, Somerville, NJ) at either 56 or 28 days on feed for JULY and SEPT entry dates respectively. Both calves and yearlings were shipped 539 Km to the Panhandle State University feedlot (Goodwell, OK) for the feedlot phase of the study.

Upon arrival at the feedlot within both ages and backgrounding regimes cattle were stratified by weight coming off pasture, representing a heavy, medium and light weight replication and randomly assigned to pens. Within all ages, backgrounds and weight replications, pens were randomly assigned to either a steam flaked corn (SF) or dry rolled corn (DR) diet. There were a total of 24 pens with 3 pens per treatment. Diets were identical except for processing method (Table 1.).

Cattle were fed in pens holding 9 or 10 hd. Feedlot pens were outdoor (39 x 30 m) dirt pens which provided 117 to 130 square m/animal depending on the number of cattle per pen. The pens were equipped with 10.8 m of fence line bunks and automatic waterers. Dirt mounds approximately .6 to .9 m tall were located in the center of each pen.

The SF corn was purchased from a local commercial feedyard and transported daily to the site of the experiment, approximately 32 Km. Steam flaked corn was steamed for approximately 20 minutes at 121°c before being rolled through a 45.7 cm x 91.4 cm corrugated roller with approximately 559 Kg/ cm^2 of pressure. The desired flake contained 21.5% moisture and had a 11.7 Kg bushel weight. Dry rolled corn was rolled at the Panhandle State University farm. through an electric roller mill. The mill was adjusted daily to break the corn into approximately 4 to 8 pieces. The DR corn contained between 86 and 88% DM. All ingredients for both rations were mixed in a Rotomix feed truck and fed once daily in the PM.

All animals were weighed at 28 day intervals. The cattle were slaughtered in one of three groups when a commercial packer buyer deemed them acceptable. Cattle were slaughtered at Excel Corp. in Dodge City, KS. Hot carcass weights were determined immediately following slaughter. After the carcasses were chilled for 48 h, the following measurements were obtained: 1) longissimus muscle area, measured by direct grid reading of the longissimus muscle at the 12th rib; 2) subcutaneous fat over the longissimus muscle at the 12th rib, taken at a location 3/4 the lateral length from the chine bone end; 3) kidney, pelvic, and heart fat (KPH) as a percentage of carcass weight, and 4) marbling score (USDA, 1965).

Fecal samples were obtained at approximately 55 and 56 days on feed for all cattle to determine OM, starch and protein digestibility. Cattle were fed chromic oxide from days 47 to 56 of the feeding period. Chromic oxide was delivered in a pellet (10% chromic oxide, 90% cottonseed hull) that was added to the feed at a rate to provide 10 grams of chromic oxide/head/day. The pellet was top dressed to the daily feed allotment immediately following feeding. Samples were collected at 0700 and 1900 for two days and composited by pen. The composited samples were dried (100° C), ground through a 2 mm screen, and analyzed for ash, kjeldahl N (AOAC, 1990), chromium (Hill and Anderson,

1958) and starch (Macrae and Armstrong, 1968; modified by the use of a glucose kit, Sigma Chemical Co., St. Louis, Mo., USA.; EC 2.4.23.1).

Intial weight was determined by reducing the final pasture weight by 3%. The carcass-adjusted final weight was calculated by dividing hot carcass weight by 63.31 (the average dress for all kill groups). Average daily gain (ADG) was calculated from initial weight and a carcass-adjusted final live weight. Feed intake was expressed as the mean DM intake over the entire feeding period for each pen divided by the number of animals per pen (deads adjusted out). Feed efficiency (FE) is expressed as a ratio of feed to gain. First and second period gains and efficiencies were based on interim unshrunk live weights. Period 1 consisted of day 0 through day 56 whereas period 2 was from day 56 through slaughter.

Profit was calculated by subtracting total cost from total value. Total value was calculated by using a base carcass price of $112.80/cwt with a $7.83/cwt offal credit, a $5.00/cwt discount for select carcasses, a $11.13/cwt discount for yield grade 4's, a $12.50/cwt discount for carcasses less than 250 Kg or greater than 432, and a slaughter cost of $25.00/hd. Total cost included purchase price, pasture cost, feed cost and interest. The purchase price was determined from the average Oklahoma City price for the respective average weight and month in which the cattle were purchased , and was $105.57/cwt and $108.97/cwt for yearlings and calves, respectively. Pasture cost was calculated based on $.25/lb of gain on pasture and interest was charged at 9% / annum. Feedlot cost included ration costs of $120.25 and $123.75 for DR and SF, respectively, and a daily $.40/hd/ cost which included feed markup, yardage and interest.

This study had a 2 x 2 x 2 factorial arrangement of treatments. Data were analyzed by the GLM procedure of SAS (1988) with the main effects being age, starting date and ration plus all interactions. Pens were the experimental units. Interactions with an OSL (P<.15) for live performance, digestibility and economics were further analyzed, because all these data were based on 24 pen observations. However, Individual animal observations (229) were measured for carcass traits, so only interactions with an OSL (P<.05) were further analyzed.

Results and Discussion

Feedlot performance

No analysis was performed on the pasture performance due to the design of our study, but the data are summarized in (table 2). The performance of these cattle while on pasture was better than for a previous study reported by McCollum et al. (1991) grazing crossbred beef heifers on the same site. However, the performance was typical of cattle grazing tall grass prairie pastures in this region.

Age. The influence of age on feedlot performance is summarized in table 3. Calves were started on feed weighing 50 kg less than yearlings and were fed 21 d longer. However, at slaughter, the calves were 64 Kg. lighter than yearlings. Calves in this trial were fed an average of 150 d; in other trials comparing calves and yearlings, calves have been fed over 200 d (Lunt et al., 1986; Sindt et al., 1991; Hickok et al., 1992). The calves, in this study, were possibly not fed an adequate period of time.

The calves gained slower (P<.05) for the first 56 d on feed but 56 d to slaughter, the calves gained more (P<.05) rapidly than the yearlings. This data is consistent with Lunt et al. (1986) who showed cattle fed as yearlings start out gaining very rapidly but then gains decline linearly until slaughter. However, Calves start more slowly but, ADG steadily increases and is constant for a period of time before showing a decline at the end of the feeding period.

Averaged over the entire trial, ADG was not different between calves and yearlings which is not consistent with Lunt et al. (1986), Sindt et al. (1991) and Hickok et al. (1992). Had the calves in the current trial been fed longer or to a similar endpoint (fat thickness), ADG probably would have been lower.

Feed efficiency for the calves was 18% better than the yearlings, over the entire feeding period. Feed efficiency from d 56 to slaughter was 25% better for calves and accounted for this difference. Calves were younger and on an earlier point on their growth curve so presumably depositing more lean relative to fat, also lean body mass was lower which would decrease maintenance enery requirements. Lean tissue contains 3 to 4 parts water to 1 part lean (Bergen and Merkel, 1991), so deposition of lean inherently leads to deposition of more water. Feed efficiency expressed as kg feed/ kg gain will favor younger animals due to deposition of relatively large amounts of water. However, the energy content of protein is low (5.6 Mcal/kg) relative to fat (9.4 Mcal/kg) (Trenkle and Marple, 1983) and the energy associated with maintenance of protein relative to fat is higher due to faster turnover (Milward et al., 1976; Pullar and Webster, 1977). Thus, the energetic efficiency (Kcal consumed/ Kcal deposited) for deposition of lean relative to fat is lower hence, energetic efficiency was poorer for calves than for yearlings.

Daily dry matter intake (DMI) was lower ($P<.05$) for calves than for yearlings during all periods of the trial, but the greatest depression occurred during the first 56 d on feed. This agrees with previous reports (Lunt et al., 1986; Sindt et al., 1991; Hickok et al., 1992). An age x starting date interaction ($P<.15$) was observed for DMI (Table 4.). During the first 56 d on feed there was no difference in DMI for calves started on feed in JULY (no prior grazing history) and those started on feed in SEPT (56 d of late season grazing). However, yearlings which started on feed in JULY (100 d of early season grazing) comsumed more ($P<.10$) feed than did yearlings started on feed in SEPT (156d season of grazing). From 56 d to slaughter, SEPT calves consumed more ($P<.05$) feed than did JULY calves and SEPT yearlings consumed more ($P<.10$) feed than JULY yearlings. Over the entire feeding period, SEPT calves consumed more ($P<.05$) feed than did JULY calves, but DMI was similar for JULY and SEPT yearlings. Although the age x starting date interaction was not significant ($P>.15$) for ADG, the numerical trends were similar to those for DMI. JULY calves had not grazed, whereas SEPT calves had 56 days of grazing; this may have increased their capacity to eat more feed and gain faster upon entering the feedlot or the calves could have experienced some compensentory gain. However, this trend is not apparent for the yearling cattle.

Starting date. Feedlot performance for the main effects of starting date are listed in Table 5. Steers entering the feedlot in JULY were fed 24 kg lighter and were fed 14 days longer than steers entering in SEPT.

Feedlot performance varies for cattle with different types and lengths of grazing or backgrounding programs. In general, as length of backgrounding increases, ADG during the feedlot period decreases (Bertrand et al., 1988; Gill et al., 1992; gill et al., 1993a). In our study, ADG over the entire feeding period was not different between grazing treatments; this is not consistent with the studies mentioned above. No differences in ADG over the entire trial were detected, but ADG for the first 56 d, was greater ($P<.05$) for cattle entering in SEPT while, ADG for from 56 d to slaughter was greater ($P<.05$) for cattle started in JULY. The fact that SEPT cattle gained better during the initial 56 d could be due to compensatory gain from a previous lower plane of nutrition or more digestive tract fill.

A ($P<.15$) starting date x ration interaction (Table 6) was detected. Steam flaking ($P<.05$) improved ADG by 11 % from 56 d to slaughter for cattle started in

JULY but, grain processing had no effect on cattle started in SEPT . This could possibly be attributed to the increased amount of available energy and lower modified heat increment (Lofgreen, 1974) from steam-flaked corn. This would be more important in the hot months when cattle are heat stressed.

Feed efficiency was superior (P<.05) for cattle started in SEPT during the initial 56 d and then superior (P<.05) for JULY cattle from 56 d to slaughter. A starting date x ration interaction (P<.15) was detected for feed efficiency over the entire trial. Steam flaking improved (P<.05) feed efficiency by 9% for cattle started in JULY but grain processing had no effect on feed efficiency for cattle started in SEPT. Reviews by Morrison (1983) and Beede and Collier (1986) suggest that increasing energy density of the ration by addition of fat or increasing the ratio of concentrate to roughage in the rations of heat stressed cattle will partially alleviate the negative effects of heat stress on production. Grain processing that improves energy availability should have a similar influence. The NEg (NRC, 1984) for a 85% steam flaked corn diet, with no added fat, is higher (70 Mcal/cwt) than the NEg content of than a 81% dry rolled corn diet with 4% added fat (68 Mcal/cwt). Consequently, changing corn processing method may help in managing heat stress.

Dry matter intake during the first 56 d was not significantly affected (P>.45) by starting date (Table 5). But, DMI was higher for SEPT cattle than JULY cattle from 56 d to slaughter and over the entire trial. Consequently, feed efficiency was superior (P<.05) for SEPT over JULY cattle during the intial 56 d but inferior (P<.05) from 56 d to slaughter with no (P>.20) effect overall. The higher intakes and poorer efficiencies of SEPT cattle is consistent with previous studies (Bertrand et al.,1988; Gill et al.,1992; Gill et al., 1993a) who all reported higher feed intakes and poorer feed efficiencies as length of backgrounding or grazing was extended. Unlike previous trials with yearling cattle (Gill et al., 1991; Gill et al., 1992; Gill et al., 1993a) feed efficiency for longer grazed yearlings was not significantly affected. A possible explanation is the difference in growth implant regimes. All animals in the current study were implanted with Revalor, which combines estrogen with trenbolone acetate (TBA), an androgenic compound. The studies reported by Gill et al. (1991), Gill et al. (1992), Gill et al. (1993a) used implants with only estrogens (Synovex S). Trenbolone acetate increases muscle accretion by decreasing muscle turnover (Vernon and Buttery, 1976; Sinnet-Smith, 1983). Muscle turnover represents a large proportion of the maintenance energy requirements of cattle. Yearling steers with extended periods of grazing had higher lean muscle masses than younger or shorter grazed yearlings or calves (Gill et al. 1993b). If TBA decreases muscle turnover and maintenance energy costs, it would be most advantageous for long grazed or older yearlings and could improve feed efficiencies.

Corn processing Feedlot performance for the main effects of corn processing are presented in Table 7. Some grain processing effects interacted with age and starting date and have been discussed previously. Averaged across age and starting date steam flaking improved ADG ($P<.07$) and feed efficiency ($P<.05$) from 56 d to slaughter. Galyean et al., (1992) also noted that the primary advantage for steam flaking versus whole shelled corn occured in the period from 56 d to slaughter. Averaged acoss the entire feeding period, SF improved ($P<.05$) feed efficiency by 5 % with no affect on DMI. This improvement in feed efficiency over the entire feeding period for SF is consistent with results reported by Ramirez et al. (1985), Zinn (1987) and Galyean et al. (1992). However, the mechanism by which the FE is presumeably improved is not totally consistent with those studies. In the current trial, improved efficiency resulted from a higher daily gain with no effect on DMI which is consistent with the results of Ramirez et al. (1985). In contrast Zinn (1987) and Galyean et al.

(1992) found no advantage in gain but a decreased DMI. It appears that SF consistently improves feed efficiency compared to dry rolled or whole shell corn, but the exact mechanism by which improvement is achieved is not always the same.

CARCASS CHARACTERISTICS

Age. Carcass traits for the main effects of age are summarized in Table 8. Carcasses from calves had lower (P<.05) marbling scores, and fewer carcassed graded choice than yearlings. Carcasses from calves has less (P<.05) backfat when coupled with lower (P=.08) numerical yield grade and lower quality grades, suggests that the calves probably were slaughtered prematurely. In some previous studies calves were fed for a longer period which resulted in higher marbling scores, a higher percentage of choice carcasses and higher numerical yield grades than yearlings (Lunt et al., 1986; Sindt et al., 1991; Hickok et al., 1992). Calves had smaller (P<.05) ribeye areas than yearlings which agrees with Hickok et al. (1992). In contrast, Lunt et al. (1986) observed no difference in ribeye area between calf and yearling heifers.

Starting date. Effects of starting date are summarized in table 9. Carcasses from JULY cattle had more (P<.11) backfat and greater (P<.11) ribeye areas. There was no difference in carcass weight but, the greater ribeye area for JULY cattle resulted in more (P<.05) ribeye area per cwt of carcass. There was a (P<.05) age x starting date interaction (Table 10) for yield grade, ribeye area, and ribeye area per cwt of carcass. Compared with JULY calves, SEPT calves had higher (P<.05) yield grades, smaller ribeye areas and ribeye area/cwt carcass. In contrast, no differences were detected between JULY and SEPT for yearlings. The lack of differences in carcass traits for JULY and SEPT yearlings is consistent with the results of Gill et al. (1993a).

Grain processing. Effects of corn processing on carcass characteristics are summarized in Table 11. Grain processing alone had no effect on any carcass characteristics. But, an age x diet interaction ($P<.05$) was detected for backfat and yield grade (Table 12). Compared to dry rolling, steam flaking increased ($P<.05$) backfat and yield grade for yearlings but had no effect on these traits for calves. Calves may chew their food more thoroughly so that grain processing will be less beneficial for calves than yearlings. Steam flaking increased ($P<.05$) backfat for JULY cattle but not for SEPT cattle (Table 13). These results follow the same trend noted and previously discussed for cattle performance.

Digestibility

Age. Effects of age on digestibility are summarized in Table 14. Calves tended ($P<.10$) to digest OM and protein more thoroughly than yearlings. Younger and or smaller animals tend to chew their food more thoroughly than older or larger animals; this possibly could explain why calves had slightly higher OM digestibilities. The reason for higher protein digestibilities for calves is not totally clear. It could reflect OM digestibility or metabolic protein loss may differ with age.

Starting date. Effects of age on digestibility are summarized in Table 15. Cattle placed on feed in JULY had higher ($P<.001$) OM and protein digestibilities than SEPT cattle. Reasons for higher OM digestibilities for JULY cattle are not clear. Several researchers have noted depressed intakes and increased digestibilities associated with heat stress. Performance from 56 d on feed until slaughter was lower for SEPT cattle, which is consistent with lower digestibilities. An age x starting date interaction ($P<.15$) was detected for OM digestibility (Table 16). Although OM digestibilities were higher for JULY cattle, the difference between JULY and SEPT cattle in OM digestibility was greater for yearlings than for calves (14% vs 6%). The reason for higher protein digestibility by JULY cattle is not clear but it could mirror of higher ruminal OM digestibility and less microbial N in the feces.

Grain processing. Effects of corn processing on digestion are summarized in Table 17. Steam flaking improved (P<.004) OM digestibility 4.2% and improved (P<.009) starch digestibility by 5.4% with no effect (P>.34) on protein digestibility. These results are consistent with Zinn (1987) who reported higher OM and starch digestibilities for steam flaked compared to dry rolled corn. Ramirez et al. (1985) also reported higher OM and starch digestibility for steam flaked corn compared to whole corn. A starting date x diet interaction (P<.15) was detected for OM digestibility and calculated NEg (Table 18). Steam flaking increased (P<.05) OM digestibility over dry rolling for both starting dates but, the magnitude of the increase was greater for SEPT than for JULY (7.9% vs 3.5%, respectively). These results do not support the increased gain, improved feed efficiency and increased backfat previously reported for steam flaking for JULY cattle. Based on performance steamflaking increased the NEg of the ration more for JULY cattle than for SEPT cattle.

Economics

Age. Effect of age on production economics are summarized in Table 19. Total backgrounding cost did not differ (P>.10) between calves and yearlings. Total backgrounding cost includes both the purchase price and the pasture cost. The yearlings grazed longer and had a greater pasture cost, but the calves were purchased at a heavier weight and a higher price/cwt. The feed cost in the feedlot tended to be greater (P=.10) for calves than yearlings due to the longer feeding period. Total feedlot cost, which includes feed, yardage and interest, was greater (P=.05) for calves, but the total cost of production of calves was not higher (P=.22) than the total cost of production of the yearlings. The total carcass value was $55.24 less (P<.01) for calves. Had the calves been fed longer, this difference may have been smaller. The lower carcass value and slightly higher feedlot cost associated with the calves resulted in (P<.01) negative profit. Although the calves lost money, they had lower (P<.05) feedlot cost of gain ($.48 vs $.51). The total cost of gain from purchase to slaughterwas similar for calves and yearlings at $.47. The value calculated for calves and yearlings represents the value of the cattle from a packer standpoint and a producer standpoint if the cattle were sold on a grade and yield basis or some value-based marketing system.

Today most cattle still are sold on a live basis. It is doubtful that visual appraisal by a packer buyer would distinguish the value difference between the calves and yearlings in this trial. Had the cattle been sold on a live basis, calves would have received the same slaughter price/cwt of live weight as the yearlings which would possibly change the profitability. This suggests that to maximize profit, producers may need to market calf fed steers on a live basis whereas yearlings would benefit from a carcass-based system.

Starting date and grain processing. Effect of starting date on economics are summarized in Table 20. Backgrounding cost was greater (P=.13) for SEPT than JULY cattle due to the extended grazing period of SEPT cattle. Feed cost and total feedlot cost were greater (P<.07 and P<.05, respectively), for JULY cattle because of a longer time in the feedlot. No other measures were affected by starting date. Although, grain processing (Table 21.) had no significant effects on any calculated costs or value, numerical benefits for SF were seen for total value, profit, feedlot and total cost of gain.

IMPLICATIONS

Due to a lack of a depression for longer grazed yearlings in this study growth implanting programs may offer a way improve feed efficiency for long grazed cattle. Calves are superior to yearlings in feed efficiency and appear to benefit from a short backgrounding period, but may need to be marketed on a live basis for maximum economic return. The increased available energy associated with steam flaking may be an effective way to manage heat stress.

Table 1. Composition of diets (dry matter basis).

Ingredient	Rolled corn	Steam flaked corn
Alfalfa hay	9.00	9.00
Dry rolled corn	81.5	-----
Steam flaked corn	-----	81.5
Cane molasses	4.25	4.25
Meat & bone meal	.50	.50
Cottonseed Meal	3.35	3.35
Limestone 38%	.55	.55
Salt	.30	.30
Rumensin 60	.0225	.0225
Tylan 100	.0113	.0113
Vitamin A-40M	.0040	.0040
Urea	.50	.50
Trace mineral	.0112	.0112

Calculated Nutrient Composition:

Nutrient	(DM Basis)	
NEm Mcal / kg	2.08	2.19
NEg Mcal /kg	1.41	1.52
Crude protein, %	12.64	12.64
Potassium, %	.72	.72
Calcium, %	.50	.50
Phosphorous, %	.33	.33
Magnesium, %	.180	.180
Sulfur, %	.17	.17
Cobalt, ppm	.201	.201
Copper, ppm	8.2	8.2
Iron, ppm	51.3	51.3
Manganese, ppm	38.6	38.6
Selenium, ppm	.199	.199
Zinc, ppm	29.5	29.5

Table 2. Summary of performance for yearling steers or steer calves grazing from may until July (JULY) or September (SEPT).

ITEM	YEARLINGS		CALVES	
	JULY	SEPT	JULY	SEPT
WEIGHT, kg				
May	233	235	----------	----------
July	322	323	251	253
September	----------	347	----------	294
GAINS, kg				
May-July	88.1	87.2	----------	----------
July-Sept	----------	24.1	----------	41.2
Total gain	88.1	111.3	----------	41.2
Average daily gains, kg				
May -July, 100d	.88	.87	----------	----------
July- Sept, 56d	----------	.43	----------	.73
Total, 156d	.88	.72	----------	.73

Table 3. Performance of calves and yearlings during the feedlot phase.

ITEM	CALVES	YEARLINGS	SEM	OSL[b]
No. steers	112	117		
No. pens	12	12		
Initial weight, kg	274	324	.46	.001
Final weight, kg	494	514	5.0	.02
Days on feed	151	130	3.5	.001
Average daily gain, kg				
day 0 - 56	1.70	1.88	.05	.03
day 56 - slaughter	1.31	1.14	.02	.001
overall	1.46	1.47	.03	.95
Daily dry matter intake, kg				
day 0 - 56	7.6	8.7	.14	.001[ad]
day 56 - slaughter	9.1	9.9	.13	.001[ad]
overall	8.5	9.4	.12	.08[ad]
Feed : Gain				
day 0 - 56	4.5	4.6	.09	.34
day 56 - slaughter	7.0	8.8	.19	.001
overall	5.9	6.4	.09	.001

[ad] indicates a ($P<.15$) age x starting date interaction.
[b]OSL = observed significance level

Table 4. Average daily dry matter intakes for calves and yearlings entering the feedlot in July (JULY) of September (SEPT)[e].

	CALVES		YEARLINGS		
ITEM	JULY	SEPT	JULY	SEPT	SEM
Daily dry matter intake, kg					
day 0 - 56	7.5[a]	7.7[a]	8.9[bc]	8.4[bd]	.19
day 56 - slaughter	8.6[a]	9.6[bc]	9.7[c]	10.1[bd]	.18
overall	8.3[a]	8.8[bc]	9.3[bd]	9.4[bd]	.16

[ab] means differ ($P<.05$)
[cd] means differ ($P<.10$)
[e]age x starting date interaction ($P<.15$)

Table 5. Feedlot performance for steers entering the feedlot in July (JULY) or September (SEPT).

ITEM	JULY	SEPT	SEM	OSL[b]
No. steers	117	112		
No. pens	12	12		
Initial weight, kg	287	310	.46	.001
Final weight, kg	502	506	5.0	.56
Days on feed	148	133	3.5	.01
Average daily gain, kg				
day 0 - 56	1.71	1.89	.05	.03
day 56 - slaughter	1.30	1.16	.02	.001[dr]
overall	1.46	1.47	.03	.95
Daily dry matter intake, kg				
day 0 - 56	8.2	8.1	.14	.46[ad]
day 56 - slaughter	9.1	10.0	.13	.01[ad]
overall	8.8	9.1	.12	.08[ad]
Feed : Gain				
day 0 - 56	4.8	4.3	.10	.01
day 56 - slaughter	7.2	8.7	.19	.001
overall	6.0	6.2	.09	.21[dr]

[ad] indicates a ($P<.15$) age x starting date interaction
[dr] indicates a ($P<.15$) starting date x diet interaction
[b]OSL = observed significance level

Table 6. Average daily gain and feed efficiency for steers entering the feedlot in July (JULY) or September (SEPT) and fed dry-rolled (DR) or steam-flaked (SF) corn rations[c].

	JULY		SEPT		
ITEM	DR	SF	DR	SF	SEM
ADG, kg					
day 56 - slaughter	1.23[a]	1.36[b]	1.16[a]	1.16[a]	.03
Feed efficiency					
overall	6.3[a]	5.8[b]	6.3[a]	6.2[a]	.13

[ab] means with different superscripts are ($P<.05$) different
[c]starting date x ration interaction ($P<.15$)

Table 7. Feedlot performance of steers consuming rations composed primarily of steam-flaked (SF) or dry-rolled (DR) corn.

ITEM	DR	SF	SEM	OSL[b]
No. steers	114	115		
No. pens	12	12		
Initial weight, kg	299	298	.46	.34
Final weight, kg	502	507	5.0	.47
Days on feed	140	140	3.5	1.0
Average daily gain, kg				
day 0 - 56	1.79	1.80	.05	.90
day 56 - slaughter	1.19	1.25	.02	.07[dr]
overall	1.45	1.48	.03	.39
Daily dry matter intake, kg				
day 0 - 56	8.2	8.1	.14	.43
day 56 - slaughter	9.6	9.4	.13	.20
overall	9.1	8.8	.12	.22
Feed efficiency				
day 0 - 56	4.6	4.5	.09	.34
day 56 - slaughter	8.2	7.6	.19	.05
overall	6.3	6.0	.09	.03[dr]

[dr] indicates a ($P<.15$) starting date x grain processing interaction.
[b] OSL = observed significance level

Table 10. Carcass traits for calves and yearlings entering the feedlot in July (JULY) or September (SEPT)^{c}.

ITEM	CALVES JULY	CALVES SEPT	YEARLINGS JULY	YEARLINGS SEPT	SEM
Yield grade	2.14^{a}	2.45^{b}	2.62^{b}	2.37^{ab}	.10
Ribeye area, in^2	12.7^{b}	12.0^{a}	12.8^{b}	12.9^{b}	.16
Ribeye area, cm^2	82.6^{b}	78.0^{a}	83.2^{b}	83.8^{b}	1.04
Ribeye area/cwt of carcass, in^2/cwt	1.85^{b}	1.74^{a}	1.80^{ab}	1.78^{ab}	.03

^{ab}means with different superscripts are (P<.05) different
^{c}age x starting date interaction (P<.05)

Table 11. Carcass traits for steers fed dry-rolled (DR) or steam-flaked (SF) corn rations.

ITEM	DR	SF	SEM	OSL^{b}
Carcass wt, kg	318	321	3.2	.47
Marbling^{c}	402	410	9.09	.51
Choice,%	50	55	6.58	.60
Select,%	47	43	6.23	.72
Backfat, cm	.96	1.04	.03	$.10^{ar, dr}$
Yield grade	2.36	2.44	.07	$.47^{ar}$
Yield grade 4's, %	.92	2.59	1.30	.39
Ribeye area, in^2	12.6	12.7	.12	.45
Ribeye area, cm^2	81.9	82.6	.78	.45
Ribeye area/cwt of carcass, in^2/cwt	1.80	1.80	.02	1.0

^{ar} indicates a (P<.05) age x grain processing interaction
^{dr} indicates a (P<.05) starting date x grain processing interaction
^{b}OSL = observed signifcance level
^{c}300, 400 = slight and small degree of marbling, respectively

Table 12. Carcass backfat and yield grades for calves and yearlings fed rations containing dry-rolled (DR) or steam-flaked (SF) corn[b].

	CALVES		YEARLINGS		
ITEM	DR	SF	DR	SF	SEM
Backfat, cm	.35[a]	.34[a]	.40[a]	.48[b]	.02
Yield grade	2.37[a]	2.23[a]	2.35[a]	2.64[b]	.10

[ab] means with different superscripts are (P<.05) different.
[b]age x ration interaction (P<.05)

Table 13. Carcass backfat for cattle entering the feedlot in July (JULY) or September (SEPT) fed rations containing dry-rolled (DR) or steam-flaked (SF) corn rations[c].

	JULY		SEPT		
ITEM	DR	SF	DR	SF	SEM
Backfat, cm	.84[a]	.1.07[b]	.84[a]	.84[a]	.05

[ab]means with different superscripts are (P<.05) different
[c]starting date x ration interaction (P<.05)

Table 14. Digestibility, fecal profiles and calculated ration energy values for calves and yearlings.

ITEM	CALVES	YEARLINGS	SEM	OSL[b]
Digestibility, % OM	78.50	76.9	.65	.10[ad]
Fecal starch, %	14.7	13.8	2.24	.77
Starch digestibility, %	95	95.4	.91	.75
Fecal protein, %	15.3	15.6	.23	.33
Starch:protein ratio	.98	.91	.16	.74
Protein digestibility, %	68.1	64.7	1.37	.10
Calculated energy of ration				
ME, Mcal/cwt	3.1	3.0	.02	.14
NEm, Mcal/cwt	91.5	89.1	1.08	.13
NEg, Mcal/cwt	60.7	59.2	.68	.14

[ad] indicates a (P<.15) age x datein interaction
[b]OSL = observed significance level

Table 15. Digestibility, fecal profiles and calculated ration energy level for steers entering the feedlot July (JULY) or September (SEPT).

ITEM	JULY	SEPT	SEM	OSL[b]
Digestibility, % OM	81.4	74.0	.65	.001[ad,dr]
Fecal starch, %	15.8	12.6	2.24	.32
Starch digestibility, %	95.5	94.9	.91	.65
Fecal protein, %	15.8	15.3	.23	.33
Starch:protein ratio	1.04	.84	.16	.37
Protein digestibility, %	71.7	61.1	1.37	.001
Calulated energy of ration				
ME, Mcal/cwt	3.0	3.0	.02	.62
NEm, Mcal/cwt	90.7	89.9	1.08	.59
NEg, Mcal/cwt	60.2	59.8	.68	.67

[ad] age x datein interaction P<.15
[dr] starting date x diet interaction P<.15
[b]OSL = observed significance level

Table 16. Ration digestibility for calves and yearlings entering the feedlot in July (JULY) or September (SEPT).[d]

ITEM	CALVES		YEARLINGS		SEM
	JULY	SEPT	JULY	SEPT	
Digestibility, % OM	80.8[a]	76.2[b]	82.0[a]	71.8[c]	.92
Protein digestibility, % DM	71.3[a]	64.8[b]	72.0[a]	57.3[c]	1.94

[abc] means with different superscripts are (P<.05) different
[d]age x starting date interaction (P<.15)

Table 17. Ration digestibility for steers consuming dry-rolled (DR) or steam-flaked (SF) corn rations.

ITEM	DR	SF	SEM	OSL[b]
Digestibility, % OM	75.6	79.8	.65	.004[dr]
Fecal tarch, %	21.6	6.8	2.24	.004
Starch digestibility, %	92.5	97.9	.91	.009
Fecal protein, %	15.0	16.0	.23	.093
Starch:protein ratio	1.46	.43	.16	.005
Protein digestibility, %	65.4	67.3	1.36	.34
Calculated ration energy values				
ME, Mcal/cwt	3.0	3.1	.02	.01
NEm, Mcal/cwt	88.0	92.6	1.08	.01
NEg, Mcal/cwt	58.5	61.4	.68	.01

[dr] indicates a (P<.15) starting date x diet interaction
[b]OSL = observed significance level

Table 18. Ration digestibility and fecal protein for steers entering the feedlot in July (JULY) or September (SEPT) and fed rations containing dry-rolled (DR) or steam-flaked SF corn.[d]

ITEM	JULY DR	JULY SF	SEPT DR	SEPT SF	SEM
Digestibility, % OM	80.0[a]	82.8[b]	71.2[c]	76.8[d]	.92
Fecal protein, %	14.8[a]	16.7[b]	15.2[b]	15.3[b]	.33
Calculated ration energy levels					
ME, Mcal/cwt	2.9[a]	3.1[b]	3.0[a]	3.0[a]	.03
NEm, Mcal/cwt	86.8[a]	94.6[b]	89.1[a]	90.6[a]	1.53
NEg, Mcal/cwt	57.8[a]	62.6[b]	59.3[a]	60.2[a]	.96

[abc] means with different superscripts are (P<.05) different
[d]starting date x ration interaction (P<.15)

Table 19. Economic data calves and yearlings.

ITEM	CALVES	YEARLINGS	SEM	OSL[b]
Backgrounding cost	623.09	619.69	12.95	.85
Feed cost	172.80	163.50	3.77	.10
Total feedlot cost	233.26	215.43	5.20	.05
Total cost	856.36	835.13	11.93	.22
Total value	805.37	860.61	11.63	.01
Profit	(50.99)	25.47	10.23	.001
Feedlot cost of gain	.48	.51	.008	.02
Total cost of gain	.47	.47	.006	.94ad

[ad] indicates a (P<.15) age x datein interaction
[b]OSL= observed significance level

Table 20. Economic data for cattle entering the feedlot in July (JULY) or September (SEPT).

ITEM	JULY	SEPT	SEM	OSL[b]
Backgrounding cost	606.84	635.94	12.95	.13
Feed cost	173.23	163.06	3.77	.07
Total feedlot cost	232.30	216.40	5.20	.04
Total cost	839.15	852.34	11.93	.44
Total value	829.38	836.59	11.63	.66
Profit	(9.76)	(15.75)	10.23	.68
Feedlot cost of gain	.49	.50	.008	.47
Total cost of gain	.46	.47	.006	.19

ad indicates a (P<.15) age x datein interaction
dr indicates a (P<.05) datein x diet interaction
[b]OSL = observed significance level

Table 21. Economic data for cattle fed rations containing dry-rolled (DR) or steam-flaked (SF) corn.

ITEM	DR	SF	SEM	OSL[b]
Backgrounding cost	621.87	620.91	12.95	.95
Feed cost	167.69	168.61	3.77	.86
Total feedlot cost	223.89	224.81	5.20	.90
Total cost	845.78	845.71	11.93	.99
Total value	827.47	838.50	11.63	.51
Profit	(18.30)	(7.21)	10.23	.45
Feedlot cost of gain	.50	.49	.008	.32
Total cost of gain	.47	.46	.006	.38

dr indicates a (P<.05) datein x diet interaction
[b]OSL = observed significance level

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VITA 2

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