To the Graduate Council:

I am submitting herewith a thesis written by William Landon Backus entitled "Genotype x Nutritional Environment of Angus, Hereford and Angus-Hereford Cross Two Year Old Females Grazing Fescue-Legume or Fescue Pastures." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

J. W. Holloway, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

The Graduate School

GENOTYPE x NUTRITIONAL ENVIRONMENT OF ANGUS, HEREFORD AND ANGUS-HEREFORD CROSS TWO-YEAR OLD FEMALES GRAZING FESCUE-LEGUME OR FESCUE PASTURES

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ABSTRACT

Eighty, first calf, two-year-old Angus, Hereford, and Angus-Hereford reciprocal cross females were allotted to fescue-legume (40% legume) or fescue pastures over a two-year period (40 each in 1981, 1982). Legume consisted of red clover (Trifolium pratense L.), ladino white clover (Trifolium repens L.) and lespedeza (Lespedeza stipulacea Maxim). Females calved in January to March and calves from each dam breed were sired by Hereford and Angus bulls. Each female was fed 3.5 g Cr_2O_c in 354 g of feed at each of two feedings (0800 hr. and 1700 hr.) per day for 214 days (March 1 to October 1). Fecal samples collected were analyzed for chromium and acid detergent lignin (ADL). Forage ADL was estimated simultaneously from random forage samples. Digestibility of fescue-legume consumed 2.9 kg/day more ($P < .01$) more dry matter (DM) and 2.7 kg/day more ($P < .01$) digestible dry matter (DDM) than females allowed fescue (12.2 vs. 9.3 kg DM/day) and 9.05 vs. 6.35 kg DDM/day). Larger values for cows grazing fescue-legume resulted from advantages during the last part of the period. Values were similar during the first 45 days. Addition of legumes to fescue pastures resulted in a 15.8 kg increase ($P < .05$) in weaning weight for calves with Angus dams, a 16.3 kg increase ($P < .05$) for calves with Hereford dams and no difference ($P > .10$) for calves with crossbred dams. Angus females grazing fescue-legume produced .9 kg/day more ($P < .05$) more milk, Hereford females experienced a .4 kg/day increase ($P < .10$) and crossbred females a .4 kg/day decrease ($P < .10$)

over the corresponding breeds grazing fescue. Angus cows allowed fescue-legume gained 5.6 kg and .07 mm more ($P > .10$) weight and fat respectively than those allowed fescue. Herefords and crossbreds tended to gain much more weight and backfat on fescue-legume than on fescue. Herefords gained 8.2 kg more weight and .84 mm more fat and crossbreds gained 14.9 kg more weight and .78 mm more fat. Angus cows responded to increased nutrients by increasing milk production and calf growth rate, whereas Herefords and especially crossbreds responded more in terms of increases in cow weight and fatness.

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CHAPTER I

INTRODUCTION

A major goal of many cow-calf producers is to maximize beef production per acre from available forage. This is most often done in Tennessee by utilizing the many acres of permanent pastures of tall fescue. These pastures provide year-round grazing for most beef herds in Tennessee, and fescue provides adequate nutrition except during the summer and winter when it becomes dormant. Many producers have overcome this problem by renovating fescue pastures in late winter with legumes to provide for nutritional needs of grazing animals during the summer months.

Crossbreeding has also become an accepted practice for commercial beef cattle producers. The producer hopes to take advantage of heterosis produced by crossbreeding to achieve the goal of maximizing beef produced per acre.

The objectives of this research were to determine the effects of pasture type on the performance of first calving heifers and to identify the interactions between pasture type and breed.

CHAPTER II

LITERATURE REVIEW

Much research has been conducted in recent years to determine methods to increase forage utilization by beef cattle. Many species and combinations of forages, as well as different system to utilize these forages, have been examined to determine combinations to provide adequate nutrition for beef cattle on a year-round basis.

In addition to the various forages studied, many breeds and breed combinations have also been examined to ascertain the effects of breed on forage utilization. An attempt has been made to determine combinations of breed of cattle and species of forage to achieve the levels of performance which are desired. This literature review will deal with the complex interrelationships which exist between forages and cow and calf performance and, more specifically, with forage species adapted to Tennessee.

Factors Associated with Forage and Forage Management

Effect of Pasture Type on Animal Performance

The incorporation of legumes into grass pasture has long been an accepted practice for improving performance of grazing animals. Blaser et al. (1956), Burns et al. (1973), Bradley et al. (1977), Holloway et al. (1979), and Stricker et al. (1979) have reported increased animal performance when legumes were present in pastures. Blaser et al.

(1956) reported increased gains of steers grazing fescue-clover and orchardgrass-clover pastures when compared with fescue and orchardgrass alone. In addition, orchardgrass was superior to fescue when measured as liveweight gains during the grazing season. This is in agreement with Smith et al. (1975) and Garrigus et al. (1975) who reported increased liveweight gains of cows and calves and increased milk production of cows grazing orchardgrass pastures as compared to cows and calves grazing fescue.

Burns et al. (1973) reported the best cow and calf gains from tall fescue-ladino clover pastures and the poorest gains from tall fescue pastures. In this study, coastal bermudagrass was included in the forage mixture. It appeared that coastal bermudagrass had similar influences on animal performance during the summer as ladino clover in pasture swards containing tall fescue. Holloway et al. (1979) reported that Angus cows consumed more digestible dry matter and accumulated more weight and backfat when grazing fescue-legume pastures as compared to cows grazing fescue pastures. In addition, calves weaned from cows grazing fescue-legume were heavier at weaning although no significant differences were found in milk production between fescue and fescue-legume. The authors stated this was due to more nutrient intake from the pasture herbage.

Brown et al. (1963) reported that the digestibility of fall grown fescue increased or did not change with increasing age of the forage up to thirteen weeks. This was possibly explained by the fact that crude fiber and lignin did not increase with age in the fall as

in the spring. In the fall as temperature decreases, growth decreases; therefore, during the fall the plant has more stored carbohydrates which are not used for growth. This is a possible explanation for the effectiveness of stockpiled fescue as a late fall and winter feed.

Hill et al. (1979) reported Kentucky bluegrass-ladino clover pastures were superior to fescue-ladino clover pastures when measured as cow and calf gains during spring and summer. This apparently reflected the more rapid decrease in the quality of fescue as it matured. Bradley et al. (1982) reported a twenty pound advantage in weaning weight when comparing fescue-legume with fescue. This is within the range of values presented by Holloway et al. (1979) of forty pounds and Burns et al. (1973) of eighteen pounds.

Influences of Fertilization on Pasture Quality and Animal Performance

Varying results have been reported on the effects of fertilization of pastures. Most work has been done with nitrogen (N) fertilization and its influence on pasture quality, carrying capacity, and animal performance.

According to Stricker et al. (1979), who studied spring N fertilization of pastures, no N fertilization of fescue-legume pastures was better than 100 pounds of N per acre when measured in terms of conception rates and calf gains for a spring calving cow herd. In addition, the authors stated spring N fertilization would increase carrying capacity but decrease individual animal performance. This

is in agreement with Blaser et al. (1956), Van Keuren and Heinemann (1958), and Blaser (1964).

Blaser et al. (1956) reported that grasses plus N fertilization were inferior to grasses plus legumes when measured as individual animal performance. According to Blaser (1964), N fertilization improved the protein content of forages but did not alter the cellulose or lignin content and, in addition, lowered the soluble carbohydrates in forages, thus either lowering or not changing the TDN content of the forage.

Van Keuren and Heinemann (1958) found that N fertilization of grass-legume mixtures will tend to decrease the percentage of legumes in the pasture mixture. In summary, N fertilization will increase production per acre but reduce production per animal.

Influence of Grazing Systems on Animal Performance

Strip Grazing

Wilson et al. (1966) reported that Hereford cows that continuously grazed fescue pastures during the winter required hay after 60 days of the trial, whereas cows which strip grazed required hay after 101 days. Cows on the continuous grazed pastures did not lose as much weight (40.4 kg vs. 62.1 kg), however, there was no effect of grazing treatment on birth weight or 205 day weight of calves or the subsequent calving percentage of the cows. Strip grazing increased the carrying capacity of the pasture by 57 percent. These results agree with Blaser et al. (1959) who compared three grazing systems for spring grazing of dairy cows: strip, rotational and continuous. The authors stated that

the methods of utilization of forage had little effect on animal performance (measured as milk production) but a large influence on milk produced per acre. Strip grazing resulted in the highest production per acre with continuous the poorest and rotational intermediate.

Rotational Grazing

Bryant et al. (1961) reported the influence of rotational grazing on milk production in dairy cows in which first and second grazers were utilized. First grazers grazed until one-half of the available forage was removed. Second grazers were then allowed to remove the remaining forage to a height of 3 cm. First grazers exhibited more selective grazing and produced more milk but exhibited no advantage in weight change pattern than second grazers. Corn supplementation benefited second grazers more in terms of increased milk production than it did first grazers.

Creep Grazing

Blaser (1982) reported that calves allowed creep grazing increased weaning weight by 40 percent. This is in agreement with Hammes et al. (1959) and Hill et al. (1979) who also found that creep grazing benefited calves suckling low-producing dams more than calves suckling high-producing dams.

Stocking Rate

Ray et al. (1969), in a four-year study utilizing Hereford cows and three stocking rates, reported that cows on a light stocking rate

exhibited more selective grazing but also were consuming more mature forage than those on a moderate or heavy stocking rate.

Weight at first calving was equal for the light and moderate stocking rates and 100 pounds lighter for the heavy stocking rate. The light and moderate rates maintained this weight advantage over the four years of the study, and the authors stated that this difference was due to condition as frame size was approximately equal. In the light and moderate rates, more mature forage was consumed and legumes tended to disappear from pastures from an initial composition of 35-45 percent legume. In the heavy stocking rate, less mature forage was consumed, and more legumes appeared in the pastures.

For each increase in stocking rate, 500 pounds additional hay was needed to winter the cow. At first calving, birth weights were heavier in the light and moderate stocking rates, but no significant differences were found in subsequent years. Calves from moderately stocked pastures exhibited the heaviest weaning weights, with calves from heavily stocked pastures being the lightest and calves from lightly stocked pastures were intermediate. In terms of pounds of calves produced per acre, however, the heavy stocking rate produced 213 pounds per acre, the moderate 176 pounds per acre, and the light 114 pounds per acre. These results are in close agreement with Blaser et al. (1959).

Factors Affecting Forage Quality and Animal Intake and Performance

Several interrelated factors have been reported which influence the quality of forage and its subsequent intake and utilization by animals. Blaser (1982) reported that seasonal factors can improve or depress forage digestibility and intake and that digestibility and intake are usually higher in the spring and fall for most temperate forages. The author further stated that low digestible dry matter intake (DDMI) was the primary factor restricting output per animal and that available pasture and stage of growth directly influenced DDMI.

McCullough (1959) reported that seasonal variation in forages could influence the intake and utilization of forages. As forage digestibility increased, forage intake increased; and therefore as forage maturity increased, animal intake decreased. Also, as the variety of forages in a pasture increased, the animal selectivity increased. This is in agreement with Brannon et al. (1954), Hutton (1962), Blaser (1964), Hodgson (1968) and Horn et al. (1979).

According to Blaser (1964) perennial forages do not supply enough energy to maximize production, and protein is often in excess. The author reported a reduced feeding value as forages mature which was due to decreased consumption and a decrease in digestible energy. This decrease in digestible energy was associated with an increase in structural carbohydrates and lignification, a reduction in soluble carbohydrates and a reduction in digestible protein.

Van Soest (1965) reported that chemical composition of forages was more closely related to digestibility than to voluntary intake and that interrelationships between intake, digestibility and chemical composition were highly species oriented. Van Soest (1965) also reported a positive relationship between voluntary intake and lignin and stated that this was due to a grass-legume interaction since it is well documented that legumes contain a higher percentage lignin. In addition, the author reported that as cell wall constituents increased, voluntary intake decreased and suggested that a possible relationship between DM digestibility and voluntary intake depends on the proportion of digestible energy from cell wall constituents.

In summary, Blaser et al. (1959) stated that yields of beef per acre are influenced by animal species, animal management, stocking rate, amount of available herbage utilized, availability of herbage, amount of selective grazing, growth stage of the herbage and the mixture of forage species in a pasture. The authors further stated that producers must compromise to retain the stand of forage and to feed the animal with the best utilization of available forage. In addition, one must keep in mind that output per animal always decreases with the completeness of forage utilization.

Factors Associated with Variation in Animal Performance

Breed

As was stated in the introduction to this review, many breeds and breed combinations of cattle have been researched. Crossbreeding has become an accepted practice for commercial cattlemen.

Deutscher and Whiteman (1971), Thrift et al. (1979) and Bradley et al. (1982) have reported increased milk production and heavier weaning weights from crossbred dams as compared to straightbred dams. Deutscher and Whiteman (1971) utilized crossbred Holstein and Angus first-calf heifers and found that crossbred dams produced more milk ($P < .01$) and heavier calves ($P < .05$ than Angus dams. However, crossbred dams also lost more weight ($P < .01$) during lactation and had lower conception rates. This is in agreement with Kropp et al. (1973) and Holloway et al. (1975) who reported Holstein cows gave more milk and weaned heavier calves than Hereford x Holstein cows, which gave more milk and weaned heavier calves than Hereford cows. However, as milk production increased, feed requirements increased, and those cows not receiving adequate supplementation exhibited lowered rebreeding performance.

Melton et al. (1967) reported Angus cows produced more milk ($P < .01$) than Charolais, and Charolais produced more milk ($P < .01$) than Herefords. Charolais calves, however, exhibited the largest gains, Herefords the least and Angus were intermediate. Thrift et al. (1979), Stricker et al. (1979) and Bradley et al. (1982) reported that

cows suckling crossbred calves produced more milk than cows suckling straightbred calves.

This is somewhat in disagreement with Wyatt et al. (1977) who used Angus x Fresian (AXF) and Charolais x Fresian (CXF) calves and cross-fostered one-half of each calf type to the reciprocal straightbred dam. The authors found that calves on the high milk producing dams exhibited 19 to 23 percent more weight at weaning but that AXF and CXF calves suckling high producing dams were similar in weight and postulated that potential growth rate has little effect on milk intake and that advantages in growth rate of some breeds may not be genetic but are a result of the higher milk production of the larger, later maturing breeds.

Calf Sex

Melton et al. (1967), Deutscher and Whiteman (1971) and Rahnefeld et al. (1980) have reported bull calves were heavier at birth, consumed more milk and were heavier at weaning than heifers.

Milk Production

As was indicated in the previous sections, increases in milk production are highly related to increases in growth rate and weaning weight of beef calves. Jeffery et al. (1971), Wyatt et al. (1977), Boggs et al. (1980) and Worley (1981) found that calves suckling high producing dams consumed more milk, gained faster preweaning and weaned more weight than calves suckling low producing dams. Neville (1962), Boggs et al. (1980) and Worley (1981) found that milk production explained a large percentage (65-68%) of the variance in weaning weight.

Worley (1981) reported that shape of the lactation curve was related to weaning weight in that Angus cows with high peaks and low persistence of milk production weaned heavier calves than Angus cows with lower peaks and higher persistence of production. In addition, as milk intake increased, forage intake decreased.

Neville (1962) reported that milk is best utilized for growth by the calf during the first 60 days of life. Similar results were reported by Gillooly et al. (1967), Melton et al. (1967), Wilson et al. (1969), Wyatt et al. (1977) and Worley (1981).

Factors Affecting the Level of Milk Production and Milk Intake

Breed

As was indicated in previous sections, breed of dam can greatly influence milk production. Jeffery et al. (1971) reported that breed of dam explained 82 percent of the explained variance in milk production when studying Angus, Hereford and reciprocal crossbred cows. Kropp et al. (1973) and Holloway et al. (1975) found that introducing Holsteins into a crossbreeding program resulted in an increase in milk production.

Age of Dam

Marlowe and Gaines (1958), Brown (1960), Melton et al. (1967), Jeffery et al. (1971) and Boggs et al. (1980) have reported that age of dam influences milk production. Marlowe and Gaines (1958) reported

two- and three-year-old cows exhibited the lowest milk production with production increasing each year until six years of age. Six- to ten-year-old cows were found to be similar in milk production with a decrease occurring after ten years of age. This evidence is substantiated by Boggs et al. (1980) who found two- and three-year-old cows to produce the least milk and Jeffery et al. (1971) who found milk production to increase through three lactations and then level off.

Nutrition

Neville (1962), Baumgardt (1967), Gillooly et al. (1967) and Worley (1981) have reported that increased energy intake by cows within 60 days after parturition would result in increased milk production. Baumgardt (1967) also reported that the efficiency of milk production increased with increasing digestible energy intake up to a point where body fat is deposited at a significant rate. This is in agreement with Onks (1976) and Crider (1981) who stated that as milk production increased, efficiency of milk production increased.

The time at which increased nutrition is available to cows will also affect milk production. Holloway et al. (1979) in studying Angus cows grazing fescue and fescue-legume pastures reported no significant differences in milk production were detected between the two treatments. Digestible dry matter intake of cows grazing fescue-legume did not increase until the fifth month of lactation. This would indicate that the level of milk production is set early in lactation and for increased nutrition to have a large effect on milk production, it would

have to be available at parturition or shortly thereafter. This is in agreement with Boggs et al. (1980) who reported that cows calving in the middle of a spring calving season produced the most milk as the most lush spring growth of forage was available.

Brumby (1959) indicated a positive relationship between grazing time, rumination time and milk production. Montgomery and Baumgardt (1965a, 1965b) reported that as forage quality increased, grazing time increased. Forage quality also influences the milk intake of calves. As lactation progresses and milk production decreases, the forage intake of calves increases to meet nutritional needs. Worley (1981) reported that calves suckling cows on fescue-legume pastures consumed more forage and weaned heavier weights than calves suckling cows on fescue pastures. Furthermore, calves on fescue pastures depended more on milk to meet their needs due to the lack of nutrients from the available forage. Boggs et al. (1980) reported that forage intake by calves during the first two months post-partum had a negative influence on gain, but forage intake by calves during the fourth, fifth and sixth months post-partum increased gain. In addition, Holloway et al. (1979) reported calves from high quality pastures were heavier at weaning, although no significant differences were detected between cows grazing fescue-legume and fescue pastures.

Creep Feeding

Marlowe and Gaines (1958) reported that spring born calves were heavier at weaning than fall born calves, but that creep feeding of

fall born calves eliminated any weight differences. This is in agreement with Brown (1960) who also reported significant weight differences between calves on low quality pastures with access to creep feed gained faster than those on high quality pastures and at 240 days of age no significant differences were detected in weight. Calves on low quality pastures were much more efficient in the use of creep feed for growth than were calves on high quality pastures. This is in complete agreement with Bradley et al. (1977) and Hill et al. (1979). It would appear that creep feeding could be beneficial to increase weaning weights in times when forage quality is low.

Factors Associated with Individual Animal Variation in Forage Intake

It has been determined that increases in rate of digestibility of forages consumed by lactating cows will generally result in an increase in the voluntary intake of those forages. Brannon et al. (1954), McCullough (1959), Van Soest (1965), Hodgson (1968) and Nutt (1979) reported that animal variation in intake was dependent on individuality, level of production and body size, with increases in production and size resulting in increases in forage intake.

Nutt (1979) also stated that rumen volume was related to cow size and that rumen volume was a limiting factor for the consumption of low quality forages. This hypothesis is in agreement with Montgomery and Baumgardt (1965a, 1965b) and Conrad (1966). In addition, the author stated that increases in body weight, wither height, depth

and length were associated with increases in relative rumen volume and that there was a negative relationship between intake and fatness. Bines et al. (1969), Graham (1969) and Reid and Robb (1971) also reported decreased intakes with increased fatness.

Holloway et al. (1979) suggested something other than just physical limitations controls consumption. In studying Angus cows on high and low quality pastures, the authors expected intake to increase as digestibility increased over the grazing season due to physical limitations. However, the opposite occurred leading the authors to suggest some other factor controls consumption. Conrad (1966) reported acetic acid and other rumen metabolites can reduce feed intake and also that thermal stress reduced feed intake in cattle and sheep.

The Effects of Cow Size on Cow and Calf Performance

Brown et al. (1980) found that cow weight and fatness were seasonal and were highly related ($P < .01$) to day of the year but not to time post-partum. Taller cows had less severe weight losses and maintained more fat than shorter cows when grazing fescue-legume. Cows grazing fescue-legume tended to have similar weight change patterns, regardless of milk production, while cows on fescue pastures, which gave smaller amounts of milk, gained weight and fat at a much faster rate than those having higher milk production. Urick et al. (1971), in studying Angus, Charolais and Hereford cows, found that cow weight was positively related to calf weaning weight and negatively related

to weaning weight per unit of body weight. Vaccaro and Dillard (1966) reported that cows which lost less weight during the last 90 days of gestation produced calves which grew faster the first 60 days post-partum. Also, first calving cows which gained weight during lactation produced heavier calves. These results are in disagreement with Jeffery et al. (1971) and Rahnefeld et al. (1980). Jeffery et al. (1971) reported heavier cows at calving produced more milk but that increases in weight after calving were negatively correlated to milk production. Rahnefeld et al. (1980) found that changes in cow weight during lactation did not significantly affect weaning weight. Blaser (1982) reported that calf growth is not influenced, after three months of age, by the dam's weight changes if adequate high quality forage is available.

Ewing et al. (1967) reported when studying Hereford cows that larger cows have higher energy requirements and are less efficient in terms of milk production than smaller cows but that as milk production increased, the efficiency of milk production increased. In addition, for each 100 kg increase in cow weight there was a 9.78 kg increase in weaning weight. Onks (1976) and Crider (1981) found similar results in Angus and Angus, Hereford and reciprocal crossbred cows respectively. This is also in agreement with Wyatt et al. (1977) who reported that total digestible energy consumption (for the cow and calf) per kg of calf gain was lower at high milk production than at low milk production.

Gill et al. (1978) found that average daily gain of calves was positively correlated with dry matter, acid detergent fiber and gross energy digestibilities of dams. Apparent crude protein digestibility

was significantly correlated with cow body weight, weight to height ratio, and dry matter consumption per unit of weight ($P < .05$). As cow weight increased, crude protein digestibility decreased at an increasing rate. Crude protein digestibility was not related to body weight but was correlated with weight to height ratio. Therefore, fatter cows had lower crude protein digestibility.

Effects of Nutrition on Reproductive Performance of Beef Cows

The quality or level of nutrition provided beef cows, both before and after parturition, can have a profound effect on reproductive performance. Fleck et al. (1980) utilized Polled Hereford heifers and three levels of feeding from weaning time to a year of age to determine the effects of nutrition on reproductive performance of first calving heifers. Heifers were maintained on 100 percent of NRC requirements after calving. First service conception rates were not related to either weaning or yearling weight but were related to gains from weaning to yearling. Heifers with moderate gains exhibited the highest first service conception rates. Rapid growth from weaning time to a year of age was found to be beneficial to reproductive performance. Increased growth from a year of age to two years of age was found to be less beneficial. These results agree with Dunn et al. (1969) who found that pregnancy rate 120 days post-calving for two-year-old Angus and Hereford heifers was directly related to the level of energy intake during the time from parturition to 120 days post-partum. Two-year-old

heifers have an increased energy need when compared to mature cows due to the requirements for growth combined with the energy drain resulting from milk production. Low energy intake post-calving increased the number of heifers not showing estrus when compared to heifers with adequate energy intakes. Kartchner (1980) reported that supplementation of dry pregnant cows was only beneficial to reproductive performance in times of severe weather when adequate forage was not available. In periods of mild weather when adequate forage was available, grain supplementation was detrimental to forage intake and digestibility.

Wiltbank et al. (1962) reported that energy intakes of 150 percent of NRC requirements after calving by Hereford cows resulted in increased weight gain, a shorter period to first post-partum heat and a higher percentage of cows pregnant. This is in agreement with Kropp et al. (1973) and Holloway et al. (1975) who reported that higher producing Holstein and Holstein x Hereford cows required more energy post-partum in order to exhibit acceptable reproductive performance. In summary, it should be realized that the nutrient requirements of cows and especially first calving heifers increase dramatically after calving due to the increased demands of energy for milk production and in the case of first calving heifers for growth also.

CHAPTER III

GENOTYPE X NUTRITIONAL ENVIRONMENT OF ANGUS, HEREFORD AND ANGUS-HEREFORD CROSS TWO-YEAR-OLD FEMALES GRAZING FESCUE-LEGUME OR FESCUE PASTURES

Summary

Cow and calf performance was measured on 80 Angus, Hereford and Angus-Hereford reciprocal crossbred, first calving heifers over a period of two years. Females grazed either fescue-legume or fescue pastures, and an attempt was made to equalize breed across pasture treatment. Cow weight, cow fat, milk production and calf weight were measured monthly. The daily forage DM intake and digestibility were measured for cows using the Cr_2O_3-ADL ratio technique.

Cows grazing fescue-legume pastures consumed more forage DM ($P < .01$) that was of higher digestibility ($P < .01$) and weaned heavier calves ($P < .07$) than cows grazing fescue. Cows grazing fescue-legume also gained more weight and backfat than those grazing fescue. Hereford and especially crossbred cows tended to gain much more weight and backfat on fescue-legume than did Angus. Angus cows responded to fescue-legume pastures by increasing milk production and calf growth rate as compared to Hereford and crossbred cows grazing fescue-legume. Crossbred cows grazing fescue pastures tended to produce heavier calves ($P > .10$) at weaning than did crossbreds grazing fescue-legume.

Introduction

Many researchers have reported the effects of the addition of legumes to grass pastures (Blaser et al., 1956; Burns et al., 1973; Holloway et al., 1979). Likewise many researchers have reported the effects of crossbreeding on animal performance (Deutscher and Whiteman, 1971; Thrift et al., 1979; Bradley et al., 1982).

Few researchers, however, have combined a study to research the effects of pasture type and crossbreeding simultaneously. The purpose of this research was to: (1) determine the effects of pasture type on cow and calf performance, (2) determine the effects of crossbreeding on cow and calf performance and (3) study the interrelationships between pasture type and crossbreeding and determine the effect of these interrelationships on cow and calf performance.

Materials and Methods

Pasture Management

Eighty two-year-old, first calving Angus, Hereford and reciprocal crossbred heifers were alloted to two pasture types over a period of two years (40 each in 1981, 1982). Four 8.0 ha pastures were managed to provide two fescue-legume pastures and two fescue pastures. The fescue-legume pastures were renovated each year with 2.7 kg per ha of red clover and Kobe lespedeza and 1.4 kg per ha of Korean lespedeza. Fescue-legume pastures received only phosphorous and potassium fertilization, to meet soil test requirements, in March of each year while

fescue pastures received nitrogen, phosphorous and potassium fertilization, to meet soil test requirements, in early April of each year. The fescue-legume pastures were composed of 60-70 percent tall fescue and 30-40 percent legumes. Species found in the fescue-legume pastures included regal ladino white clover (Trifolium repens L.), red clover (Trifolium pratense L.), Korean and Kobe lespedeza (Lespedeza stipulacea Maxim), bluegrass (Poa pratensis L.) and Kentucky-31 tall fescue (Festuca arundinacea Schreb.). The fescue pastures consisted of Kentucky-31 tall fescue with a contamination of crabgrass (Digitaria sanguinalis L.), which occurred during the summer months. Cows were allowed to continuously graze the pastures on a year-round basis with hay harvested about June of each year fed to cows in their respective pasture treatments during the winter months.

Animal Management

Cows were bred to calve in January, February and March of each year, and all bull calves were castrated in April. Cows entered the study in December prior to calving and were obtained from four stations of the Tennessee Agricultural Experiment Station. Cows were randomly assigned to pasture type, however an attempt was made to equalize breed type and cow size among pasture treatments. Average calving date for cows was February 2. Calves from each dam breed were sired by Angus and Hereford bulls. Animals were rotated weekly between pastures in their respective pasture types to expose them to all forage species found in each pasture treatment. Water and a commercial salt, trace

mineral mixture were provided ad libitum. All calves were weaned in mid-October at an approximate age of 240 days.

Cow Body Measurements

Cow body measurements and photographs (using a grid chute) were taken in December preceding the start of each trial and again in October at weaning. Measurements recorded were weight, hook width (measured with a precision caliper) and fat thickness at the twelfth rib (measured ultrasonically, Swain et al. (1966)). Slides were projected to life size, and linear measurements were made: height at the top of the withers, length from point of shoulder to hooks and depth of heart. Cows were weighed and ultrasonic fat at the twelfth rib measured bi-weekly from March to April and then monthly from May to October. Calf weights were recorded monthly.

Estimation of Forage Intake and Digestibility

Total fecal DM excretion was estimated for each cow for a period of 214 days each year (March 1 to October 1) by the Cr_2O_3 dilution method (Linkous et al, 1954; Hopper et al., 1978). Cows were individually fed 354 g of a carrier feed containing 3.5 g of Cr_2O_3 at 0800 and 1700 hours each day. One AM and one PM fecal sample was collected from each cow each week during the trial, either by rectal grab sample or picking up fresh samples in the pastures (2,560 samples each year). Fecal samples were dried in a 60°C oven for 7-10 days and then ground in a Wiley mill using a 40 mesh screen to facilitate analysis. Acid detergent fiber (ADF) and acid detergent lignin (ADL) analyses were

done on each sample by methods described by Van Soest (1963). AOAC (1970) procedures were used to determine dry matter and ash content while Cr_2O_3 analyses were performed using an atomic absorption-emission spectrophotometer. Cr_2O_3 values were corrected for diurnal variation by methods described by Hopper (1977). Ten random forage samples from each 8.0 ha pasture were obtained monthly. Samples were dried in a 60°C oven, ground in a Wiley mill (40 mesh screen) and analyzed for dry matter (AOAC, 1970), ADF and ADL (Van Soest, 1963). DM indigestibility was calculated using the following formula:

$$\text{DM indigestibility} = \frac{\%\ \text{ADL (pasture)}}{\%\ \text{ADL (feces)}} \times 100$$

Milk Production

Lactation yields were estimated monthly from March to October for a total of seven estimates each year using the calf suckle technique. Calves were separated from their dams at 1800 hr. preceding the day of estimation, with cows being returned to their respective pastures and calves being penned in a central working area. At about 0600 hr. the following day, calves were weighed and then paired with their dams and allowed to nurse. After nursing, the calves were again separated and reweighed, and the difference in weight was assumed to be 12-hour milk production. This procedure was repeated at about 1800 hr. the same day, and the two 12-hour estimates were totaled to achieve a measurement of 24-hour milk production. Urine and feces losses were assumed to be negligible.

Statistical Analysis

Formulas used to obtain data used for comparison of least squares means are as follows:

1. DM intake (kg/day) = b_0 intake + (b_1 intake x Julian day) + (b_2 intake x (Julian day)^2)
2. Digestible DM intake (kg/day) - DM intake x DM digestibility
3. Cow weight (kg) = A + (A1 x sin(C x day)) + (A2 x cos(C x day)) + (A3 x (sin(2 x C x day))) + (A4 x (cos(2 x C x day)))
4. Cow fat (mm) = b_0 cow fat + (b_1 cow fat x Julian day) + (b_2 cow fat x (Julian day)^2)
5. Calf weight (kg) = b_0 calf weight + (b_1 calf weight x Julian day) + (b_2 calf weight x (Julian day)^2)
6. Milk production (kg/day) = b_0 milk + (b_1 milk x Julian day) + (b_2 milk x Julian day)^2)

Analysis of variance procedures were performed on the dependent variables: cow weight, change in cow weight, cow fat, change in cow fat, milk production, calf weight, change in calf weight, DM intake and digestibility, digestible DM intake, cow measurements (length, height, depth) and changes in cow measurements (change in length, change in height, change in depth). The model or variations of the model, $\hat{Y}$ = March 1 weight, year, pasture type, calving date, sex, sire breed (sire), dam breed (dam), sire x dam, sire x pasture type, dam x pasture type were used to calculate residual standard deviations and least squares means for each variable.

The variables involving change in variables over time were calculated by subtracting values recorded at the beginning of the trial from values recorded at the conclusion of the trial. These values may represent some bias as they only reflect total changes and do not reflect the pattern of these changes during the trial.

Results and Discussion

Forage Dry Matter and Digestible Dry Matter Intake

Females grazing fescue-legume pastures in 1981 consumed more forage DM and digestible DM as an average of the grazing season than did those grazing fescue pastures ($P < .01$, Table 1). Hereford and crossbred females grazing either fescue-legume or fescue tended to consume similar amounts of forage but more than Angus, with Angus cows tending to consume the least forage and Herefords consuming intermediate amounts. No significant differences were observed between breeds within pasture treatment. The trends shown by this data would agree with that of McCullough (1959), Brannon et al. (1954) and Nutt (1979) who reported that increases in body size or production would result in increases in intake.

Forage digestible DM intake was 2.70 kg/day higher ($P < .01$, Table 1) for females grazing fescue-legume pastures than for those allowed fescue pastures. Digestible DM intake for the two pasture types were similar in the early spring but became increasingly different as the grazing season progressed (Figure 1). This difference is a result of the small change in digestibility of fescue legume during

TABLE 1. Forage consumption of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures[a,b]

Item	Fescue-legume			Fescue			RSD[c]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
DM digestibility, %	73.7	74.1[d]	74.5[d]	68.7[e]	67.6[e]	68.3[e]	2.92
DM intake, kg/day	11.5	12.5[d]	12.6[d]	8.8[e]	9.0[e]	10.1[e]	.65
Digestible DM intake, kg/day	8.4	9.3[d]	9.4[d]	6.0[e]	6.1[e]	6.9[e]	.18

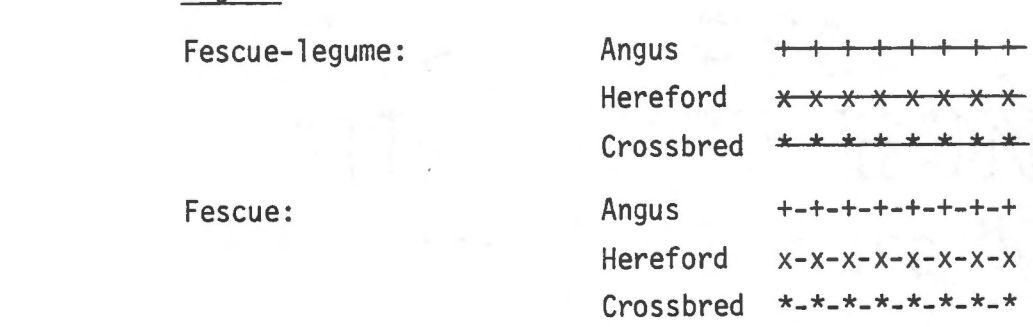
[a]Year 1981 only.

[b]Least squares means from the model: Item = March 1 weight, calving date, sire breed (sire), dam breed (dam), sire x dam, sex, pasture type, sire x pasture type, dam x pasture type.

[c]Residual standard deviation.

[d,e]Means on the same line with different superscripts are different ($P < .01$).

FIGURE 1. Digestible dry matter intake of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures



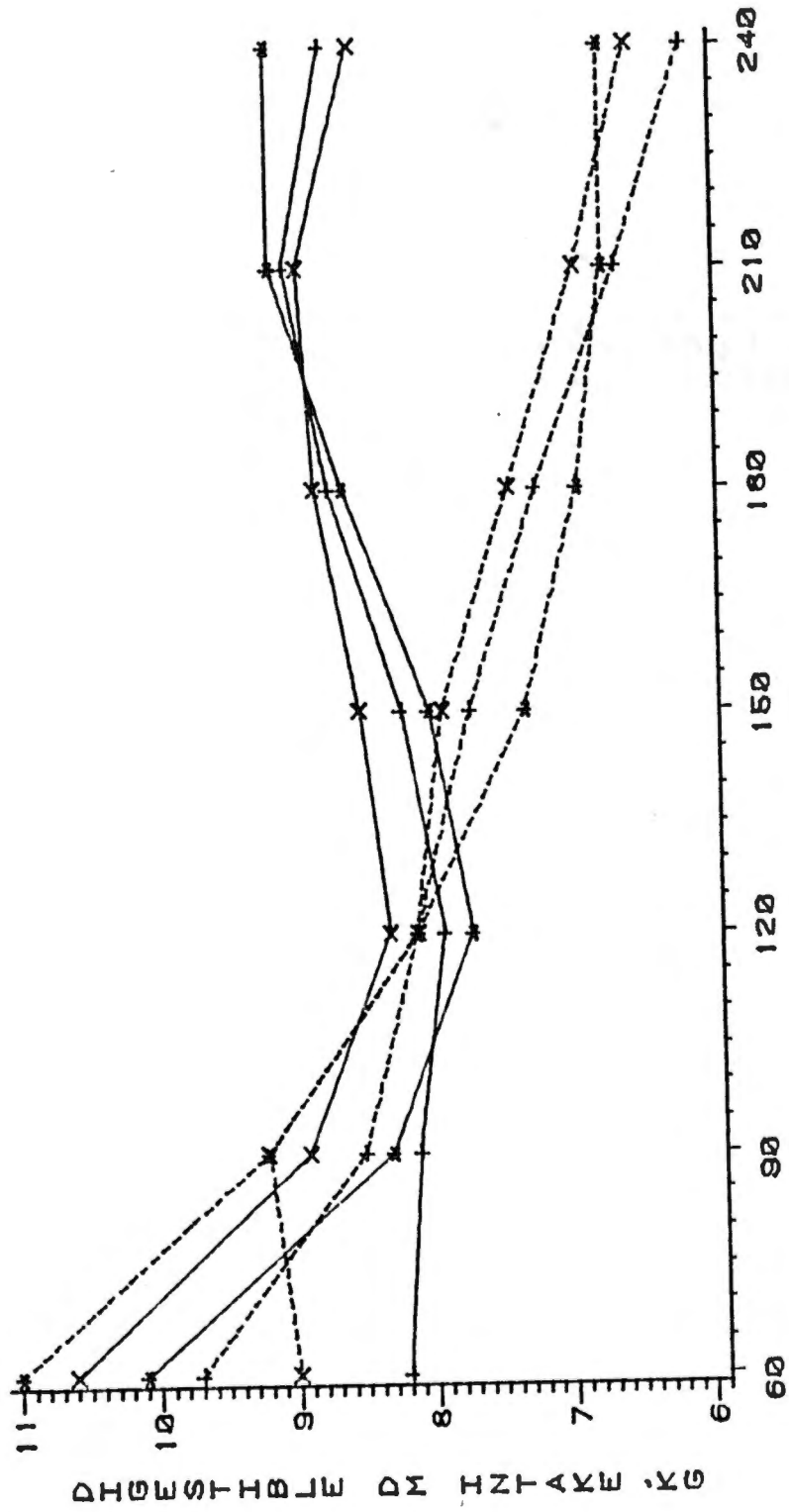


FIGURE 1

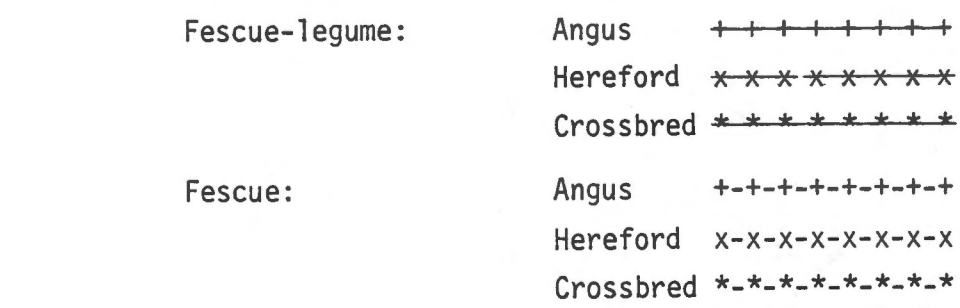
the summer and the gradual decrease in intake and digestibility for cows grazing fescue (Figure 1, Figure 2). Barth et al. (1972) and Beaty (1977) found similar patterns of change in intake and digestibility when studying fescue and fescue-legume pastures.

Percent Forage Digestibility

As an average of the grazing season, the digestibility of forage consumed from fescue-legume pastures was 4.6 percentage units higher ($P < .01$) than the digestibility of forage consumed from fescue pastures (72.5 vs. 67.9). These values were higher than those reported by Barth et al. (1972) who reported the digestibility of fescue-lespedeza to be around 60 percent for the summer months. Beaty (1977) reported digestibilities of 58 and 54 percent for fescue-legume and fescue respectively from these same pastures. Several factors may account for these higher values. Selective grazing by cows could cause overestimation of the digestibility of the pasture sward. If the digestibility of forage consumed by cows was higher than that harvested for forage analysis, this could greatly inflate the estimation of forage digestibility. Another possible explanation for these higher values is the cooler than normal temperatures during the early summer of 1981 which may have delayed maturing of the forage.

During the grazing season, digestibility of the fescue-legume remained stable while digestibility of fescue pastures decreased from spring levels and then increased in the fall (Figure 2). Beaty (1977) found similar trends for these same pastures. Blaser et al. (1956),

FIGURE 2. Dry matter digestibility of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures



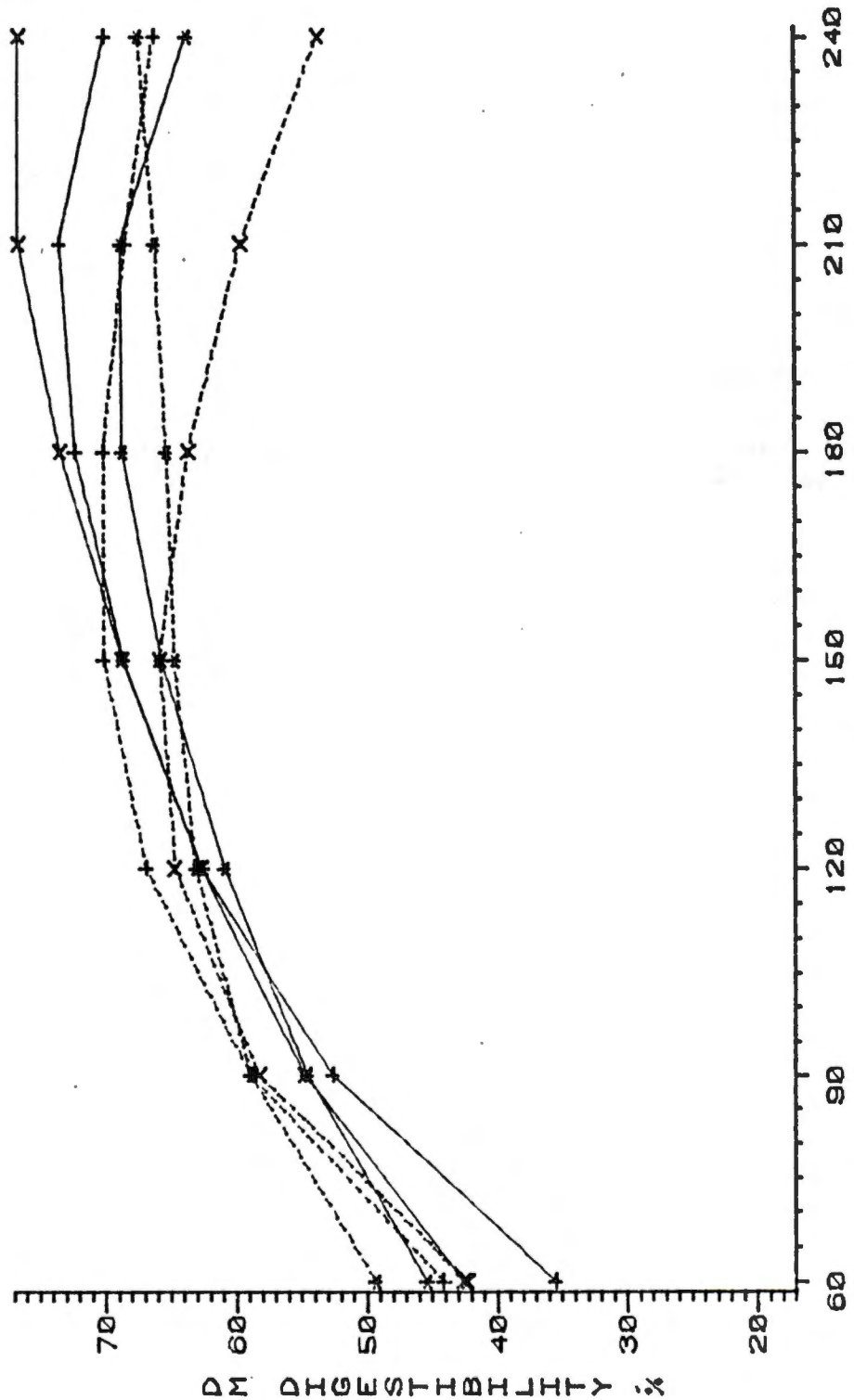

% DIGESTIBILITY OF DM
70
60
50
40
30
20
60
90
120
150
180
210
240
DAY

FIGURE 2

Brown et al. (1963) and Van Soest (1965) found that digestibility of fescue pastures decreased during the summer and increased in the fall. A recent development reported by Lacefield et al. (1983) and many others is a condition known as summer syndrome. The full effects of this syndrome are not yet characterized, but it is associated with cattle grazing tall fescue during the summer. Some outward signs are reduced feed intake, decreased rate of gain and/or milk production, rough hair coat, rapid breathing, increased body temperature and a generally unthrifty condition. An endophytic fungus, Epichloe typhina, has been shown to be associated with the occurrence of alkaloids in tall fescue which are closely associated with the summer syndrome condition. These alkaloids have been observed to have negative effects on animal performance. Summer syndrome may be a contributing factor to the poor performance exhibited by those animals grazing fescue pastures.

With respect to fescue-legume pastures, Barth et al. (1972) reported the digestibility of fescue-lespedeza pastures decreased slightly until June and then increased slightly, although non-significantly through September. This is in close agreement with results observed from this research and also with McCullough and Russell (1962) who found that digestibility of forage is related to maturity in that as summer progressed, digestibility decreased.

Seasonal Cow Weight and Fat Change

Females grazing fescue-legume gained more weight and backfat during lactation than those allowed fescue. Angus females allowed

fescue-legume gained only slightly more ($P > .10$, 5.6 kg and .07 mm) weight and backfat during lactation than those allowed fescue (Table 2). Hereford females grazing fescue-legume tended to gain much more weight and backfat ($P < .01$, 8.2 kg and .84 mm) than Herefords grazing fescue (Table 2). Crossbreds on fescue-legume tended to gain the most weight and backfat. When compared to crossbreds grazing fescue, they gained 14.9 kg and .78 mm more ($P < .01$) weight and backfat (Table 2).

Deutscher and Whiteman (1981) found that crossbred Holstein females lost more weight during lactation than Angus females. Bradley et al. (1982) also found that crossbred dams lost more weight and backfat during lactation than did straightbred dams when both dam types were grazing pastures composed of Kentucky bluegrass-legumes and fescue-legumes.

Angus females grazing fescue-legume tended to exhibit more growth in length ($P < .01$, 8.5 cm vs. 4.2 cm) than those grazing fescue, however, changes in height and depth were similar ($P > .10$, Table 2). Hereford females grazing fescue-legume exhibited increases in height (5.5 cm vs. 2.7 cm, $P < .01$, Table 2), length (8.6 cm vs. 3.8 cm, $P < .01$, Table 2) over those grazing fescue. Crossbred cows grazing fescue-legume also exhibited increases in height (3.6 cm vs. 2.8 cm, $P < .01$, Table 2), length (9.9 cm vs. 6.1 cm, $P < .01$, Table 2) and depth (2.2 cm vs. 1.5 cm, $P < .01$, Table 2) over those grazing fescue. It would appear from this data that females grazing fescue-legume, and especially Hereford and crossbred females, used some of the extra nutrients for growth when compared to females grazing fescue (Figures 3, 4). Angus

TABLE 2. Performance of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures[a]

Item	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
Initial wither height, cm	118.3^{h}	116.1^{h}	117.7^{h}	118.0^{h}	114.1^{i}	118.9^{h}	3.3
Final wither height, cm	120.5^{h}	121.6^{i}	121.2^{i}	120.2^{h}	116.8^{h}	121.7^{h}	3.1
Change in wither height[c], cm	2.2^{h}	5.5^{i}	3.6^{j}	2.2^{h}	2.7^{h}	2.8^{h}	2.9
Initial depth, cm	66.1^{h}	63.5^{h}	63.5^{h}	65.5^{h}	63.6^{h}	64.0^{h}	1.8
Final depth, cm	11.6^{h}	63.9^{i}	65.6^{i}	66.2^{h}	63.8^{j}	65.5^{k}	1.9
Change in depth[d], cm	.7^{h}	.4^{h}	2.1^{i}	.7^{h}	.2^{j}	1.5^{k}	2.2
Initial length, cm	124.9^{h}	124.8^{h}	122.9^{h}	126.0^{h}	125.4^{i}	123.5^{h}	5.5
Final length, cm	133.5^{h}	133.3^{h}	132.9^{h}	130.2^{i}	129.2^{i}	129.6^{i}	5.6
Change in length[e], cm	8.6^{h}	8.6^{h}	9.9^{h}	4.2^{i}	3.8^{i}	6.1^{h}	12.7
Initial cow weight, kg	337.8^{h}	338.3^{h}	334.9^{h}	337.8^{h}	338.5^{h}	335.8^{h}	54.3
Final cow weight, kg	355.5^{h}	358.1^{i}	356.1^{i}	349.9^{h}	350.1^{h}	342.1^{j}	57.6
Change in cow weight[f], kg	17.7^{h}	19.8^{h}	21.2^{h}	12.1^{h}	11.6^{h}	6.3^{h}	26.2
Initial cow fat, mm	2.0^{h}	2.0^{i}	1.8^{i}	1.9^{h}	2.2^{h}	1.8^{h}	.5
Final cow fat, mm	2.2^{h}	2.9^{i}	2.7^{i}	2.1^{h}	2.2^{h}	1.9^{h}	.9
Change in cow fat[g], mm	.2^{h}	.9^{i}	.9^{i}	.1^{h}	.05^{h}	.1^{h}	.8

[a]Least squares means from the model: Item = March 1 weight, year, pasture type, sex, calving date, sire breed (sire), dam breed (dam), sire x breed, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

[c]Final wither height (October 1) - initial wither height (March 1).

[d]Final depth (October 1) - initial depth (March 1).

[e]Final length (October 1) - initial length (March 1).

[f]Final weight (October 1) - initial weight (March 1).

[g]Final fat (October 1) - initial fat (March 1).

[h,i,j,k]Means on the same line with the same superscript are not different (P > .10).

FIGURE 3. Seasonal cow weights of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures

Legend

Fescue-legume:	Angus	+-+-+-+-+-+-+-+
	Hereford	x-x-x-x-x-x-x-x
	Crossbred	*-*-*-*-*-*-*-*
Fescue:	Angus	+-+-+-+-+-+-+-+
	Hereford	x-x-x-x-x-x-x-x
	Crossbred	*-*-*-*-*-*-*-*

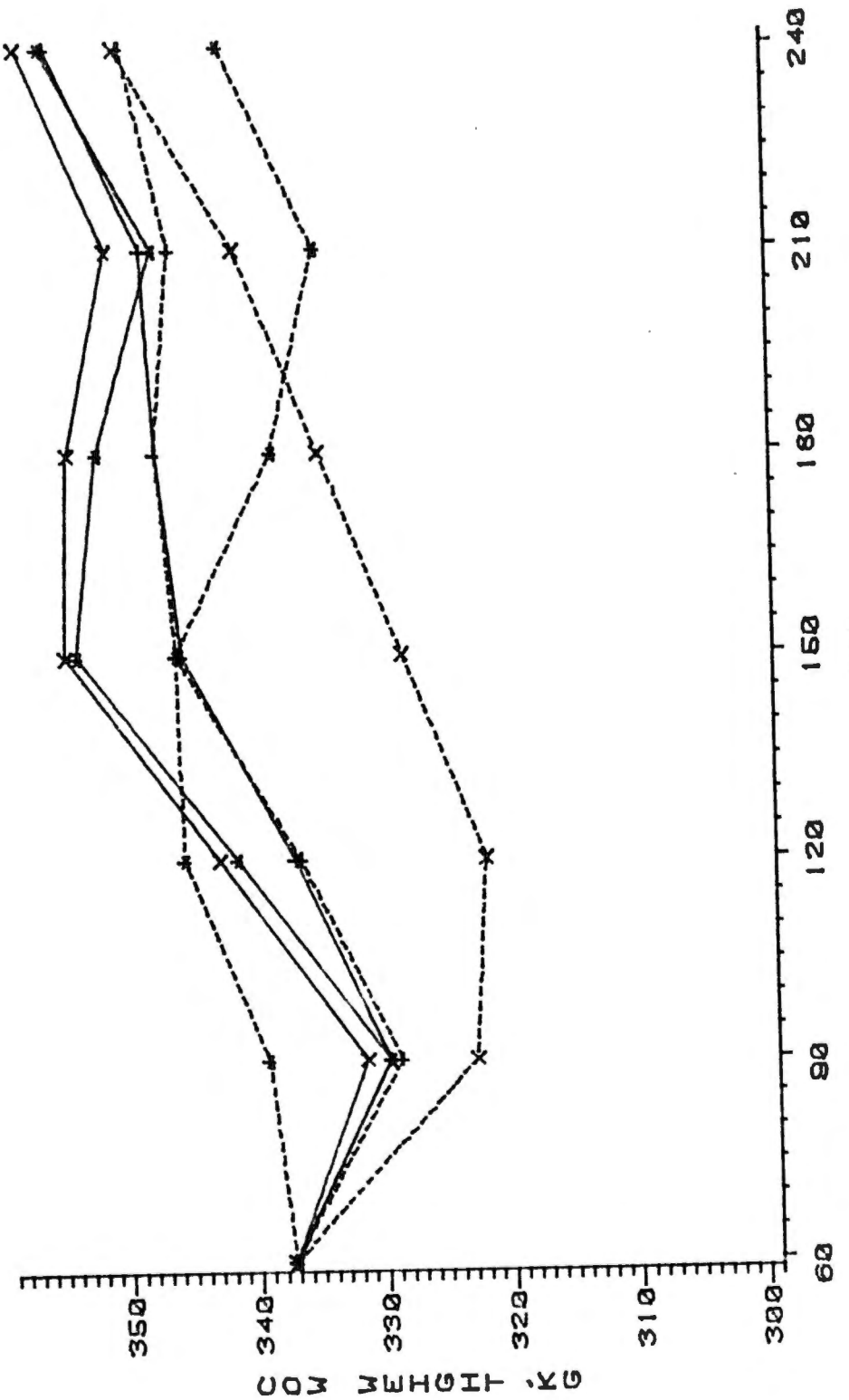

COW WEIGHT, KG
350
340
330
320
310
300
60
90
120
150
180
210
240
DAY

FIGURE 3

FIGURE 4. Seasonal backfat of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures



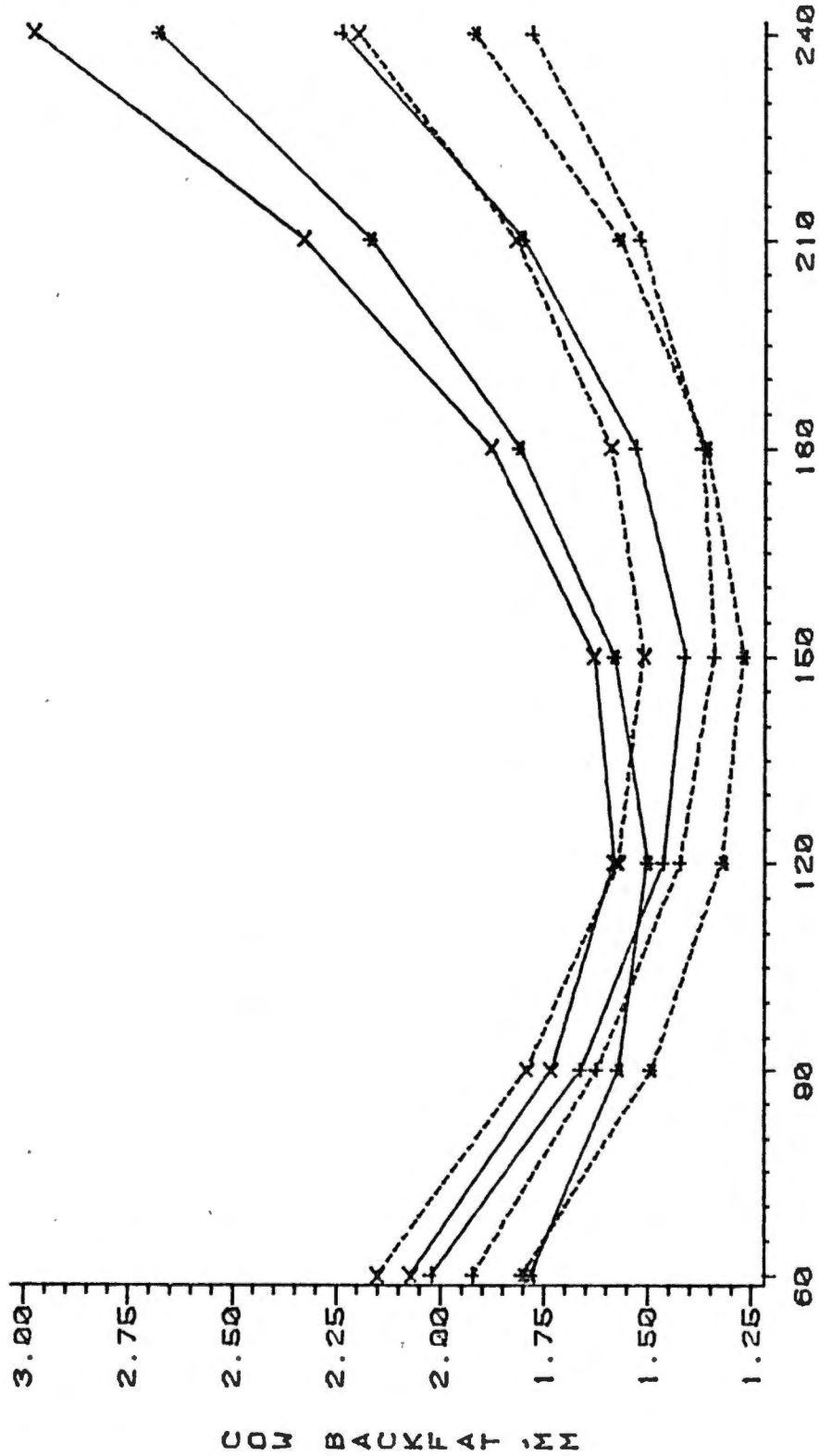

COW BACKFAT, MM
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
60
90
120
150
180
210
240
DAY

FIGURE 4

females grazing fescue-legume exhibited lower increases in growth (weight, fat, height, length, depth) than did Hereford and crossbred females due to their use of extra nutrients for increased milk production.

Milk Production and Calf Growth

Addition of legumes to fescue pastures resulted in increases in average milk production during lactation of .9 kg per day for Angus females ($P < .05$, 5.1 vs. 4.2 kg/day, Table 3). Herefords had a .4 kg per day increase ($P < .05$, 4.7 vs. 4.3 kg/day, Table 3) and crossbreds a .4 kg per day decrease ($P < .05$, 4.2 vs. 4.6 kg/day, Table 3). Worley (1981) reported that shape of the lactation curve was related to weaning weight in that females with similar levels of milk production exhibiting high peaks and low persistence weaned heavier calves than those with lower peaks and higher persistence of milk production. Angus females grazing fescue-legume and crossbred females grazing fescue, in addition to giving more average milk, exhibited those type curves with high peaks and low persistence (Figure 5) and also weaned the most weight (Table 3). Similar trends to milk production were noted for calf growth. Angus cows allowed fescue-legume weaned 15.8 kg heavier calves (153.5 vs. 137.7 kg, $P < .05$, Table 3) (Figure 6). The increase for calves with Hereford dams was 16.3 kg (144.9 vs. 128.6 kg, $P < .05$, Table 3) (Figure 6), whereas for calves with crossbred dams there was no difference (144.9 vs. 148.7 kg, $P > .10$, Table 3) (Figure 6). This is a reflection of the higher milk production of crossbred dams grazing fescue who also exhibited lactation curves with high peaks and low

TABLE 3. Milk production and calf weaning weight of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures[a,b]

Item	Fescue-legume			Fescue			RSD[c]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
Milk production, kg/day	5.1[e]	4.7[e]	4.2[f]	4.2[f]	4.3[f]	4.6[e]	.8
Weaning weight[d], kg	153.5[e]	144.9[e]	144.9[e]	137.7[f]	128.6[f]	148.3[e]	13.4

[a]Average calving date = February 3.

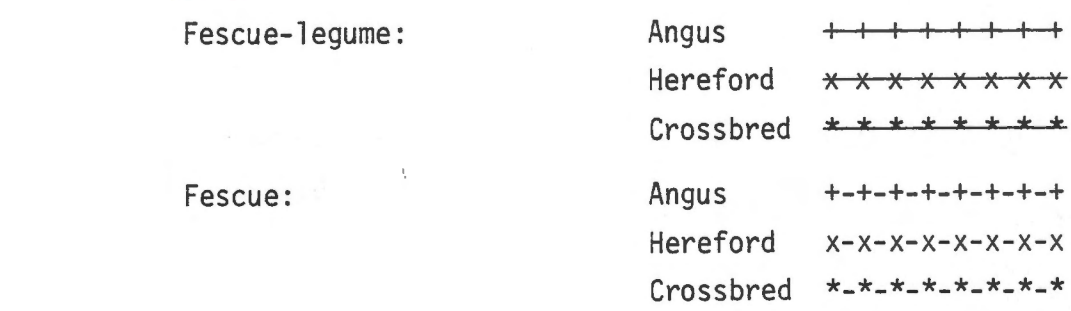
[b]Least squares means from the model: Item = birth weight, calving date, sire breed (sire), dam breed (dam), sire x dam, sex, pasture type, sire x pasture type, dam x pasture type.

[c]Residual standard deviation.

[d]Approximate age at weaning = 240 days.

[e,f]Means on the same line with different superscripts are different ($P < .05$).

FIGURE 5. Seasonal milk production of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures



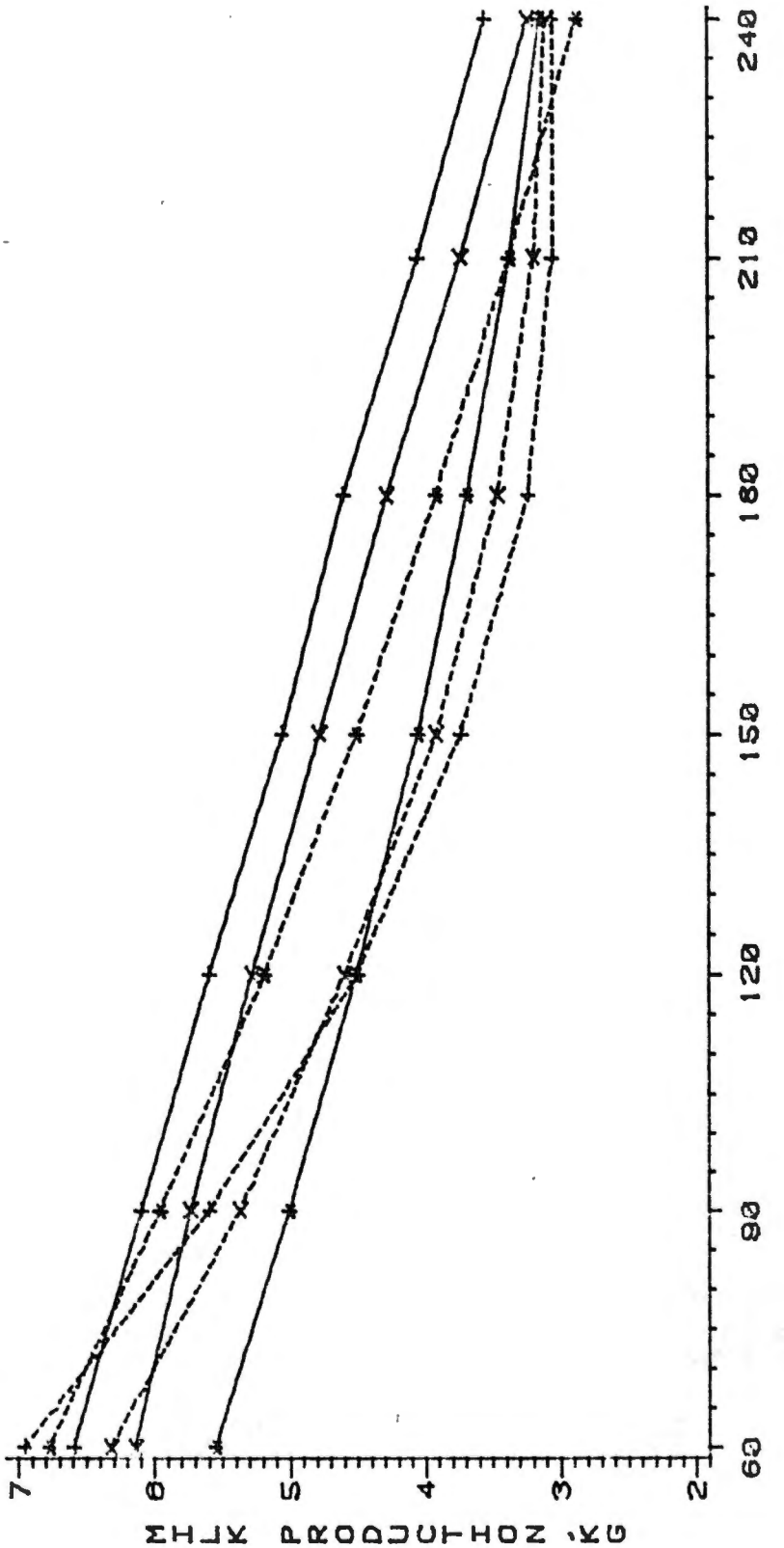
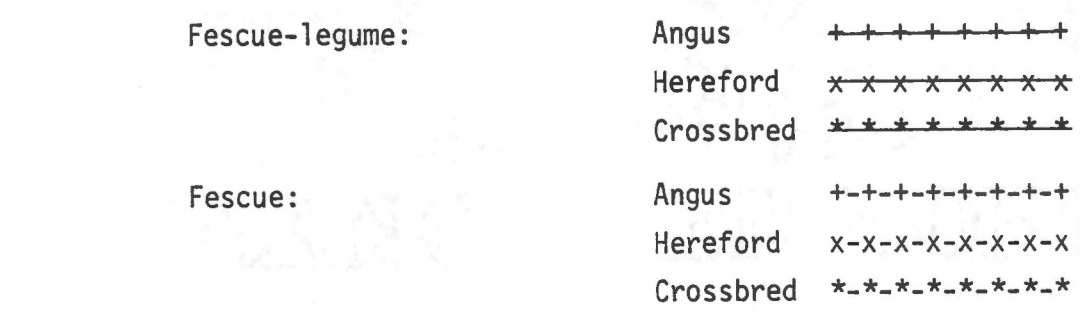


FIGURE 5

FIGURE 6. Seasonal calf weights of calves suckling Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures



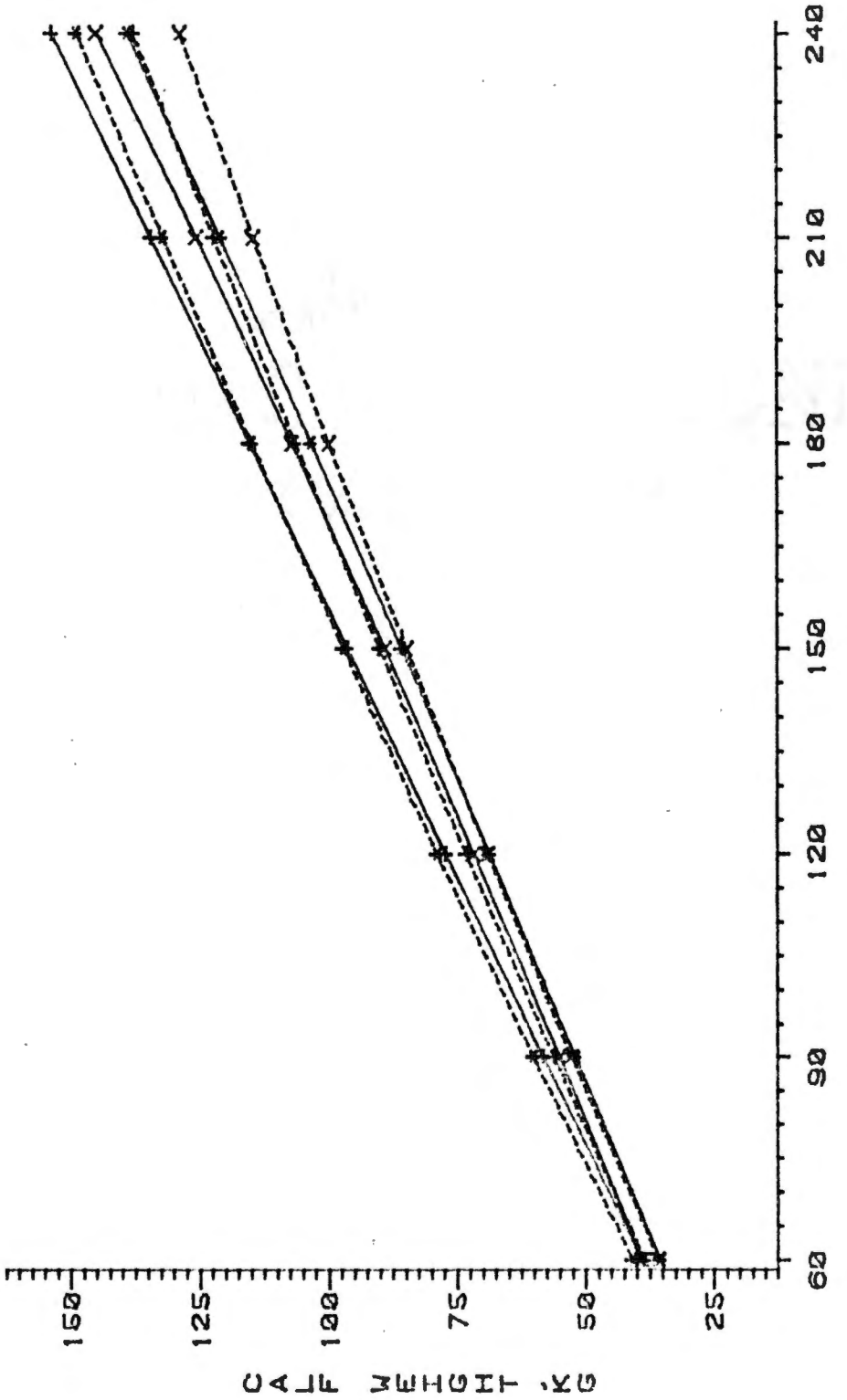


FIGURE 6

persistence which has been shown by Worley (1981) to result in increased weaning weights. It is a possibility that crossbred cows grazing fescue had a higher priority of nutrient use for milk production than did crossbred females grazing fescue-legume.

The increased weaning weights observed for calves with dams exhibiting higher average milk productions are not of the magnitude to account for the increases in milk production. Worley (1981) reported that calves suckling dams grazing fescue-legume pastures depended more on forage after 60 to 90 days of age to supply the additional nutrients required for growth than did calves suckling dams grazing fescue. A possible explanation for the lower than expected weaning weights is that calves of first calving heifers may not be able to utilize available forage in a manner that allows them to reach their full potential for growth.

Conclusions

These results would indicate that Hereford and crossbred females used the additional nutrition available from fescue-legume pastures to increase weight and backfat at the expense of milk production when compared to Angus females grazing the same pastures. Angus females allowed fescue-legume experienced an increase in milk production and exhibited much lower gains in weight and backfat. Cows of all breed types grazing fescue, and especially crossbreds, exhibited small increases in weight and backfat thus using a greater percentage of their nutrients consumed for maintenance and milk production.

When measured in terms of cow and calf performance, the genotype x nutritional environment was found to be significant only in terms of the performance of the crossbred females grazing fescue pastures which increased milk production and calf growth while on a lowered plane of nutrition. The remaining significant effects reported can be attributed to breed or to pasture type. Further research needs to be conducted to determine if similar results will be observed in mature females.

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LITERATURE CITED

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APPENDIX

TABLE A1. Seasonal weights (kg) of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures with March 1 weight in the model[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	337	337	337	337	337	337	
April 1	329	331	329	328	322	339	13.7
May 1	336	342	341	336	321	345	17.3
June 1	345	354	353	345	328	345	34.7
July 1	347	354	351	347	334	338	29.2
August 1	348	350	347	345	340	334	15.9
September 1	355	358	356	349	350	342	17.4

[a]Least squares means from the model: Y = March 1 weight, year, pasture type, sex, calving date, sire breed (sire), dam breed (dam), sire x dam, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A2. Seasonal weights (kg) of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures without March 1 weight in the model[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	337	338	334	337	338	335	8.7
April 1	325	329	330	325	318	337	15.4
May 1	337	347	346	333	324	342	19.1
June 1	343	358	359	340	330	344	30.2
July 1	349	359	355	345	335	335	31.3
August 1	356	352	350	343	346	333	16.5
September 1	361	364	362	351	353	341	18.6

[a]Least squares means from the model: Y = year, pasture type, sex, calving date, sire breed (sire), dam breed (dam), sire x dam, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A3. Seasonal backfat (mm) of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures with March 1 weight in the model[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	2.0	2.1	1.8	1.9	2.2	1.8	.5
April 1	1.7	1.7	1.6	1.6	1.8	1.5	.5
May 1	1.5	1.6	1.5	1.4	1.6	1.3	.5
June 1	1.4	1.6	1.6	1.3	1.5	1.3	.5
July 1	1.5	1.9	1.8	1.4	1.6	1.4	.6
August 1	1.8	2.3	2.2	1.5	1.8	1.6	.7
September 1	2.2	2.9	2.7	2.1	2.2	1.9	.8

[a]Least squares means from the model: Y = March 1 weight, year, pasture type, sex, calving date, sire breed (sire), dam breed (dam), sire x dam, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A4. Seasonal backfat (mm) of Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures without March 1 weight in the model[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	2.1	2.2	1.8	2.1	2.3	1.9	.6
April 1	1.8	1.8	1.7	1.6	1.9	1.6	.7
May 1	1.6	1.6	1.6	1.5	1.5	1.4	.4
June 1	1.5	1.7	1.6	1.6	1.4	1.3	.4
July 1	1.6	1.8	1.8	1.4	1.7	1.2	.8
August 1	1.9	2.4	2.3	1.8	1.9	1.5	.7
September 1	2.2	3.1	2.8	2.1	2.4	2.0	.8

[a]Least squares means from the model: Y = year, pasture type, sex, calving date, sire breed (sire), dam breed (dam), sire x dam, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A5. Seasonal milk production (kg/day) of Angus, Hereford and Crossbred females grazing fescue-legume or fescue pastures[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	6.6	6.1	5.5	6.9	6.3	6.8	2.0
April 1	6.1	5.7	5.0	5.6	5.4	5.9	1.1
May 1	5.6	5.3	4.5	4.5	4.6	5.2	1.0
June 1	5.0	4.8	4.0	3.7	3.9	4.5	1.5
July 1	4.6	4.3	3.7	3.2	3.5	3.9	1.6
August 1	4.0	3.7	3.4	3.0	3.2	3.4	1.0
September 1	3.5	3.2	3.1	3.0	3.1	2.9	1.1

[a]Least squares means from the model: Y = birth weight, calving date, sire breed (sire), dam breed (dam), sire x dam, sex, year, pasture type, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A6. Seasonal calf weights (kg) of calves suckling Angus, Hereford and Crossbred females grazing fescue-legume and fescue pastures[a]

Date	Fescue-legume			Fescue			RSD[b]
	Angus	Hereford	Crossbred	Angus	Hereford	Crossbred	
March 1	39.2	39.1	35.5	38.5	35.8	40.8	5.0
April 1	58.2	55.1	51.9	56.1	52.7	60.1	6.8
May 1	77.2	71.7	68.7	73.2	69.1	78.9	8.7
June 1	96.2	89.1	85.8	90.1	84.7	97.1	10.3
July 1	115.2	107.1	103.2	106.3	99.9	114.8	11.6
August 1	134.4	125.6	121.0	122.2	114.5	132.1	13.4
September 1	153.5	144.9	144.9	137.7	128.6	148.7	15.2

[a]Least squares means from the model: Y = birth weight, calving date, sire breed (sire), dam breed (dam), sire x dam, sex, year, pasture type, sire x pasture type, dam x pasture type.

[b]Residual standard deviation.

TABLE A7. Number of each breed type by year

	Angus		Hereford		Crossbred	
	81	82	81	82	81	82
Fescue-legume	8	11	11	6	3	5
Fescue	10	8	5	6	3	4

VITA

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