THE INFLUENCE OF PREWEANING PLANE OF NUTRITION
ON GROWTH, LACTATION AND REPRODUCTION
OF THE BEEF FEMALE

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CHAPTER I

INTRODUCTION

The development of replacement females with maximum productivity at a minimum cost is of utmost importance to the cow-calf industry. The plane of nutrition during early life has been shown to have broad implications on the consequent growth, production and reproduction of many species. The detrimental effects of a low plane of nutrition during the growth period on subsequent performance of animals has been recognized for many years. Recently, the possible detrimental influence of a high plane of nutrition during the growth period of mammals has been studied.

Some research has been conducted to determine the effects of plane of nutrition during early life upon subsequent performance of the bovine female (Reid et al., 1957a; Pope, 1955; Pinney et al. , 1962; Swanson, 1960). No research, however, has been conducted with beef cattle in which treatments were limited to the preweaning period.

The present study was conducted to measure the influence of the preweaning plane of nutrition on consequent growth, lactation and reproductive performance of Angus and Hereford cattle.

CHAPTER II

REVIEW OF LITERATURE

A very high or a very low plane of nutrition during the developmental stages of life is detrimental to the growth, productivity, reproductivity and longevity of an animal (McCay, Crowell and Maynard, 1935; Sherman and Campbell, 1937; MacIntyre and Aitken, 1959). The purpose of this review, in general, is to report the effects of the plane of nutrition during all stages of life on the growth, productivity and reproductivity of animals, and specifically, to report the effects of the preweaning plane of nutrition on the growth, productivity, reproductivity and longevity of the beef female. In this review the effects of nutrition are presented according to the chronological development of the animal, first the effects of the prenatal plane.

The Effects of Prenatal Plane of Nutrition

Christenson _et al_. (1967) fed Hereford heifers a ration containing either 196 or 127 kcal. of D.E. per kg metabolic weight ($B.W.^{0.75}$) per day for a 140-day pre-partum period. The cows on a high plane of nutrition produced calves that were 3.3 kg heavier at birth and 13.6 kg heavier at 8 weeks of age.

Joubert (1954) found that Holstein, Jersey, Shorthorn and Afrikaner cows fed a high plane of nutrition during early growth and during gestation have heavier calves at first parturition than cows fed a low plane.

Joubert (1954) found that although the low plane cows had calves that weighed less at birth, successive weights indicated that the prenatal plane of nutrition of the dam had no permanent influence on the growth of the progeny. Reid *et al.* (1957) reported that Holstein heifers fed 65 percent of Morrison's upper TDN requirement from birth to weaning had calves that were smaller than the first calves weaned by groups fed 100 and 140 percent of Morrison's TDN requirement. Expressed as a percent of dam's weight, however, the birth weights of the first calves were 9.7, 8.3 and 7.8 percent, respectively, for the low, medium and high groups.

The heavy feeding of mature Hereford cows for 5 months before calving did not significantly affect weaning weight of the calves as compared to normal feeding (Pope, *et al.*, 1963). Similar results have been shown by Joubert and Bonsma (1957) and Eckles (1918). Eckles (1918) reported that Jersey and Holstein cows on a low plane before calving produced calves that weighed only .9 kg less at birth than calves from cows fed a high plane. He explained that the fetus is nurtured by the blood stream which remains rather constant in composition even under adverse conditions of nutrition. If a constituent of the blood is deficient, the body stores are drawn upon to replenish the blood supply. Therefore, at a very low feeding level during the gestation period, the fetus is nourished at the expense of the dam's tissues.

The Effects of Postnatal Plane of Nutrition

The Effects of Restricting the Plane of Nutrition During Early Life

The plane of nutrition during early life is of utmost importance to the growth, reproduction, longevity and production of an animal and these effects will be considered in that order.

Growth. Essentially, growth is a preparation for life and any interruption of growth will influence the later developing physiological tissues relatively more than the earlier developing tissues (Moulton, Trowbridge and Haigh, 1921; McMeekan, 1940a,b,c; Hammond, 1955; Stuedemann, 1967). This differential growth rate was studied intensively by McMeekan (1940a,b,c) and Palsson and Verges (1952). In the former study, animals of the same chronological age were found to differ in their physiological age, especially if they were subjected to different planes of nutrition. McMeekan (1940c) discovered that pigs on a low plane of nutrition before weaning were similar to the primitive and unimproved form. He explained this phenomenon on the basis of differential response of tissues to various nutritional planes due to differential growth rates of tissues and the resultant prior claim of the earlier developing parts to nutrients. According to McMeekan (1940c), restriction of growth during early life affects the later maturing tissues relatively more than the earlier maturing tissues. The six extremities grow the fastest, gradating toward a common point in the latest developing lumbar regions.

In animals retarded for the first 8 months of life, retardation of growth was greatest in fat tissue followed respectively by lean and bone. As the level of nutrition decreased in early life, the percent fat increased as measured at the time of slaughter (Winchester and Howe, 1955; Hammond, 1960). According to Widdowson, Dickerson and McCance (1960) severe undernutrition cannot prevent some developmental processes, although some processes are inhibited and some are reversed. They also reported that when compared to the composition of skeletal tissues, the composition of the vital organs is affected the least by severe undernutrition during early life. Guilbert and Gregory (1952) found an anterior to posterior gradient in growth of Hereford cattle. Crichton, Aitken and Boyne (1960a) found that skeletal tissue matures before body weight.

Foote et al. (1959), however, studied pregnant ewes which were subjected to various sequences of grass-alfalfa hay and the grass-alfalfa hay plus concentrate. Upon slaughter and examination of the tissues and organs of the fetuses at various stages of development, there was no evidence of a differential effect due to feed. Guenther (1965) reported that early nutrition level did not affect bone development significantly.

Elsley and McDonald (1964) reanalyzed McMeekan's work and questioned his theory of priority of tissues for nutrients. When McMeekan's data was adjusted to a constant fat content, there was no effect of plane of nutrition on total weight of bone or total weight of muscle in proportion to the total weight of bone and muscle. Elsley and McDonald (1964) did concede that extreme restrictions, especially in the early stages of growth can upset the balances that exist between tissues. Lister and McCance (1967) reported that rehabilitated pigs appeared to be fatter, but the ratio of muscle to bone was that expected for normal pigs.

Jackson and Stewart (1920) studied the effects of different planes of nutrition on the rates of tissue growth. Albino rats were retarded from birth to 3, 6 and 10 weeks of age. After refeeding, the rats grew variably, but usually did not reach normal adult size. The final body size varied according to the length of the retardation period, the severity and nature of retardation and the sex. In rats fed to maximum body weight after retardation, the body and tail were slightly shorter than normal, but the head, limbs and trunk were nearly normal in weight.

Growth is not completely stopped by a low plane of nutrition, its rate is merely altered, and the period of growth is extended. Steensberg (1940) and Pinney et al. (1962) reported that cattle maintained on a low plane of nutrition for a long period of time adjusted to a more economical growth rate than cattle more liberally fed.

The length of time an animal is on a restricted diet determines to a great extent its ability to reach mature size. Experimentation in many species has shown this to be the case. Holstein heifers fed at a rate of 60 to 70 percent of Morrison's upper TDN requirements for the first 2 years of life had not reached the weights of cattle fed 140 to 160 percent of Morrison's upper TDN requirements by the fifth lactation (Bratton et al., 1957). According to Pope (1955) and Hogan (1929), beef cattle on a low plane of nutrition for the first three years or longer do not usually reach normal mature size, but this growth retardation does not cause conformation abnormalities. Lister and McCance (1967) reported that if pigs are subjected to severe undernutrition early in life, they do not attain their possible genetic potential. They stated that at a certain chronological age bones fail to respond to the amount of growth hormones present in the circulation and, thus, causes cessation of growth at that time.

Widdowson and McCance (1963) found that rats stopped growing at a fixed chronological age and not at a fixed body size. Wardrop (1966), in studying the effect of plane of nutrition during rearing on permanent body size in Holsteins and Hereford X Holstein crosses stated that the critical period for the bovine may be the first 3 weeks of life (the non-ruminant stage).

According to McCay et al. (1939), rats, after being retarded for 1000 days, were capable of growth, but retardation for 300 days prevented the rats from attaining maximum size of normal rats. Reid et al. (1957a) studied Holsteins stunted by restricting energy to 65 percent of Morrison's upper TDN requirement from birth to first calving. He found that the restricted cattle retained a considerable capacity to grow, up to 4 years of age provided they were fed adequately at that time. He also found that high level cows (140 percent of Morrison's upper TDN requirements from birth to first calving) constantly maintained a weight advantage over the medium (100 percent) and low (65 percent) groups as late as 7 years of age. When growth is resumed after a period of retardation, it occurs at a much more rapid rate (Osborne and Mendel, 1914; Winchester, Hiner and Scarbrough, 1957).

Reproduction. The age at which heifers become sexually mature is affected markedly by the level of nutrition during early life (Joubert, 1954; Reid et al., 1964; Crichton et al., 1960a). Sorensen et al. (1954) fed Holstein heifers 140 percent, 100 percent, and 60 percent of Morrison's TDN standards. They discovered that the group fed 140 percent reached first estrus at 37.4 weeks, whereas the groups fed 100 percent and 60 percent reached estrus at 47.1 and 65.0 weeks of age, respectively. Bratton et al. (1957) found almost identical results when they fed the same levels of TDN.

Reid et al. (1957a) and Crichton et al. (1960a) showed that although dairy cattle reached first estrus at different ages, all dairy heifers came into heat at about the same heart girth size, body length and wither height. Therefore, it can be said that skeletal size or physiological age is a more dependable predictor of sexual maturity than chronological age.

Much work has been done on the effect of level of nutrition on age at puberty in other species. In work by Joubert (1954) with rats a low plane of nutrition delayed puberty an average of 221 days. In one test, some rats on a low plane of nutrition did not breed until the normally fed rats were approaching menopause (Osborne, Mendel and Ferry, 1917). Asdell and Crowell (1935) compared rats fed a good quality ration _ad libitum_ to rats fed to maintain a constant weight of 40 grams and rats fed to maintain a constant weight of 80 grams. As the severity of nutritional treatment increased, they observed an increase in the age at which the vagina opened, but a decrease in the weight of the rat at the time the vagina opened. As severity of treatment increased, age and weight interval between occurrence of first estrus and the opening of the vagina increased.

When chicks were restricted during the growth period, sexual maturity was delayed 2 to 4 weeks (Schneider, Bohrens and Anderson, 1955; Sunde _et al_., 1954; Quisenberry _et al_., 1959). Milby and Sherwood (1953) found that restricted nutrition for the first 12 weeks of life of chicks delayed sexual maturity by 2 weeks. The amount of feed required to reach puberty, however, was the same as that required by well-fed chicks.

The work done in chickens is pertinent to the study of the effects of nutrition on ovulation. Schneider _et al_. (1955) found that the early egg size of chicks restricted during growth was smaller, but there was no significant difference after 32 weeks of age. The total number of eggs was the same for both groups.

Reid et al. (1957a) studied the number of services per conception in Holsteins for three levels of nutrition during early life (140 percent, 100 percent and 60 percent of Morrison's upper TDN requirement). He found little difference in number of services per conception for the first two parturitions. In an experiment with similar treatments, Bratton et al. (1957) found no significant differences ($P > .05$) between number of services per conception for the first five breedings.

Gossett and Sorensen (1959) studied the reproduction of gilts on two planes of energy; 55 and 93 therms of productive energy per 45 kg weight. Gilts on the lower energy level had a larger number of normal 40 day living embryos than gilts on the higher plane.

Longevity. Sherman (1955) working with rats stated that diets which produce rapid growth also increase longevity. Hansson (1956), however, reported an increase in metabolic activity of the body with increased feeding intensity. This indicates that a high plane of nutrition possibly decreases longevity. Osborne and Mendel (1914) and McCay et al. (1935) working with rats agree with this conclusion. Restriction of energy and protein during the growing period of chicks did not affect mortality during the growing period, but decreased mortality significantly in the mature animal (Sunde et al., 1954; Schneider et al., 1955). Riesen et al. (1947) reported an increase in longevity of rats restricted in energy for the first 100 weeks of life, but they found an increase in death rate in early life. Although they found no difference in the number of respiratory infections, there were significantly fewer tumors for animals that were restricted in energy. Perhaps these contradictions can be explained by the fact that the authors did not make clear exactly what nutrients were deficient. An excess of energy is more important in decreasing longevity than an excess of protein or any other nutrient.

Productivity. Holtz, Erb and Hodgson (1961) and Christian, Hauser and Chapman (1965) reported that those factors that contribute to rapidity of early growth do not contribute to subsequent milk yields. Holtz, Erb and Hodgson (1961) collected 393 milk records from 200 cows of the following breeds: Guernsey, Jersey and Holstein. Average daily gain (from birth to 6 months of age) and 4 percent F.C.M. (fat corrected milk) yields per 454 kg cow wt. (for first lactation) were negatively correlated. Reid *et al.* (1957) studied milk production records on 102 Holsteins for the first five lactation periods. They found that plane of nutrition during early life had no significant effect upon the milk yield during any lactation period. There was a trend, however, for the cows on a low plane of energy to produce more 4 percent F.C.M. in the fourth and fifth lactation periods than the cows fed the medium and high planes.

These trends were also found by Swanson and Spann (1954) in tests with Jersey cattle and rats. They found that the concentrate fed heifers (fed *ad libitum* until weaning) gave less milk than the restricted heifers. In the rat experiment, rats fed 80 percent of normal rations raised a larger percentage of their young to a heavier weight at 21 days of age than the overfed rats. This was attributed to the lack of development of the mammary glands in the overfed rats.

Crichton *et al.* (1960a) noted that Holstein, Ayrshire and Holstein X Ayrshire cross cows on a continuously high plane of nutrition entered production 3 to 4 months earlier than those cattle on continuously low plane. The low plane cows, however, were much more economical producers of F.C.M. than the high plane cows. Kieffer (1960) published evidence that there is a possible breed difference as to the consequences of preweaning nutrition on future performance. He found a negative regression of performance of daughters on performance of dams in Angus but not in Herefords. Christian, Hauser and Chapman (1965), Totusek (1968) and Koch (1969) indicated a detrimental relationship between high plane of preweaning nutrition and subsequent maternal ability of the beef cow. The same relationship was observed in dairy cattle by Wallace (1953), Swanson and Spann (1954) and Hansson (1956). Supposedly the physiological mechanism was the deposition of fat in the udder preventing the development of alveolar tissues. Mangus and Brinks (1971a) studied the records of 610 Hereford cows (2,226 calf weaning weights) and reported product moment correlations of the cows' weaning weight, weaning age and wean-score with MPPA (Most Probable Producing Ability) of 0.14, 0.05 and -0.02, respectively, indicating a low relationship between these factors and cow productivity. They did find a trend, however, for high weaning weight to be associated with low subsequent maternal ability.

The Effects of Restricting the Plane of Nutrition During Later Life

Growth. Cattle fed at 62 and 66 percent of standard TDN intake can sustain growth at a rate of 70 to 75 percent of normal growth (Hansson, 1956; Swanson, 1960; Reid *et al.*, 1964). Bal, Barnes and Visscher (1947) studied weanling mice fed an energy deficient diet. This diet delayed occurrence of sexual maturity but did not diminish the capacity for maturation. This result indicates that the ability to grow is not limited to a particular period of life. To the contrary, if an animal that has been restricted is allowed a high level of nutrition, growth will occur. This was substantiated by Thomas (1952) who found that Angus and Hereford heifers wintered at a low level made less gain than either medium or high level heifers during winter, but made the most gain on grass the following summer. Pinney et al. (1962) reported that Angus and Hereford cows on a low plane during winters rustled more and made more economical gains.

Palsson and Verges (1952a,b) designed an experiment patterned after that of McMeekan (1940a) to determine the effects of level of nutrition throughout life on the differential growth of tissues, organs and systems. Palsson and Verges (1952a) stated that organs develop at a rate correlated with their function. Nervous tissue was found to be the earliest developing followed by skeletal, muscular and fatty tissues in that order. There was significantly less bone in calves fed a continuously low plane of nutrition. Bones develop in length before they develop in thickness. Shape of bones is more affected by nutrition than the weight. The later maturing bones such as the femur or pelvis are more affected by nutrition than the earlier maturing bones. All tissues evidence recuperative powers to a great extent unless their period of high growth intensity has passed.

Reproductivity. Smithson et al. (1966) found that Hereford and Angus cows on a high plane of nutrition calved earlier than cows on a low plane, until the fourth productive year at which time there was no difference in time of calving.

Wiltbank et al. (1964) studied reproduction in Hereford cows fed five levels of TDN for the last 140 days of pregnancy. Treatments in kg of TDN per day were: I, 5.7; II 7.5; III, 11.3; IV, 3.9, for 28 days, then 7.5; and V, 3.9 for 28 days then 11.3. They reported a significant difference ($P < .01$) for interval from calving to first estrus ranging from 49 days for Group II to 82 days for Group V. Groups III and V had larger follicles and greater ovarian volume ($P < .01$) than the other groups. Group V had the best conception rate of 87 percent compared to 83, 54, 46 and 31 percent, respectively, for Groups III, I, IV and II. Cattle on rations that were either lower in TDN (Group I) or higher in TDN (Group III) than that recommended by N.R.C. experienced a significant ($P < .05$) 30 day delay in the onset of estrus. More ($P < .05$) cows on lower caloric rations failed to show estrus.

Totusek et al. (1961) compared reproductivity between an extremely high level of nutrition and a moderate one. They employed a paired experiment using twins, one of which was placed on an adequate diet with only enough energy to promote from .23 to .30 kg gain per day. The other twin was placed on a full-feed of corn. There was little difference in breeding efficiency between treatments, but the high level cows had more calving difficulties, more calf losses and more cow losses. Bradford, Weir and Terrell (1961) compared range-reared ewes to ewes that were reared on irrigated pasture and fed hay and grain in drylot during the winter. These treatments were imposed from 6 to 16 months of age after which both groups were allowed to graze the same range. No significant difference was found between treatments ($P > .05$) in number of lambs born but the difference in number of lambs raised was significant ($P \simeq .09$) favoring range-reared ewes. The fed ewes were larger but this was not a benefit to them in terms of number of lambs weaned.

Longevity. As in studies of restricted diets prior to weaning, animals restricted all of their lives live longer than moderately fed animals (McCay et al., 1935; Ball and Visscher, 1947; Zimmerman, 1958; Pinney, 1962; Arnett, 1963).

Production. It is generally recognized that cows on a low plane of nutrition do not produce significantly less milk than cows on a high plane if they are well fed before parturition (Swanson, 1960; Pope et al., 1963). It is also the consensus of researchers that a lean cow will remain a good milker over a longer period of time than an excessively fat cow (Hughes, 1971). Broster, Ridler and Foot (1958) found that prepartal treatment of Shorthorns and Holsteins did not significantly affect milk production. Swanson and Hinton (1962), however, found that feeding extra concentrates during the dry period produced a significant increase ($P < .01$) of 137 kg of F.C.M. in the first 15 weeks of the following lactation. Totusek et al. (1961) found that high level cows produced an average of 35 percent less milk (3.1 vs. 4.2 kg per cow daily) than cattle fed a moderate level. Chambers, Armstrong and Stephens (1960) found similar results. Perhaps these differences in results in cattle can be explained by the differences in body type of experimental cattle and the variation in time, length and severity of treatment.

Summary

In summary, it is very difficult to compare the results of these various experiments because many give no exact description of precisely what plane of nutrition was fed and exactly what nutrients were deficient, but the following general conclusions can be drawn. 1. A low prenatal plane of nutrition decreases birth weight but possibly does not affect weaning weight. 2. Any interruption of growth will influence the later developing tissues relatively more than the earlier developing tissues. 3. Animals restricted in early life will grow faster than normal in later life, but generally will not reach normal adult size. 4. Restricting nutrition in early life extends the growth period and delays puberty. 5. A low plane of nutrition tends to increase longevity. 6. Weaning weight is not a good indication of subsequent milk production but rapid preweaning growth is associated with lower subsequent milk production. 7. Low planes of winter nutrition delay estrus in cattle. 8. Beef cattle on a very high or a very low level of winter nutrition produce less milk than cattle on moderate planes.

CHAPTER III

MATERIALS AND METHODS

Four trials with Angus and Hereford cattle were conducted at Lake Carl Blackwell Experimental Range near Stillwater, Oklahoma. The purpose of these trials was to study the effects of the preweaning plane of nutrition on the growth, development, productivity and reproductive performance of the beef female. The first trial was begun in 1963, the second in 1964, the third in 1965 and the fourth in 1966.

The experimental cattle used in the four trials (1963, 1964, 1965 and 1966) were the successive calf crops of a group of Angus and Hereford cows that were born in 1959 on the Federal Reformatory Farm, El Reno, and on the Lake Carl Blackwell Range, respectively. These experimental cattle were of known genetic background. Therefore, the experimental females were sired by purebred Angus and Hereford bulls from the breeding project at the Fort Reno Research Station. Therefore, the experimental cattle were of known genetic background. Calf production records on the dams of the experimental cattle were collected for 2 years previous to the 1963 trial.

Allotment to three preweaning treatments was on the basis of sire, age and previous production of the dam. No dam had two successive calves on the same treatment. The allotment, therefore, was not on a random basis, but the experimental units were considered to be representative of Angus and Hereford cattle in Oklahoma.

The experimental design is illustrated in Table I, along with the number of cattle in each breed, treatment and trial for each year of the study. Three treatments were employed to produce low, medium and high levels of preweaning nutrition. The low level was accomplished by weaning the heifers at approximately 140 days of age and then allowing them to gain at a rate of .45 kg per day until they reached 240 days of age. The actual gain was .33 kg per day. For the 1963 trial, the 140-day weaned females were on grass and supplemental concentrate from 140 to 240 days of age. The 1964, 1965 and 1966 trials were kept in a drylot and fed alfalfa hay to maintain the desired rate of gain. The medium level was accomplished by weaning at 240 days of age. High level heifers were allowed creep feed during the suckling period and were weaned at 240 days of age. These levels of nutrition were imposed in an attempt to produce a 45.5 kg range in body weight among the three treatment groups at 240 days of age. The actual range among treatments was 50.3 kg, with a 30.9 kg difference between the 140-day weaned and 240-day weaned and creep-fed 240-day weaned groups and a 19.5 kg difference between the 240-day weaned and creep-fed 240-day weaned groups. These ranges were averages of the first three trials since the 1966 240-day weights were lost.

All heifers in each trial were managed alike after the approximate age of 240 days. During the first winter they were maintained on a moderate plane of nutrition under range conditions to gain approximately .23 to .34 kg per head daily. The 1963 and 1964 trials were supplemented with cottonseed meal, whereas the 1965 and 1966 trials were supplemented with alfalfa hay each winter.

Every year all females of the same breed in each trial were

TABLE I

EXPERIMENTAL DESIGN WITH NUMBER OF CATTLE IN EACH BREED, TREATMENT AND TRIAL FOR EACH YEAR

Trial	Breed	Trt.	Year							
			'63	'64	'65	'66	'67	'68	'69	'70
1963	Angus	140[a]	8	8	8	8	8			
		240[b]	10	10	9	8	8			
		240C[c]	7	7	7	7	7			
	Hereford	140	8	8	8	8	8			
		240	10	9	9	9	9			
		240C	5	5	5	5	5			
1964	Angus	140		9	9	9	9	9		
		240		8	8	8	8	8		
		240C		11	11	11	11	11		
	Hereford	140		8	8	8	7	7		
		240		6	6	6	6	6		
		240C		10	10	10	10	8		
1965	Angus	140			8	8	8	8	8	
		240			7	7	7	7	6	
		240C			8	8	8	8	8	
	Hereford	140			9	9	9	9	8	
		240			9	9	8	8	7	
		240C			9	9	9	9	9	
1966	Angus	140				10	10	10	10	9
		240				7	7	7	7	7
		240C				8	8	8	8	8
	Hereford	140				10	10	10	10	8
		240				10	10	10	10	10
		240C				11	11	11	11	11

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

pastured together and bred to the same purebred bull of that breed. The bulls were from the purebred herd at the Fort Reno Experiment Station. Some crossbred calves were born due to inefficient partition fences. The 1965 and 1966 cows were artificially inseminated in 1969. All trials were pasture bred in other years. The heifers were bred to calve first at 2 years of age. The breeding season started May 20 each year. The cows were removed from experiment after three productive years (approximately 4.7 years of age). Breeds were rotated between pastures at approximately two month intervals. A mineral mix (50 percent dicalcium phosphate or bonemeal and 50 percent salt) was provided free choice at all times.

Cows were culled from the herd on the basis of disease or failure to conceive 2 consecutive years. Cows and calves were identified by ear tags and ear tattoos. Cows were also identified by hot brands. All calves were dehorned and vaccinated for blackleg. Almost all bull calves were castrated within 24 hours after birth. Spraying or dusting to control flies was practiced every 3 to 4 weeks during the summer.

The following measurements were taken at 140 days, 240 days and 1 year of age, and then at subsequent 6-month intervals until the cattle reached 4.5 years of age. Four types of measurements were taken: body development, performance of offspring, milk production and reproduction.

Three estimates of body development of the experimental females were taken. They were body weight, skeletal measurements and condition scores. Weights were taken to the nearest 2.3 kilograms. Skeletal measurements were taken by two methods: actual measurements and photographic measurements. Actual measurements were taken while cows were confined behind a grid. They were: height at withers, width at hooks, and heart girth circumference. Height at withers and width at hooks were measured with wooden calipers; the heart girth circumference was measured with a steel tape. Photographic measurements were made from 20.3 x 25.4 cm photographs of the cow posed behind a grid of predetermined proportions. The camera was positioned 3.7 m from the grid each time photographs were taken. The measurements made from photographs were: height at withers, height at hooks, chest floor to ground, length of rump and horizontal length from point of shoulder to hooks. Condition scores were taken on a fifteen point scale by one technician with one being the thinnest and fifteen being the fattest. The same technician did not score animals at all measurement periods for all trials but did score all cattle at any one measurement period. Actual measurements taken at 140 and 240 days of age for the 1966 cows and photographic measurements taken at 2.5 years of age for the 1964 cows were lost. After the cows reached 2.5 years of age, the body measurements from cows that had not weaned calves that year were not included in the analysis in order that analysis be on cows that were comparable.

Performance of offspring was determined by the same measurement techniques as described for the cows. The measurements were taken on the calves at 140 days of age. Weights were also taken at time of birth, at time of milk production (weight after a 12-hour shrink) and at time of weaning. Weaning weights were corrected to a constant age by the formula:

$$\left(\frac{\text{Actual weaning wt.} - \text{Actual birth wt.}}{\text{Age in days}}\right) 205 + \text{Actual birth wt.}$$

The bulls and heifers were also corrected to a steer equivalent by the method suggested by Smithson (1966). This method employs the multiplication of the 205-day adjusted weaning weights of bulls by .95 and heifers by 1.05. The weaning weights of crossbred calves were corrected to a straightbred basis by multiplication of the 205-day adjusted weaning weights by .95.

The estimated 12-hour milk production was determined by the calf weight change technique. Calves were allowed to nurse and then separated from their dams for one 12-hour period. At the end of this period (approximately 6:00 p.m. to 6:00 a.m.) calves were weighed to the nearest .045 kg before and after nursing. Milk production for the 1965 and 1966 trials in 1969 and for the 1966 trials in 1970 was estimated during two successive 12-hour periods. The calves were weighed to the nearest .045 kg before and after nursing, and the mean of these two estimates was used as a 12-hour estimate. The first milk production was taken after the calves reached 60 days of age in order to eliminate calf capacity as limiting factor and to insure that all estimates be taken when green grass was available. At least three estimates were taken for each lactation.

Reproduction performance of the cows was measured by analyzing date at first calving, percent of cows which calved and percent of cows which weaned calves.

Since there were unequal numbers among treatments and between breeds, the data were analyzed by techniques described by Snedecor and Cochran (1967) for two-way classifications with unequal numbers and proportions. Heirarchial analyses of variance were utilized to obtain unweighted means for each treatment and breed for each period (age of cow or calf crop number) for each variable. Then analyses of variance were run on each period for each trial for each variable. Analyses were then run on each period combining trials for each variable. Since all analyses of variance were on unweighted means, the error mean squares were divided by harmonic means so that analyses were on a per cow basis. The preceding procedures were employed in the analysis of all data except the percentage of cows which calved, percentage of calf crop weaned, milk production and average calving date. The percentage of cows which calved, percentage of calf crop weaned and average calving date were analyzed by a randomized block design as explained by Snedecor and Cochran (1967). Milk production data were not analyzed. Treatment differences were determined by LSD tests.

CHAPTER IV

RESULTS AND DISCUSSION

Because of the utilization of analyses on unweighted means, the levels of significance are not exactly correct as reported, but are close approximations. The levels of statistical significance of F tests for treatment effects on body weight and measurements of cows fed different levels of preweaning nutrition are shown in Table II. Table III depicts unweighted means and levels of significance of differences between breeds for body weights and measurements. Treatment means for body weight, circumference of heart girth, horizontal length from point of shoulder to hooks, height at withers and height at hooks are presented graphically in Figures 1 through 5, respectively. Treatment means, standard errors and levels of significance for ages of cows with significant treatment F values ($P < .05$) are shown in Tables IV through X.

Table II is a summary of the results of body weight and body measurement comparisons between treatments. All of the actual measurements (body weight, circumference of heart girth, height at withers and width at hooks) indicated a significant difference between treatment means ($P < .005$) through 1.5 years of age. In general, no expression of treatment affect was detectable by the time the cow attained 2.0 years of age. More inconsistency was noted for the photographic measurements, but the general trend was that treatment significance was not detectable

TABLE II

LEVELS OF SIGNIFICANCE OF TREATMENT EFFECTS ON BODY WEIGHTS AND BODY MEASUREMENTS OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Variable	Body Weight	Circumference of Heart Girth[1]	Height at Withers[1]	Width at Hooks[1]	Length of Rump[2]	Length of Body[2]	Chest to Ground[2]	Height at Withers[2]	Height at Hooks[2]
Age of Cow									
140 Days	NS[3]	NS	NS	NS	P <.05	NS	NS	NS	NS
240 Days	P <.005	P <.005	P <.005	P <.005	P <.005	P <.005	P <.005	P <.005	P <.005
1.0 Year	P <.005	P <.005	P <.005	P <.005	P <.005	P <.005	NS	P <.005	P <.005
1.5 Year	P <.005	P <.005	P <.005	P <.005	NS	P <.05	NS	P <.05	P <.01
2.0 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS
2.5 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS
3.0 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS
3.5 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS
4.0 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS
4.5 Year	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1]Actual measurement.

[2]Photographic measurement.

[3]NS = nonsignificant (P <.05).

by the time the cows reached 2.0 years of age. The variables most influenced by condition (body weight, circumference of heart girth and width at hooks) showed a significant ($P < .10$) treatment effect at 2.0 years of age, indicating a possible treatment effect on body condition at that time. The more subjective condition score, however, failed to detect a treatment difference ($P > .10$) at 2.0 years of age. These results are in contrast to results found in dairy and beef cattle that were treated for longer periods of time. Bratton et al. (1957) found a treatment difference on weight through the fifth lactation for Holstein heifers fed either 60-70 percent or 140-160 percent of Morrison's upper TDN requirements for the first 2 years of life. Pope et al. (1955) and Hogan (1959) reported that beef cattle on a low plane of nutrition for the first three years or longer never regained normal mature size.

Another general trend was the consistency of a highly significant ($P < .01$) breed effect (Table III) and birth year effect for all variables and for all ages of the cow. At 140 days of age the Herefords were significantly taller ($P < .005$) at hooks (photographic measurement), taller ($P < .05$) at withers (actual measurement) and longer ($P < .005$) in body (horizontal distance from point of shoulder to hooks measured photographically) than the Angus. At 240 days and 1.0 year of age the Angus were heavier ($P < .005$), had more condition ($P < .005$) and had greater circumference of heart ($P < .005$), all of which were indications of fatness. As a general trend, the Angus tended to be larger structurally at 240 days and 1.0 year of age. After 1.0 year of age the trend reversed and by 2.5 years of age the Herefords held the advantage in nearly every trait measured. The results indicate that the Angus matured earlier than the Herefords, but that the Herefords grew to a

TABLE III

UNWEIGHTED MEANS AND LEVELS OF SIGNIFICANCE OF DIFFERENCES BETWEEN BREEDS FOR BODY WEIGHTS AND MEASUREMENTS

Age of Cow	140 Days		240 Days		1.0 Year		1.5 Year		2.0 Year		2.5 Year		3.0 Year		3.5 Year		4.0 Year		4.5 Year	
Breed	A	H	A	H	A	H	A	H	A	H	A	H	A	H	A	H	A	H	A	H
Body Weight[c]	145.77	145.69	209.07^{g}	196.37^{g}	257.09	230.39^{g}	346.69	350.63	342.80	348.31	349.24^{g}	378.87^{g}	379.13^{g}	398.00^{g}	395.29^{g}	428.48^{g}	414.16^{e}	420.12^{e}	447.12	458.94
Condition Score[a]	9.07	8.80	9.84^{e}	9.35^{e}	7.73^{g}	7.09^{g}	9.70	10.16	7.18^{g}	7.80^{g}	7.92^{g}	8.66^{g}	7.56	7.77	8.51	8.73	8.30	8.10	8.51^{e}	8.11^{e}
Circumference of Heart Girth[ad]	120.78	119.85	135.39^{g}	131.19^{g}	146.40^{g}	140.43^{g}	163.45	162.04	161.46	161.11	161.51^{g}	164.34^{g}	165.71^{g}	168.65^{g}	166.58^{g}	169.97^{g}	171.86	172.17	171.99	173.38
Height at Withers[ad]	87.38^{e}	88.59^{e}	95.93	95.62	101.09	100.42	109.13^{f}	110.38^{f}	111.09^{e}	112.48^{e}	112.36	113.48	114.01^{g}	116.46^{g}	113.46^{g}	116.39^{g}	116.33^{e}	117.94^{e}	116.11^{g}	118.01^{g}
Width at Hooks[ad]	28.26^{g}	28.73^{g}	33.34	33.04	37.65^{g}	36.53^{g}	43.44	43.39	44.21	44.85	44.70^{g}	46.44^{g}	46.97^{g}	48.79^{g}	47.20^{g}	48.87^{g}	49.05^{e}	49.79^{e}	49.79^{g}	50.97^{g}
Length of Rump	28.55	28.59	31.63	31.29	32.68^{g}	33.16^{g}	34.69^{g}	35.63^{g}	35.52	36.27	34.49^{f}	36.21^{f}	34.49^{g}	38.31^{f}	36.63^{g}	38.04^{g}	36.65^{g}	38.85^{g}	36.38^{g}	38.34^{g}
Length of Body	63.66	63.67	71.52^{g}	69.53^{g}	77.09	75.39	35.12	36.42	88.13	87.96	86.94	86.57	92.80	92.21	90.22^{g}	92.43^{g}	95.35	94.62	93.53	94.31
Chest to Ground	44.20	44.90	44.72^{g}	45.63^{g}	45.53^{g}	47.08^{g}	48.89^{g}	50.42^{g}	51.29	51.90	53.31^{f}	54.70^{f}	51.18^{g}	52.49^{g}	51.11^{g}	53.46^{g}	50.96^{g}	53.27^{g}	50.27^{g}	53.49^{g}
Height at Withers[bd]	88.96	88.93	95.73	94.82	101.40^{g}	100.09^{g}	108.44	108.76	110.85	110.87	110.82^{e}	112.32^{e}	110.70^{e}	113.20^{e}	112.16^{g}	113.94^{g}	114.25^{g}	115.88^{g}	113.59^{g}	115.63^{g}
Height at Hooks[bd]	87.43	89.39	93.74	94.50	98.80^{g}	99.40^{g}	106.06^{g}	108.09^{g}	108.24^{g}	110.40^{g}			108.78^{g}	112.19^{g}	108.58^{g}	112.10^{g}	109.63^{g}	112.49^{g}	110.07^{g}	113.29^{g}

[a]Actual measurements.

[b]Photographic measurements.

[c]Weight in kg.

[d]Measurement in cm.

[e]Significant difference between breeds at $P < .05$.

[f]Significant difference between breeds at $P < .01$.

[g]Significant difference between breeds at $P < .005$.

larger size. There is no evidence that treatment affected the breeds differently as shown by the fact that there were only two breed x treatment interactions that exhibited a significant F ($P < .05$). Because a total of 110 variables were tested statistically, approximately five of these could be statistically significant ($P < .05$) due entirely to chance. Likewise, only two treatment x birth year interactions were significant ($P < .05$). A trend was evident, however, for breed x birth year to be significant indicating that the Hereford and Angus breeds reacted to their environments differently but did not react to their preweaning treatments differently.

The various growth curves (Figures 1 through 5) indicate that generally the creep-fed 240-day weaned group remained heavier and larger until 1.5 years of age. At that time this group decreased dramatically in rate of growth, as shown by the radical decrease in slope after 1.5 years of age for all variables depicted. The measurements of body growth will now be considered.

Body Weight

Unweighted means of cow body weight for each treatment within each age of cow are presented graphically in Figure 1. Unweighted treatment means, standard errors and levels of significance for each cow age with a significant treatment F value ($P < .05$) are presented numerically in Table IV. From 240 days to 3.0 years of age the differences between treatments gradually decreased with the greatest decrease between 240 days and 1.0 year. Body weight continually increased until the end of the study except for the decrease in the creep-fed 240-day weaned group between 1.5 and 2.0 years of age. This indicates that the first

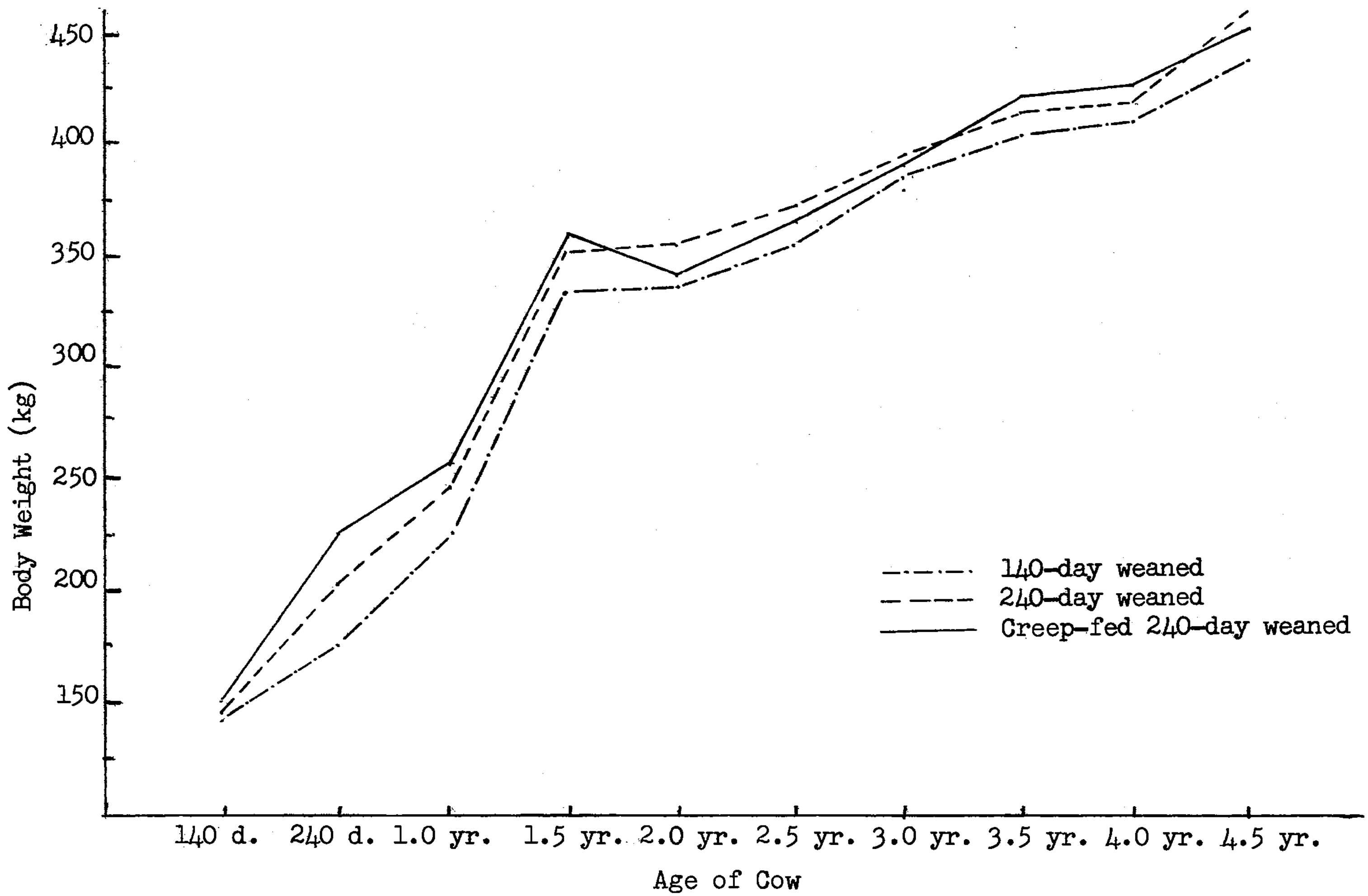

Figure 1. Average Values for Body Weight of Cows Fed Different Levels of Nutrition Before Weaning

TABLE IV

AVERAGE BODY WEIGHT OF COWS FED DIFFERENT LEVELS OF NUTRITION BEFORE WEANING[a]

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance
Age				
240 Days	175.68[b] ± 2.50[c]	206.53 ± 2.60	225.95 ± 2.52	1<2<3[d]
1.0 Year	225.95 ± 3.01	246.67 ± 3.15	258.59 ± 3.04	1<2[d] 1<3[d]
1.5 Year	334.85 ± 3.50	354.35 ± 3.69	356.79 ± 3.55	1<2[d] 1<3[e]
2.0 Year	336.41 ± 5.06	354.03 ± 4.73	346.23 ± 4.59	1<2[f]

[a]Only ages with significant treatment F values ($P < .05$) included.

[b]Unweighted means in kg.

[c]Standard error.

[d]Significant at $P < .01$.

[e]Significant at $P < .05$.

[f]Significant at $P < .10$.

pregnancy affected body condition for the creep-fed 240-day weaned group relatively more than the other treatments. At the completion of the treatment period (240 days) all three treatments differed significantly ($P < .01$). The treatments imposed produced a larger weight difference (30.85 kg) between the 140-day weaned and the 240-day weaned groups than between the 240-day weaned and creep-fed 240-day weaned groups (19.42 kg). This larger difference persisted until the cattle reached 2.0 years of age. The 140-day weaned group remained significantly lighter ($P < .05$) than the other two groups through 1.5 years of age, but by 2.0 years the creep-fed 240-day weaned group was not significantly different from the other groups. The cattle were growing at the end of the study. Knox and Koger (1945) and Brinks _et al_. (1962) reported that Hereford range cows increase in body weight until 8 years of age.

The fact that no significant difference ($P > .05$) between treatments was detectable at 2.0 years of age indicates compensatory growth by the cattle fed lower planes of nutrition to weaning. This is in agreement with Osborne and Mendel (1914), Winchester _et al_. (1957) and Reid _et al_. (1957a). Reid _et al_. (1957a), however, found that Holsteins restricted to 65 percent of Morrison's upper TDN level from birth to first calving did not attain the weight of normally fed heifers until 7 years of age. A strict comparison between these data and those of Reid _et al_. (1957a) is not logical because of differences in body type of experimental females and differences in length and severity of treatments.

The average date of measurement when the cows were 140 days and 240 days of age was June 10 and September 20, respectively. The average date of winter measurement (1.0, 2.0, 3.0, 4.0 years of age) and summer measurement (1.5, 2.5, 3.5, 4.5 years of age) was February 3 and August 18, respectively. There was not as much seasonal variation in weight as normally occurs due primarily to the fact that the "spring" weight was taken in February before weight losses of parturition occurred.

Circumference of Heart Girth

Figure 2 depicts graphically the unweighted means of circumference of heart girth for each treatment within each age of cow. These means along with their standard errors and levels of significance are presented numerically in Table V. A comparison between Figures 1 and 2 indicates a close relationship between body weight and circumference of heart girth. This is in agreement with Hughes (1971). The curves of these two variables were almost congruent. At the end of the treatment period (240 days of age), the range between 140-day weaned and 240-day weaned and between 240-day weaned and creep-fed 240-day weaned was 8.03 and 6.01 cm, respectively. By 1.5 years of age these ranges had dwindled to 0.93 and 3.30 cm, respectively. After 2.0 years of age no significant differences ($P > .05$) were detectable between treatments (Table V).

Condition Score

Since condition score was not estimated by the same person at different ages of the cow, one cannot logically compare condition score over age. A treatment difference between 140-day weaned and 240-day weaned and between 240-day weaned and creep-fed 240-day weaned cattle persisted through 1.0 year of age (Table VI). For this variable, birth year was confounded with scorer and, therefore, the variation due to

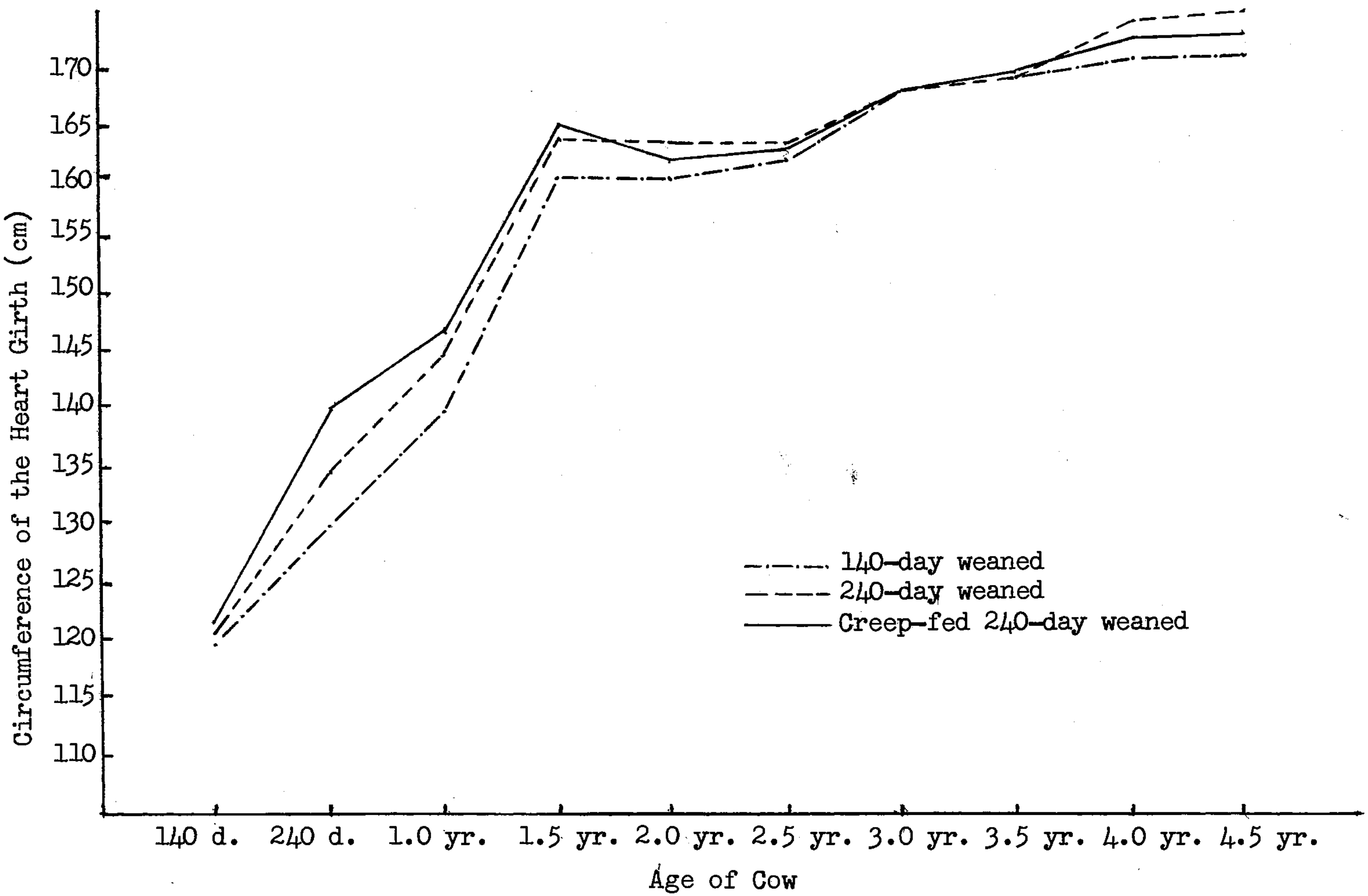

Figure 2. Average Values of Circumference of the Heart Girth of Cows Fed Different Levels of Nutrition Before Weaning

TABLE V

AVERAGE CIRCUMFERENCE OF HEART GIRTH OF COWS FED DIFFERENT LEVELS OF NUTRITION BEFORE WEANING[a]

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance
Age				
240 Days	125.93[b] ± .63[c]	133.96 ± .65	139.97 ± .64	1 < 2 < 3[d]
1.0 Year	139.13 ± .68	144.47 ± .71	146.65 ± .68	1 < 2[d] 1 < 3[d]
1.5 Year	160.24 ± .62	163.54 ± .65	164.47 ± .63	1 < 2[e] 1 < 3[d]
2.0 Year	159.83 ± .84	162.73 ± .79	161.30 ± .76	1 < 2[e]

[a]Only ages with significant treatment F values ($P < .05$) included.

[b]Unweighted means in cm.

[c]Standard error.

[d]Significant at $P < .01$.

[e]Significant at $P < .05$.

TABLE VI

AVERAGE CONDITION SCORE OF COWS FED DIFFERENT LEVELS OF NUTRITION BEFORE WEANING[a]

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance
Age				
240 Days	7.32[b] ± .15[c]	9.60 ± .16	11.85 ± .15	1<2<3[d]
1.0 Year	6.88 ± .10	7.39 ± .10	7.96 ± .10	1<2[e] 1<3[e]

[a]Only those ages with significant treatment F values ($P < .05$) included.

[b]Unweighted mean.

[c]Standard error.

[d]Significant at $P < .01$.

[e]Significant at $P < .05$.

scorer should not affect precision of estimation of probability levels for treatment. Birth year was consistently a significant source of variation ($P < .005$ at all ages of cow except at 240 days of age when $P < .05$).

Width at Hooks

Significance between the two extreme treatments persisted until 1.5 years, but became less significant as the cows aged. The unweighted means, standard errors and levels of significance for cow ages with significant F values are shown in Table VII. The range between the extreme treatments was 2.92 cm at 240 days of age and decreased to 1.09 cm at 1.5 years.

Length of Body

By the completion of treatment (240 days of age), a significant ($P < .05$) difference of 3.09 cm was noted between 140-day weaned and 240-day weaned cattle. Also a significant ($P < .01$) difference of 4.10 cm was noted between 140-day weaned and creep-fed 240-day weaned groups. No difference ($P > .05$) was detected between 240-day weaned and creep-fed 240-day weaned groups. At 1.0 year of age the difference between these two treatments remained significant ($P < .05$). The range between extreme treatments remained significant ($P < .05$) until 1.5 years of age. At that age the range was 2.5 centimeters. These results are depicted numerically in Table VIII. Wiltbank, Bond and Warwick (1965) observed a deficit of 11 cm in body length at first estrus of beef heifers that had been fed an energy deficient ration. When the heifers were fed an adequate ration after parturition this difference disappeared. Figure

TABLE VII

AVERAGE WIDTH OF HOOKS[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION[b]

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance
Age				
240 Days	31.65[c] ± .20[d]	33.35 ± .21	34.57 ± .20	1<2<3[e]
1.0 Year	36.14 ± .20	37.06 ± .21	38.07 ± .20	1<2[f] 1<3[e] 2<3[f]
1.5 Year	42.81 ± .20	43.52 ± .21	43.90 ± .20	1<3[f]

[a]Actual measurement.

[b]Only ages with significant treatment F values ($P < .05$) included.

[c]Unweighted means in cm.

[d]Standard error.

[e]Significant at $P < .01$.

[f]Significant at $P < .05$.

TABLE VIII

AVERAGE LENGTH OF BODY[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance	
Age					
240 Days	68.13[c] ± .59[d]	71.22 ± .61	72.23 ± .59	1<2[f]	1<3[e]
1.0 Year	74.26 ± .57	75.91 ± .58	78.51 ± .57	1<3[e]	2<3[f]
1.5 Year	84.45 ± .56	85.90 ± .59	86.95 ± .57	1<3[f]	

[a]Photographic measurement of horizontal length from point of shoulder to hooks.

[b]Only ages with significant treatment F values ($P < .05$) included.

[c]Unweighted means in cm.

[d]Standard error.

[e]Significance at $P < .01$.

[f]Significance at $P < .05$.

3 indicates that creep-fed 240-day weaned heifers remained longer and 140-day weaned heifers remained shorter until 2.0 years of age, but as age increased beyond 240 days the differences became progressively smaller.

Body Height

Three measurements of height were analyzed statistically: photographic measurement of height at withers, actual measurement of height at hooks and actual measurement of height at withers. It is difficult to determine which of these is the best estimate of structural height but the actual measurement of height at withers and photographic measurement of height at hooks exhibited smaller standard errors than photographic measurement of height at withers (Tables IX, X and XI). Actual measurement of height at withers and photographic measurement of height at hooks showed a difference ($P < .05$) between extreme treatments through 1.5 years of age whereas no significant F ($P > .05$) was calculated later than 1.0 year of age for photographic measurement of height at withers. This decrease in precision for photographic measurement of height at withers may be due to a more variable head positioning at the time the photograph was taken.

Figures 4 and 5 are similar to each other and to the figures of other growth measurements. They indicate that by the time of first calving no treatment difference was evident. Thus, the low plane of nutrition possibly delayed maturity in height. These results are similar to those of Crichton *et al.* (1960a) although not as dramatic. They found that dairy heifers which received a low plane of nutrition prior to first parturition attained maturity in height at withers 8 to 9

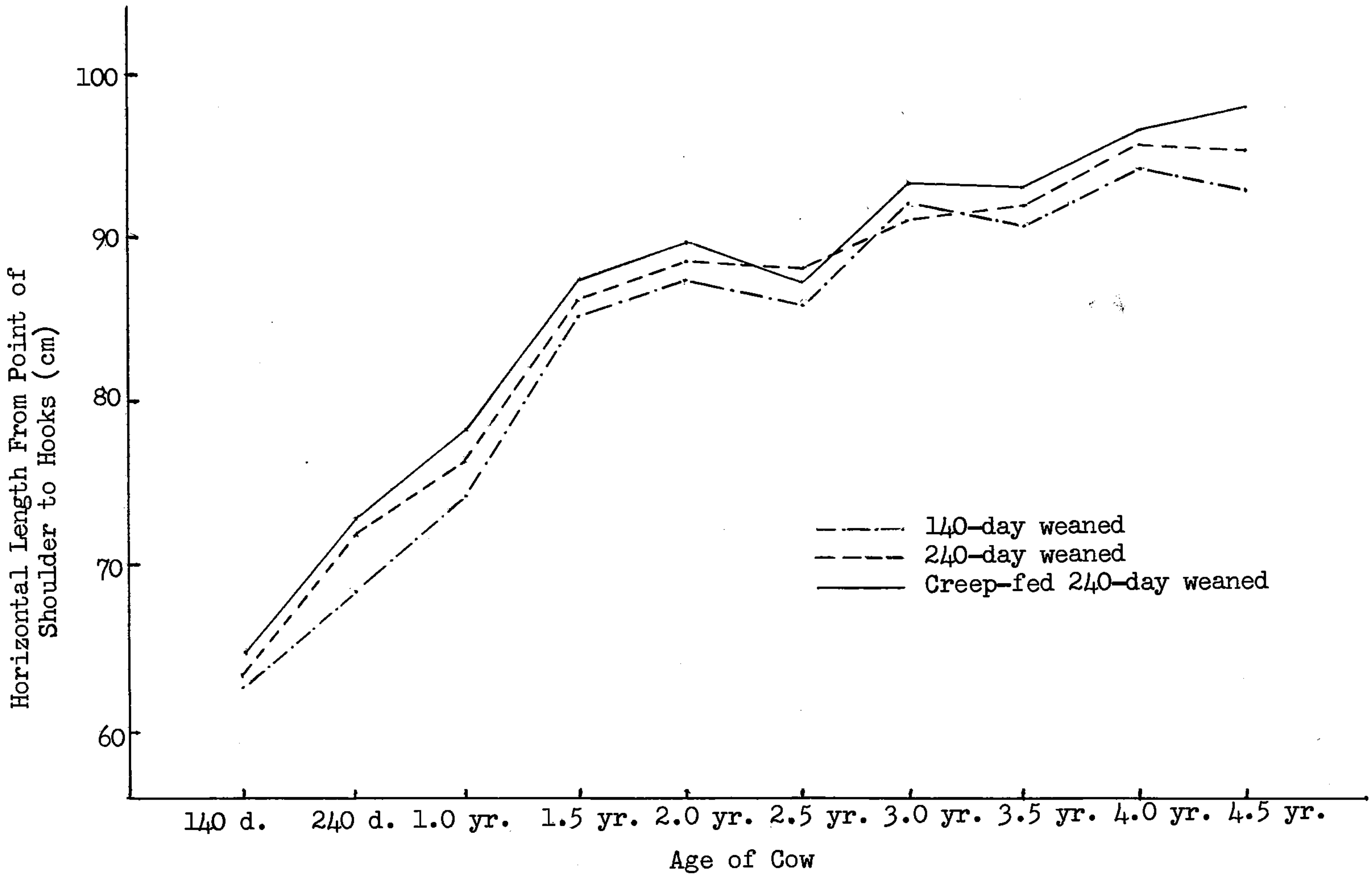

Figure 3. Average Values of Horizontal Length From Point of Shoulder to Hooks of Cows Fed Different Levels of Nutrition Before Weaning

TABLE IX

AVERAGE HEIGHT AT WITHERS[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance	
Age					
240 Days	93.28[c] ± .36[d]	96.40 ± .37	97.65 ± .36	1<2[e]	1<3[e]
1.0 Year	98.65 ± .51	100.92 ± .53	102.68 ± .51	1<2[f]	1<3[e]
1.5 Year	108.70 ± .38	109.97 ± .40	110.60 ± .38	1<3[f]	

[a]Actual measurement.

[b]Only ages with significant treatment F values ($P < .05$) included.

[c]Unweighted means in cm.

[d]Standard error.

[e]Significant at $P < .01$.

[f]Significant at $P < .05$.

TABLE X

AVERAGE HEIGHT AT WITHERS[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION[b]

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance
Age				
240 Days	92.55[c] ± .39[d]	96.09 ± .40	97.19 ± .39	1 < 2[e] 1 < 3[e]
1.0 Year	98.68 ±	101.40 ±	102.15	1 < 2[e] 1 < 3[e]

[a]Photographic measurement.

[b]Only ages with significant treatment F values ($P < .05$) included.

[c]Unweighted means in cm.

[d]Standard error.

[e]Significant at $P < .01$.

TABLE XI

AVERAGE HEIGHT AT HOOKS[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Treatment	1. 140-Day Weaned	2. 240-Day Weaned	3. Creep-fed 240-Day Weaned	Significance	
Age					
240 Days	91.60[c] ± .41[d]	94.97 ± .43	95.78 ± .41	1<2[e]	1<3[e]
1.0 Year	97.12 ± .41	99.71 ± .42	100.48 ± .41	1<2[e]	1<3[e]
1.5 Year	105.97 ± .42	107.41 ± .45	107.84 ± .43	1<3[f]	

[a]Photographic measurement.

[b]Only ages with significant treatment F values ($P<.05$) included.

[c]Unweighted means in cm.

[d]Standard error.

[e]Significant at $P<.01$.

[f]Significant at $P<.05$

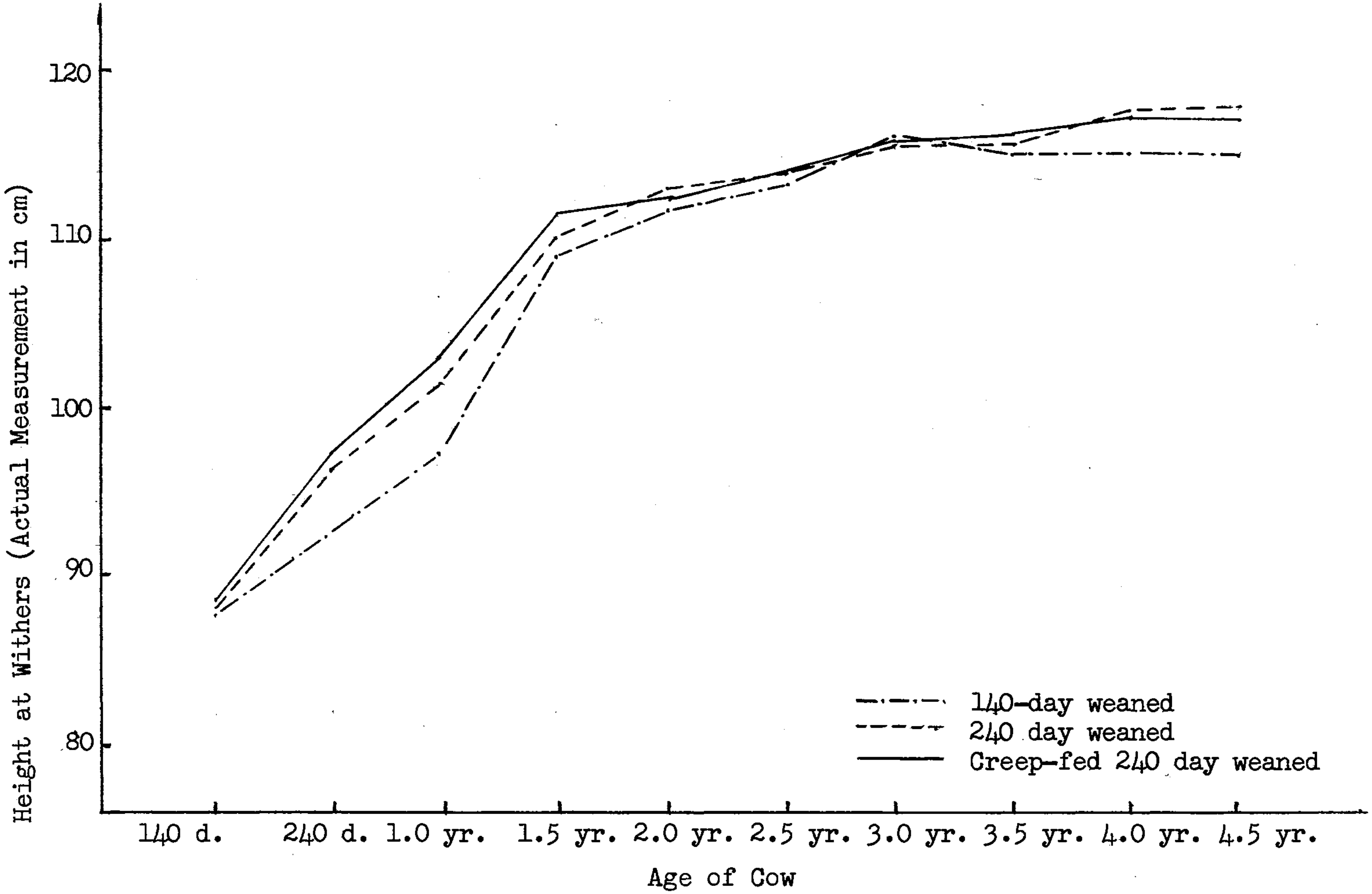

Figure 4. Average Values of Height at Withers of Cows Fed Different Levels of Nutrition Before Weaning

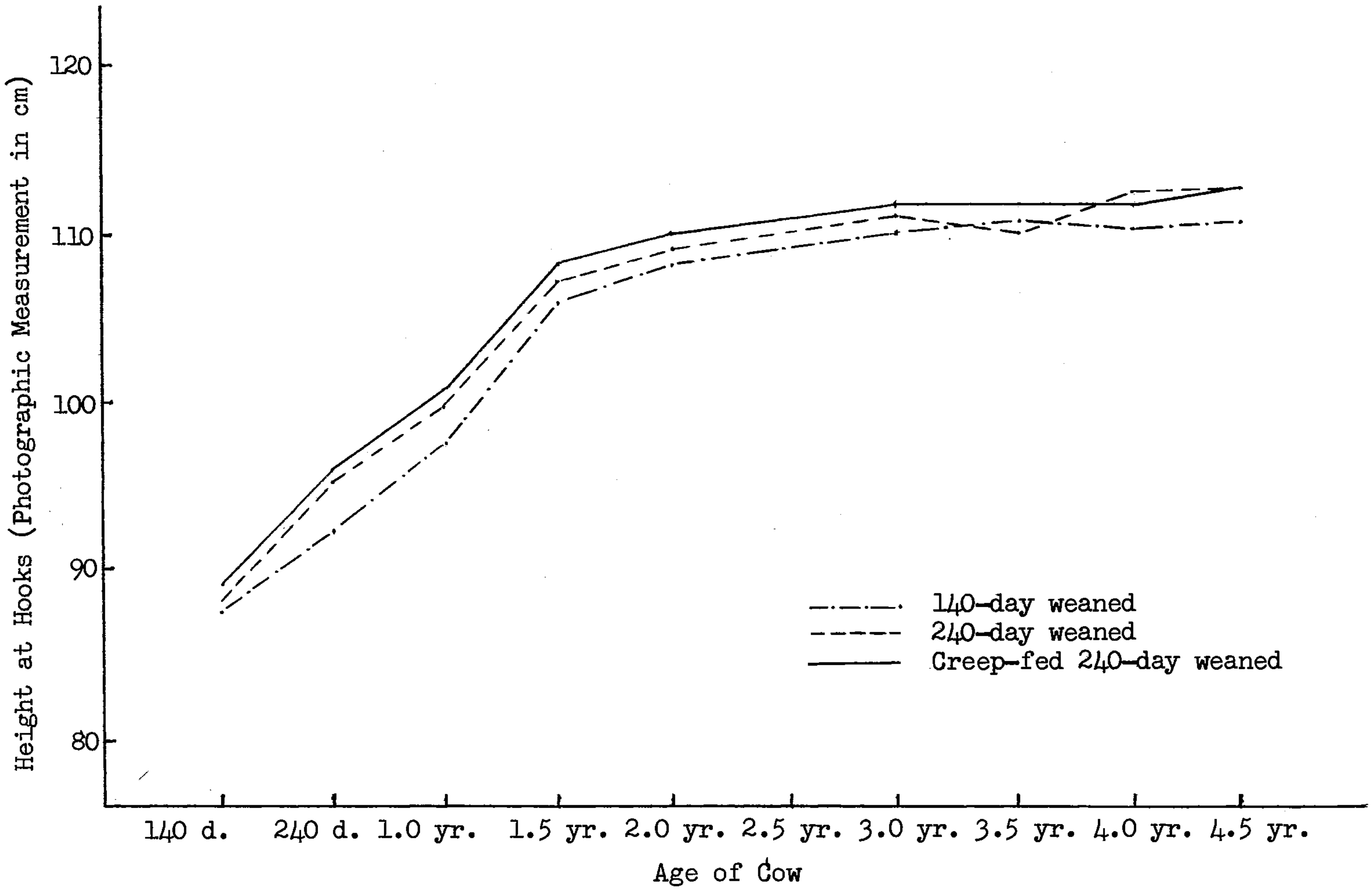

Figure 5. Average Values of Height at Hooks of Cows Fed Different Levels of Nutrition Before Weaning

months later than heifers on a high plane.

At 140 days of age, actual height at withers was approximately .12 cm larger than photographic height at hooks. As the animal increased in age, the height at hooks increased at a relatively greater rate than height at withers. The advantage in height at hooks over height at withers was 4.99 cm at 240 days, 2.62 cm at 2.0 years, 4.75 cm at 3.0 years and 0.23 cm at 4.0 years. These data indicate that maturity in height at withers was attained earlier than maturity in height at hooks, which is in agreement with Guilbert and Gregory (1952) who observed an anterior to posterior gradient in development of body parts.

Reproductive Efficiency

The average calving dates for cows fed different levels of pre-weaning nutrition are shown in Figure 6. No significant treatment differences were obtained ($P > .10$) and no general trends were observed. Sorensen et al. (1954), Reid et al. (1957a), Crichton et al. (1959) and Hughes (1971) reported a delay in first estrus for heifers on an extended low plane of nutrition. Perhaps the treatments in the experiment reported herein were not severe enough to produce a change in physiological age of the heifers.

No significant treatment differences ($P > .10$) were obtained for percent of cows which calved. There was a trend, however, for the 140-day weaned group to have a lower percent calf crop for the different trials especially for the first calf crop. As shown in Figure 7, for the first calf crop the 140-day weaned group was 15.80 percent lower than the 240-day weaned group and 15.57 percent lower than the creep-fed 240-day weaned group. Wiltbank et al. (1969) found that Hereford

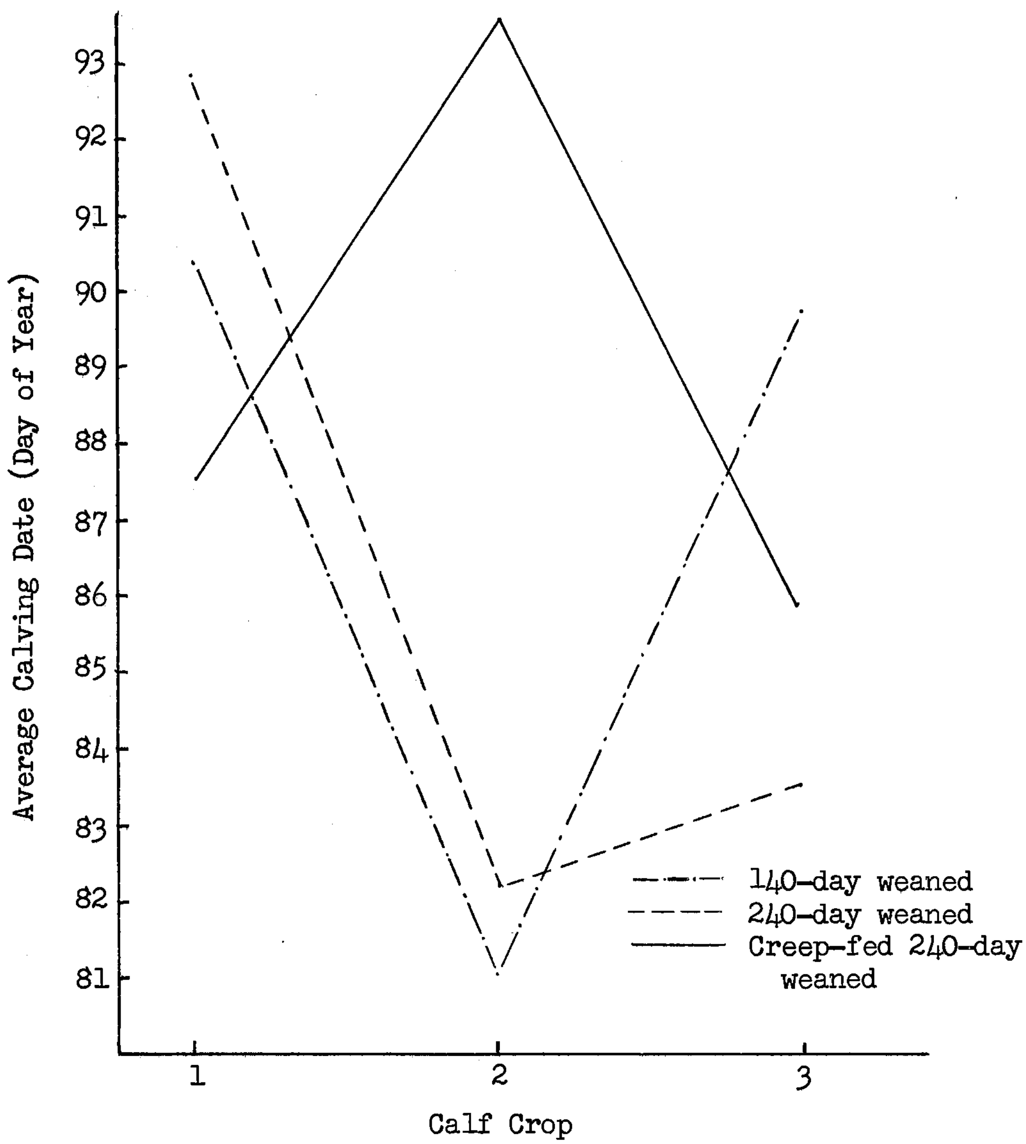

Figure 6. Average Calving Date for Cows Fed Different Levels of Preweaning Nutrition

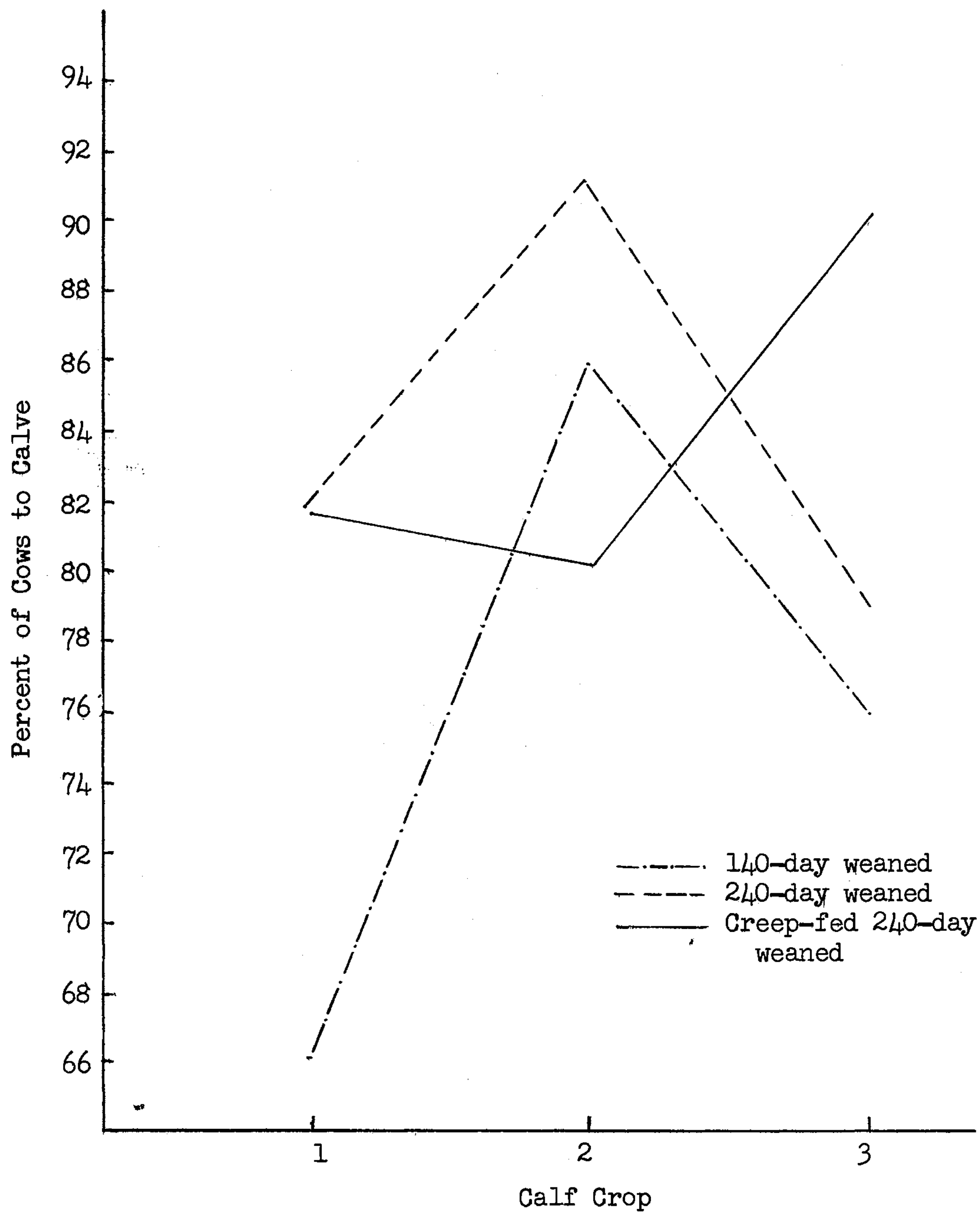

Figure 7. Average Percent of Cows Which Calved for Three Calf Crops

and Angus heifers on a low plane of nutrition from 6 to 12 months of age attained puberty 273 and 109 days later, respectively, than cows on a high plane. Wiltbank et al. (1965) found that Angus heifers wintered to gain .45 kg per head daily attained puberty in 11.2 months at a weight of 260 kg, whereas Herefords attained maturity in 13.6 months at 302 kilograms. When Angus and Hereford heifers were wintered to gain .23 kg per head daily, they attained puberty in 13.1 months at a weight of 236 kg and 15.5 months at a weight of 270 kg, respectively.

In this study, all cattle were exposed to a bull at a fixed date (an average of May 20 for all trials); it is possible that the 140-day weaned cattle had not attained puberty at that time. This could explain the poor performance of the 140-day Hereford (59.4 percent) as compared to the 140-day weaned Angus (72.9 percent) for percent cows which calved the first time, since the Herefords were later maturing than the Angus. The Herefords and Angus weaned at 140 days of age weighed approximately 256 and 281 kg, respectively, at the time they were first exposed to the bull. According to Wiltbank et al. (1965), these heifers should have already attained puberty unless the preweaning plane of nutrition was an interfering factor. By the second calf crop no great differences were noted between the treatments for percent of cows which calved. The average percent of cows which calved over all three productive years was 75.96, 84.05 and 83.99 percent for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups, respectively. Reid et al. (1957a) and Bratton et al. (1957) reported no significant differences ($P > .10$) for number of services per conception due to nutritional treatments imposed during early life.

No significant treatment differences ($P > .10$) were obtained for percent of cows to wean calves, but a trend was noted for the 140-day weaned group to wean a smaller percent of calves for the first calf crop. As shown by Figure 8, no trend over calf crop can be distinguished. The average percent calf crop weaned over all three productive years was 67.34, 72.80 and 76.83 percent for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups, respectively.

Calf Birth Weight

Treatment of the dam affected the birth weight of the calves significantly ($P < .05$) only the first calf crop. The means for birth weight for the first calf crop from 140-day weaned, 240-day weaned and creep-fed 240-day weaned dams were 26.73, 26.73 and 27.4 kg, respectively. As shown in Figure 9, no definite trend was noted for calf crops two and three. The 140-day weaned and 240-day weaned cows apparently had not completely overcome the detriment of their preweaning nutrition at the time they were first bred as illustrated by all growth curves (Figures 1 through 5) and therefore, possibly did not provide the prenatal maternal environment provided by the creep-fed 240-day weaned cows. Joubert (1954), Reid et al. (1957a), Pinney (1962) and Hight (1966) reported lighter birth weights for calves of cows on low planes of nutrition during the growth period.

Calf Weaning Weight and Skeletal Measurements

Analyses of variance failed to show a significant ($P > .05$) treatment effect upon weaning weight of three calf crops. As shown in Figure 10 and Table XII, however, the creep-fed 240-day weaned group tended to wean lighter calves for all three calf crops. The treatment F tests for

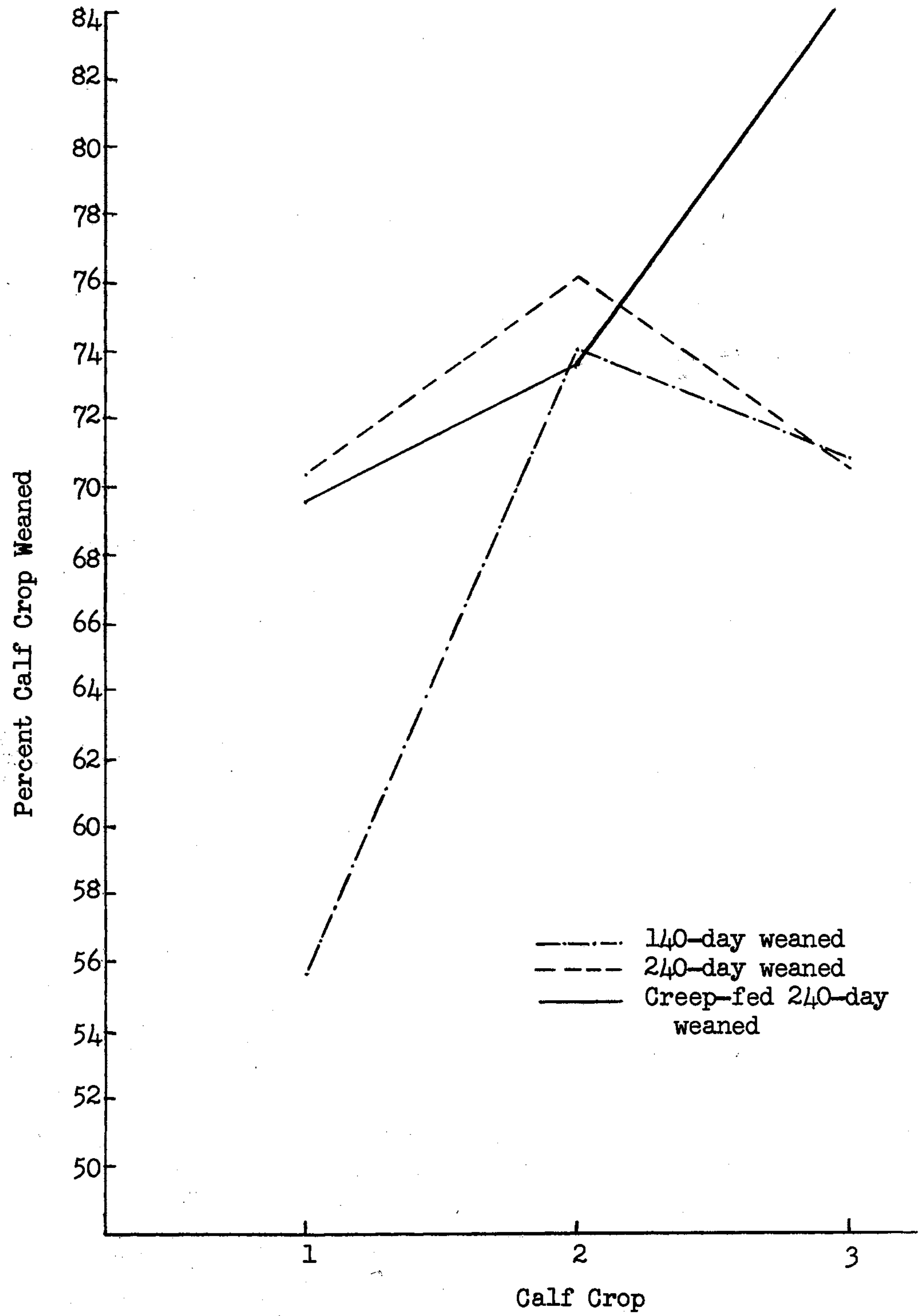

Figure 8. Average Percent Calf Crop Weaned for Three Calf Crops

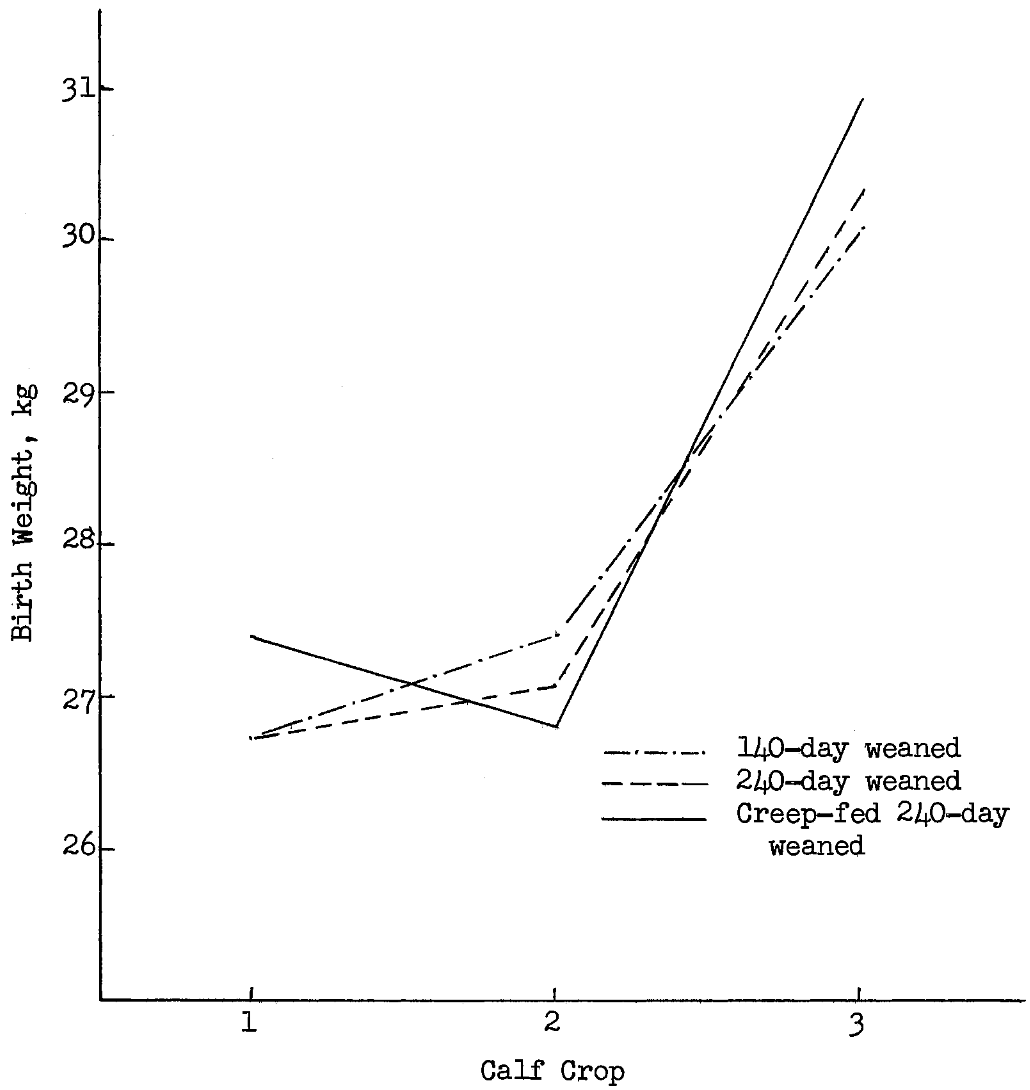

Figure 9. Average Birth Weight of Calves From Cows Fed Different Levels of Preweaning Nutrition

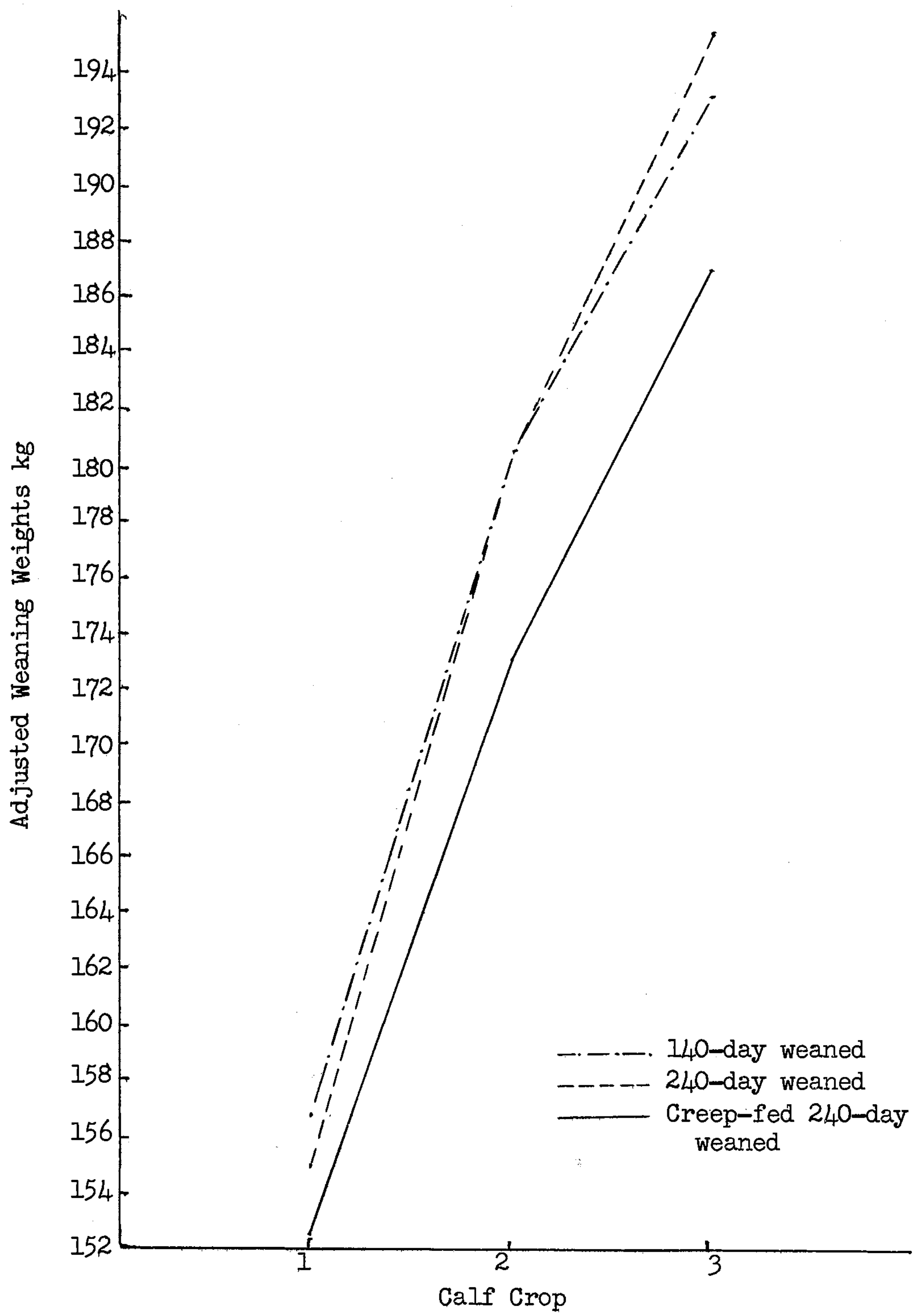

Figure 10. Average Sex, Age and Crossbreed Corrected Weaning Weights of Calves From Cows Fed Different Levels of Preweaning Nutrition

TABLE XII

AVERAGE SEX, AGE, AND CROSSBREED CORRECTED WEANING WEIGHTS OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Treatment	140-Day Weaned	240-Day Weaned	Creep-fed 240-Day Weaned	Significance
Calf Crop				
1	156.77[a] ± 1.25[b]	155.08 ± 1.16	152.37 ± 1.12	NS[c]
2	180.58 ± 1.26	180.49 ± 1.26	173.43 ± 1.22	NS
3	191.66 ± 1.48	195.60 ± 1.52	187.30 ± 1.33	NS

[a]Unweighted mean in cm.

[b]Standard error.

[c]Nonsignificant (P > .10).

calf crops two and three approached significance ($P > .10$). Since these analyses are on unweighted means, the probability levels are only approximations and there possibly was a true difference not detectable by the analysis used.

These results agree with Mangus and Brinks (1971a) who reported product moment correlations of the cow's weaning weight, weaning age and weaning score with MPPA (Most Probable Producing Ability) of 0.14, 0.05 and -0.02, respectively, indicating a low relationship between these factors and cow productivity. There was a trend, however, for high weaning weight to be associated with low subsequent maternal ability. Holtz, Erb and Hodgson (1961) concluded that early gain is a poor predictor of producing ability in dairy cattle. Christian, Hauser and Chapman (1965), and Koch (1969) reported an inverse relationship between preweaning growth potential and maternal ability in beef cattle. This same relationship was noted in dairy cattle by Wallace (1953), Swanson and Spann (1954), Hansson (1956) and Swanson (1957). Christian, Hauser and Chapman (1965), studying identical and fraternal twin Hereford heifers, found a significant negative correlation between weaning weight of dam and her butterfat production for the first 60 days of the first lactation, but the negative correlations between weaning weight and milk production were not significantly different from zero.

Totusek (1968), reporting preliminary results from this study, indicated a larger difference between treatment means than is reported here. This can be explained by the fact that his means were based upon a different method of pooling than the method used in this study. He pooled all sex and age corrected weaning weights for the 1965, 1966 and 1967 calf crops regardless of age of cow at time of calving. In this paper sex, age and crossbreed corrected weaning weights were pooled for all cows of the same age regardless of year the calf was born. Weight of calf produced for three calf crops (sum of percent calf crop weaned x mean weaning weight over three calf crops) for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups was 356.4, 384.4 and 393.1 kg, respectively. Thus, although the creep-fed 240-day weaned group tended to wean lighter calves, their advantage in percent calf crop weaned overcame this disadvantage. The weight of calf produced for each calf crop is presented graphically in Figure 11. The creep-fed 240-day weaned group did not consistently maintain an advantage in weight of calf produced over calf crop.

Because of the high correlation between milk production of dam and weaning weight of calf (Knapp and Black, 1941; Pinney, 1962; Gifford, 1953; Valesco, 1962), milk production will be discussed in this context. As shown in Figure 12 the milk production trends are similar to those of weaning weight for the first two calf crops lending support to the possibility of a treatment effect on lactation.

No trends, however, were noted among treatments for the three calf crops for height at withers, height at hooks and length of body of calves at 140 days of age. Neither weight nor condition score nor skeletal measurement (height at withers, width at hooks, length of rump, length of body, distance from chest floor to ground and height at hooks) showed any statistical treatment effect ($P > .05$) for any calf crop as measured at 140 days of age. Birth year, however, was generally significant ($P < .05$) for these analyses indicating that continuous environment had a greater effect on calf performance than level of dam's preweaning nutrition.

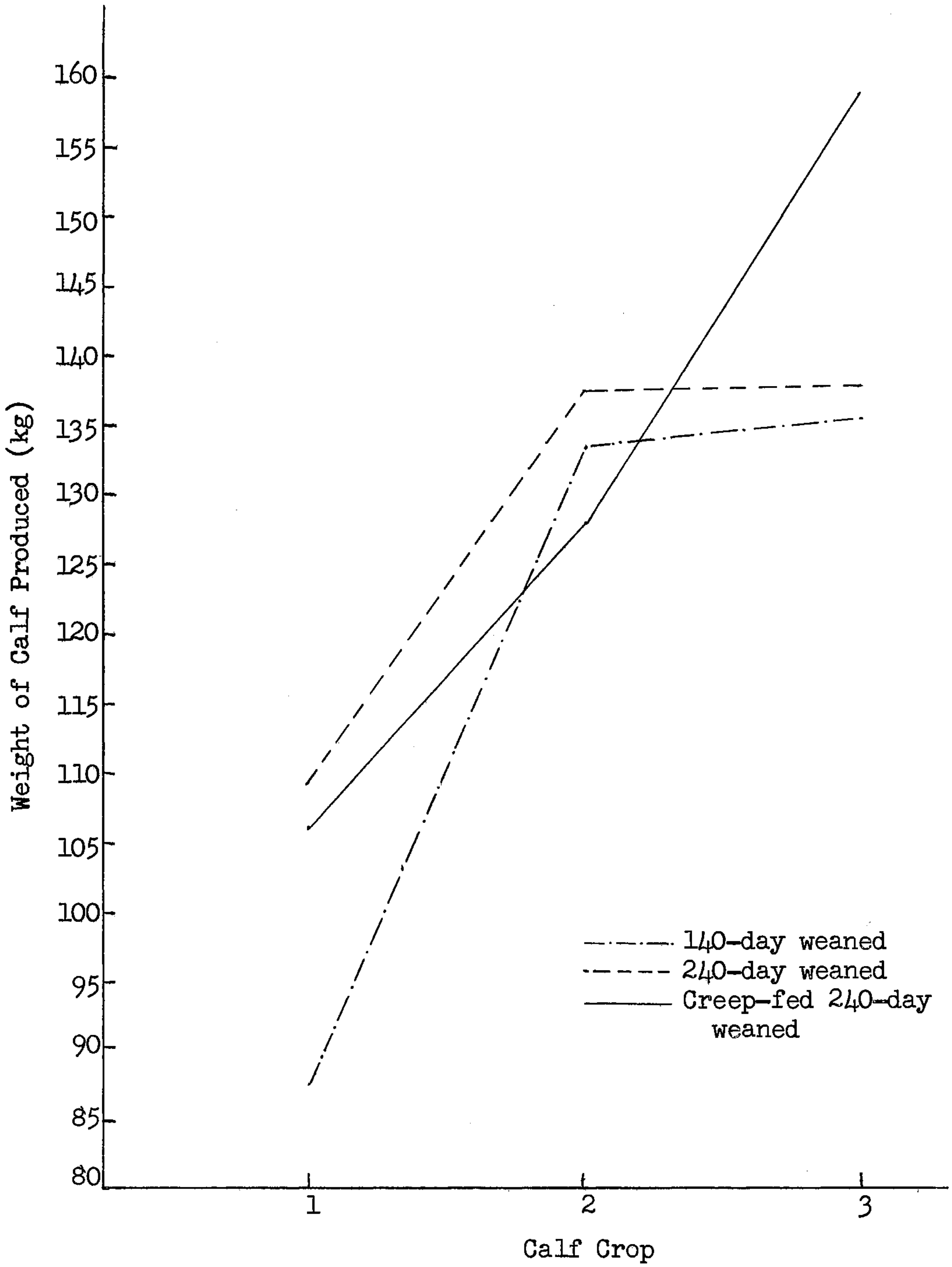

Figure 11. Average Values of Weight of Calf Produced for Three Calf Crops

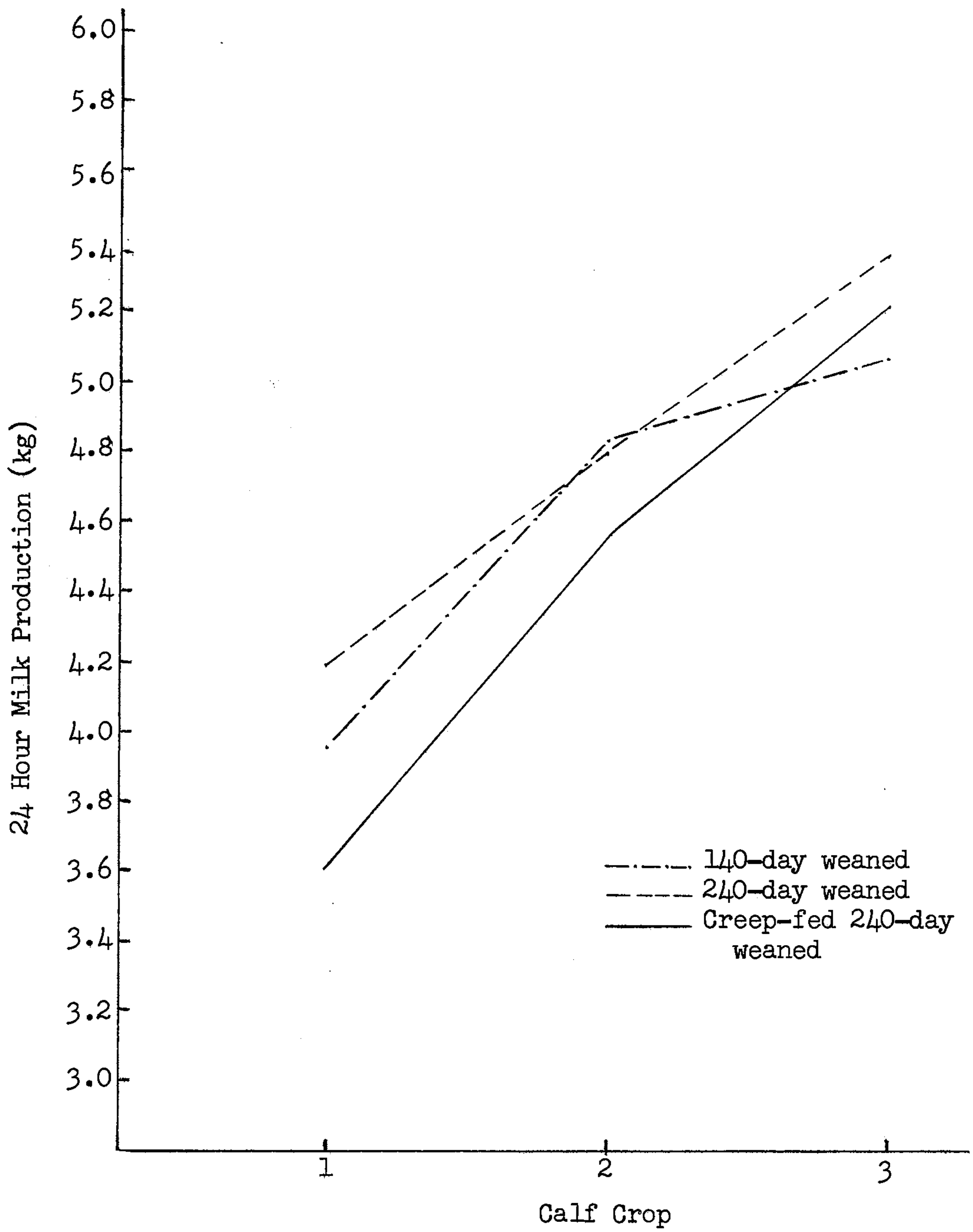

Figure 12. Average Values of Milk Production of Three Calf Crops

CHAPTER V

SUMMARY

A study was initiated in 1963 employing approximately 50 Hereford and Angus females in each of four trials to determine the effects of three preweaning planes of nutrition. These planes of nutrition were accomplished by: (1) weaning at 140 days, (2) weaning at 240 days and (3) creep-feeding and weaning at 240 days. At 240 days of age, 140-day weaned, 240-day weaned, and creep-fed 240-day weaned females weighed 175.7, 206.5 and 226.0 kg, respectively. After weaning all females were treated alike under range conditions. Weights and body measurements, actual and photographic, were taken at 140 days, 240 days, one year, and at six month intervals thereafter to 4.5 years.

The Angus females tended to mature earlier but the Herefords attained a greater maximum body size. No breed interaction with treatment, however, was observed. Height at withers increased at a relatively greater rate than height at hooks indicating an anterior to posterior gradient in growth.

Body weight, condition score and other measurements of growth tended to be significantly ($P < .05$) affected by treatment to 1.5 years. The creep-fed 240-day weaned cattle gained the least in structural size and the 140-day weaned group gained the most between 240 days and 2.0 years of age. The creep-fed 240-day weaned cattle lost more weight and condition during time of first pregnancy than did the other treatments

(which remained rather constant). The creep-fed 240-day weaned cattle, however, provided a better prenatal maternal environment for the first calf crop as shown by heavier ($P < .05$) calf birth weights. By 2.0 years of age (time of first calving) no significant difference ($P > .05$) between treatments was observed for any of the skeletal measurements. This indicates that by the time of first calving there was little anatomical difference due to treatment. This possibly explains why no significant ($P > .05$) treatment effect on weaning weights for any calf crop was observed. A trend was evident, however, for the creep-fed 240-day weaned cows to wean lighter calves. The average sex and age corrected weaning weight for three calf crops for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups was 156.8, 155.0 and 152.4 kg, respectively. Milk production data was not analyzed statistically but exhibited a similar trend to that of weaning weight. Neither weight nor condition score nor structural measurements of calves showed any statistical treatment effect ($P > .05$) for any calf crop as measured at 140 days of age.

Different levels of preweaning nutrition did not significantly ($P > .05$) affect average calving dates, percent cows which calved, or percent calf crop weaned. A trend for the 140-day weaned group to give birth to a smaller percent of calves for the first calf crop was noted. The average percent calf crop weaned over all three productive years was 67.34, 72.80 and 76.83 percent for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups, respectively. The total weight of calf produced per cow for three calf crops for 140-day weaned, 240-day weaned and creep-fed 240-day weaned groups was 356.4, 384.4 and 393.1 kg, respectively.

LITERATURE CITED

Arnett, D. W. 1963. Studies with twin beef females. I. Some effects of level of nutrition. II. Milk production techniques. Ph.D. Thesis. Oklahoma State University, Stillwater, Oklahoma.

Asdell, S. A. and M. F. Crowell. 1935. The effects of retarded growth upon the sexual development of rats. J. Nutr. 10:13.

Ball, Z. B., R. H. Barnes and M. B. Visscher. 1947. The effects of dietary caloric restriction on maturity and sescence with particular reference to fertility and longevity. Amer. J. Physiol. 150:511.

Bradford, G. E., W. C. Weir and D. T. Torrell. 1961. Effect of environment from weaning to first breeding on lifetime production of ewes. J. Anim. Sci. 20:281.

Bratton, R. W., S. D. Musgrave, H. O. Dunn and R. H. Foote. 1957. Breeding difficulties in dairy cattle. Cornell Univ. Agr. Exp. Sta. Bull. 924.

Brinks, J. S., R. T. Clark, N. M. Kieffer and J. R. Quisenberry. 1962. Mature weight in Hereford range cows - heritability, repeatability and relationship to calf performance. J. Anim. Sci. 21:501.

Broster, W. H., B. Ridler and A. S. Foot. 1958. Levels of feeding of concentrates for dairy heifers before and after calving. J. Dairy Res. 25:373.

Chambers, D., J. Armstrong and D. F. Stephens. 1960. Development of replacement beef heifers for expression of maternal traits. Okla. Agr. Exp. Sta. Misc. Pub. 57:89.

Christian, L. L., E. R. Hauser and A. B. Chapman. 1965. Association of preweaning and postweaning traits with weaning weight in cattle. J. Anim. Sci. 24:652.

Christenson, R. K., D. R. Zimmerman, D. C. Clanton, L. E. Jones, R. L. Tribble and R. Stotomayor. 1967. Effect of precalving energy levels on performance of beef heifers. J. Anim. Sci. 26:916. (Abstr.).

Crichton, J. A., J. N. Aitken and A. W. Boyne. 1959. The effect of plane of nutrition during rearing on growth, production, reproduction and health of dairy cattle. I. Growth to 24 months. Anim. Prod. 1:145.

Crichton, J. A., J. N. Aitken and A. W. Boyne. 1960a. The effect of plane of nutrition during rearing on growth, production, reproduction and health of dairy cattle. II. Growth to maturity. Anim. Prod. 2:45.

Eckles, C. H. and W. W. Swett. 1918. Some factors influencing the rate of growth and the size of dairy heifers at maturity. Mo. Agr. Exp. Sta. Res. Bull. 31.

Elsley, F. W. H. and I. McDonald. 1964. The effect of plane of nutrition on carcasses of pigs and lambs when variations in fat content are excluded. Anim. Prod. 6:141.

Foote, W. C., A. L. Pope, A. B. Chapman and L. E. Casida. 1959. Reproduction in the yearling ewe as affected by breed and sequence of feeding levels. II. Effect on fetal development. J. Anim. Sci. 18:463.

Guenther, J. J., D. H. Bushman, L. S. Pope and R. D. Morrison. 1965. Growth and development of the major carcass tissues in beef calves from weaning to slaughter weight, with reference to the effect of plane of nutrition. J. Anim. Sci. 24:1184.

Gifford, Warren. 1953. Records of performance tests for beef cattle in breeding herds. Ark. Agr. Exp. Sta. Bull. 531.

Gosset, J. W. and A. M. Sorensen, Jr. 1959. The effect of two levels of energy and seasons on reproductive phenomena of gilts. J. Anim. Sci. 18:40.

Guilbert, H. R. and P. W. Gregory. 1952. Some features of growth and development of Hereford cattle. J. Anim. Sci. 11:3.

Hammond, John. 1955. Progress in physiology of farm animals. Vol. II. Buttersworth Scientific Publications, London.

Hammond, John. 1961. Growth in size and body proportion in farm animals in M. S. Zarrow (Ed.) Growth in living systems. Proceedings of International Symposium on Growth. Basic Books Inc., New York.

Hansson, A. 1956. Influence of rearing intensity on body development and milk production. Proc. Brit. Soc. Anim. Prod. pg. 51.

Hight, G. K. 1966. The effects of undernutrition in late pregnancy on beef cattle production. New Zealand J. Agr. Res. 9:479.

Hogan, A. G. 1929. Retarded growth and mature size of beef steers. Mo. Agr. Exp. Sta. Res. Bull. 123.

Holtz, E. W., R. E. Erb and A. S. Hodgson. 1961. Relationship between rate of gain from birth to six months of age and subsequent yields of dairy cattle. J. Dairy Sci.

Hughes, Joe H., Jr. 1971. The influence of winter nutrition on the growth and milk production of Hereford females and the birth date and growth of their calves. Ph.D. Thesis, Oklahoma State University, Stillwater, Oklahoma.

Jackson, C. M. and C. A. Stewart. 1920. The effects of inanition in the young upon the ultimate size of the body and of the various organs in the albino rat. J. Exp. Zoology. 30:97.

Joubert, D. M. 1954. The influence of winter nutritional depressions on the growth, reproduction and production of cattle. J. Anim. Sci. 44:5.

Joubert, D. M. and F. N. Bonsma. 1957. The effect of nutrition on the birth weight of calves. Union of South Africa Dept. of Agr. Sci. Bull. No. 371, Pretoria, South Africa.

Kieffer, N. M. 1959. Inheritance of certain maternal traits in beef cattle. Ph.D. Thesis, Oklahoma State University, Stillwater.

Knapp, Bradford, Jr. and W. H. Black. 1941. Factors influencing rate of gain of beef calves during the suckling period. J. Agr. Res. 63:249.

Knox, J. H. and Marvin Koger. 1945. Effect of age on the weight and production of range cows. New Mex. Agr. Exp. Sta. Press Bull. 1004.

Koch, R. M., K. E. Gregory, J. E. Ingalls and R. L. Arthaud. 1959. Evaluating the influence of sex on birth weight and preweaning gain in beef cattle. J. Anim. Sci. 18:738.

Lister, D. and R. A. McCance. 1967. Severe undernutrition in growing and adult animals. Brit. J. Nutr. 21:787.

MacIntyre, T. M. and J. R. Aitken. 1959. The performance of laying hens reared on restricted and full feeding programs. Can. J. Ani. Sci. 39:217.

Mangus, W. L. and J. S. Brinks. 1971. Relationships between direct and maternal effects in growth in Herefords. I. Environmental factors during preweaning growth. J. Anim. Sci. 32:17.

McCay, C. M., M. F. Crowell and L. A. Maynard. 1935. The effect of retarded growth upon the length of life span and upon the ultimate body size. J. Nutr. 10:63.

McCay, C. M., L. A. Maynard, G. Sperling and L. C. Barnes. 1939. Retarded growth, life span, ultimate body size and age changes in the albino rat after feeding diets restricted in calories. J. Nutr. 18:1.

McMeekan, C. P. 1940a. Growth and development in the pig, with special reference to carcass quality characters. I. J. Agri. Sci. 30: 276.

McMeekan, C. P. 1940b. Growth and development in the pig with special reference to carcass quality characters. II. The influence of the plane of nutrition on growth and development. J. Agri. Sci. 30:287.

McMeekan, C. P. 1940c. Growth and development in the pig with special reference to carcass quality characters. III. Effect of the plane of nutrition on the form and composition of the bacon pig. J. Agri. Sci. 30:287.

Milby, T. T. and D. H. Sherwood. 1953. The effect of restricted feeding on growth and subsequent production of pullets. Poul. Sci. 32:916.

Moulton, C., P. F. Trowbridge and L. D. Haigh. 1921. Studies in animal nutrition changes in form of weight on different planes of nutrition. Mo. Agr. Exp. Sta. Bull. 338.

Osborne, T. B. and L. B. Mendel. 1914. The suppression of growth and the capacity to grow. J. Biol. Chem. 18:95.

Osborne, T. B., L. B. Mendel and E. L. Ferry. 1917. The effect of retardation upon the breeding period and duration of life of rats. Science. 45:294.

Palsson, H. and J. B. Verges. 1952a. Effects of the plane of nutrition on growth and the development of carcass quality in lambs. I. The effects of high and low planes of nutrition at different ages. J. Agri. Sci. 42:1.

Palsson, H. and J. B. Verges. 1952b. Effects of the plane of nutrition on growth and the development of carcass quality in lambs. II. Effects on lambs of 30 pound carcass weight. J. Agri. Sci. 42:93.

Pinney, D. O. 1962. Performance of range beef cows as affected by supplemental winter feed and age at first calving. M. S. Thesis. Oklahoma State University, Stillwater, Oklahoma.

Pinney, D. O., L. S. Pope, D. F. Stephens and L. M. Henderson. 1962. Lifetime performance of beef cows wintered each year on three different levels. Okla. Agr. Exp. Sta. Misc. Pub. 67:63.

Pope, L. S., J. D. Shroder, R. D. Humphrey, D. F. Stephens and R. MacVicar. 1955. Effects of level of wintering and age at first calving on the performance of range beef cows. Okla. Agri. Exp. Sta. Misc. Pub. 43:35.

Pope, L. S., L. Smithson, D. F. Stephens, D. O. Pinney and M. Valesco. 1963. Factors affecting milk production of range beef cows. Okla. Agri. Exp. Sta. Misc. Pub. 70:69.

Quisenberry, J. H., J. W. Deaton, D. C. Ferebee and J. W. Bradley. 1959. Some effects of caloric restriction during the growing period on the laying house performance of a commercial egg production stock. Poul. Sci. 38:1239. (Abstr.).

Reid, J. T., J. K. Loosli, G. W. Trimberger, K. L. Turk, S. A. Asdell and S. E. Smith. 1964. Causes and prevention of reproductive failures in dairy cattle. IV. Effect of plane of nutrition during early life on growth, reproduction, production, health and longevity of Holstein cows. I. Birth to first calving. Cornell Univ. Agr. Exp. Sta. Bull. 987.

Reid, J. T., J. K. Loosli, K. L. Turk, G. W. Trimberger, S. A. Asdell and S. E. Smith. 1957a. Effect of nutrition during early life upon the performance of dairy cows. Proc. Cornell Nutr. Conf. p. 65.

Riesen, W. H., E. J. Herbst, C. Walliker and C. A. Elvehjem. 1947. The effect of restricted caloric intake on longevity of rats. Amer. J. Physiol. 148:614.

Schneider, A. J., B. B. Bohrens and V. L. Anderson. 1955. The effect of restricted feeding on several genetically controlled characters in the fowl. Poul. Sci. 34:691.

Sherman, H. C. and H. L. Campbell. 1934. Rate of growth and length of life. Science. 80:547.

Sherman, H. C. and H. L. Campbell. 1937. Nutritional well-being and length of life as influenced by different enrichments of an already adequate diet. J. Nutr. 14:609.

Smithson, L. J. 1966. An Analysis of the relative difference in the weights of bovine males and females at birth and weaning. M. S. Thesis. Oklahoma State University, Stillwater, Oklahoma.

Smithson, Larry, S. A. Ewing, L. S. Pope and D. F. Stephens. 1966. The cumulative influence of level of wintering on the lifetime performance of beef females through six calf crops. Okla. Agr. Exp. Sta. Misc. Pub. 78:49.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (6th ed.) Iowa State University Press, Ames, Iowa.

Sorensen, A. M., R. W. Bratton, W. Hansel and W. H. Haugh. 1954. The growth and sexual development of young Holstein heifers as influenced by three levels of nutrition. J. Anim. Sci. 13:1031. (Abstr.).

Steensberg, V. 1947. Feeding requirements of young cattle. Brit. J. Nutr. 1:139.

Stuedemann, J. A. 1967. The effect of nutritional level imposed from birth to eight months of age on the growth and development patterns of beef calves fed the same ration from eight months to a constant market weight. M. S. Thesis. Oklahoma State University, Stillwater, Oklahoma.

Sunde, M. L., W. W. Cravens, H. R. Bird and J. G. Halpin. 1954. The effect of complete and imcomplete growing diets on subsequent performance of the laying hen. Poul. Sci. 33:779.

Swanson, E. W. 1957. The effect of fattening dairy heifers upon their growth and lactation. J. Dairy Sci. 40:611. (Abstr.).

Swanson, E. W. 1960. Effect of rapid growth with fattening of dairy heifers on their lactational ability. J. Dairy Sci. 43:377.

Swanson, E. W. and S. A. Hinton. 1962. Effects of adding concentrate to ad libitum roughage feeding in the dry period. J. Dairy Sci. 45:48.

Swanson, E. W. and T. R. Spann. 1954. The effect of rapid growth with fattening upon lactation in cattle and rats. J. Anim. Sci. 13: 1032.

Thomas, O. O. 1952. I. Relation of nutrition and age at first calving to lifetime performance of beef cows. II. The effect of low phosphorus rations upon carotene metabolism in ruminants. Ph.D. Thesis, Oklahoma State University, Stillwater, Oklahoma.

Totusek, Robert. 1968. Early weaning vs. normal weaning vs. creep feeding of heifer calves. Okla. Agr. Exp. Sta. Misc. Pub. 80:72.

Totusek, Robert, G. L. Holland, Dudley Arnett and E. W. Jones. 1961. The influence of excessive fatness on the performance of beef females. Okla. Agr. Exp. Sta. Misc. Pub. 64:63.

Valesco, M. 1962. Level of winter feeding of range beef cows. M. S. Thesis. Oklahoma State University, Stillwater, Oklahoma.

Wallace, Joe D. and R. J. Raleigh. 1964. Calf production from Hereford cows wintered at different nutrition levels. Proc. West Sec. Amer. Soc. Anim. Sci. 15:LVII-1.

Wardrop, I. D. 1966. The effects of the plane of nutrition in early postnatal life on subsequent growth and development of cattle. Australian J. Agr. Res. 17:375.

Widdowson, E. M. J. W. T. Dickerson and R. A. McCance. 1960. Severe undernutrition in growing and adult animals. Brit. J. Nutr. 14:331.

Widdowson, E. M. and R. A. McCance. 1963. The effect of finite periods of undernutrition at different ages on the composition and subsequent development of the rat. Proc. R. Soc. B. 158:329.

Wiltbank, J. N., C. W. Kasson, J. A. Rothlisberger, J. E. Ingalls and K. E. Gregory. 1965. A reproduction comparison: straightbred and crossbred cows. Neb. Agr. Exp. Sta. Beef Cattle Progress Report.

Wiltbank, J. N., C. W. Kasson and J. E. Ingalls. 1969. Puberty in crossbred and straightbred beef heifers on two levels of feed. J. Anim. Sci. 29:602.

Wiltbank, J. N., J. Bond and E. J. Warwick. 1965. Influence of total feed and protein intake on reproductive performance of the beef female through second calving. U.S.D.A. Tech. Bull. 1314.

Wiltbank, J. N. W. W. Ronden, J. E. Ingalls and D. R. Zimmerman. 1964. Influence of post-partum energy level on reproductive performance of Hereford cows restricted in energy intake prior to calving. J. Anim. Sci. 23:1049.

Winchester, C. F., R. L. Hiner and V. C. Scarborough. 1957. Some effects on beef cattle of protein and energy restriction. J. Anim. Sci. 16:426.

Winchester, C. F. and P. E. Howe. 1955. Relative effects of continuous and interrupted growth on beef steers. U.S.D.A. Tech. Bull. 1108:3.

Zimmerman, J. E. 1958. Effect of different levels of wintering and different ages at first calving upon performance of beef cows. M. S. Thesis. Oklahoma State University, Stillwater, Oklahoma.

APPENDIX

TABLE XIII

AVERAGE BODY WEIGHT (KG) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					140 Days[d]							
63	129.10	(8)	134.37	(8)	145.40	(9)	141.61	(10)	160.70	(7)	136.08	(5)
64	142.63	(9)	142.31	(8)	143.16	(8)	138.72	(6)	144.12	(11)	144.69	(10)
65	146.11	(8)	162.23	(9)	150.98	(7)	155.83	(9)	149.74	(8)	155.33	(9)
EMS = 33.45			df = 131									
					240 Days							
63	165.84	(8)	141.75	(8)	198.73	(8)	186.65	(10)	233.28	(7)	200.94	(5)
64	189.20	(9)	182.46	(8)	220.05	(8)	201.77	(6)	234.75	(11)	228.56	(10)
65	191.36	(8)	183.45	(9)	214.35	(7)	217.62	(9)	234.00	(8)	224.12	(9)
EMS = 54.98			df = 130									
					1.0 Year							
63	238.70	(8)	193.63	(8)	266.20	(8)	222.01	(9)	288.68	(7)	230.88	(5)
64	245.19	(9)	217.72	(8)	269.04	(8)	240.78	(6)	270.92	(11)	259.00	(10)
65	249.76	(8)	243.93	(9)	267.62	(7)	246.95	(9)	273.57	(8)	259.55	(9)
66	219.31	(10)	199.35	(10)	244.61	(7)	216.14	(10)	251.46	(8)	234.63	(11)
EMS = 77.71			df = 179									
					1.5 Year							
63	333.67	(8)	326.59	(8)	366.28	(8)	361.87	(9)	377.13	(7)	353.35	(5)
64	348.56	(9)	356.13	(8)	361.63	(8)	369.15	(6)	365.51	(11)	377.66	(10)
65	308.44	(8)	333.14	(9)	323.99	(7)	341.45	(9)	319.22	(8)	347.50	(9)
66	337.70	(10)	334.52	(10)	365.47	(7)	344.96	(10)	352.67	(8)	361.23	(11)
EMS = 106.18			df = 179									
					2.0 Year							
63	332.26	(6)	340.95	(3)	363.78	(5)	343.97	(3)	352.90	(5)	331.88	(3)
64	347.85	(8)	373.65	(4)	358.34	(8)	372.70	(3)	353.80	(11)	366.28	(6)
65	327.34	(6)	344.35	(6)	353.80	(6)	351.53	(7)	346.24	(6)	354.45	(7)
66	322.05	(3)	302.77	(6)	340.52	(7)	347.50	(9)	314.60	(7)	349.64	(6)
EMS = 209.01			df = 177									
					2.5 Year							
63	347.75	(6)	361.36	(3)	374.67	(5)	386.31	(3)	364.69	(5)	372.70	(3)
64	326.21	(6)	391.79	(4)	344.73	(7)	377.99	(3)	335.89	(10)	394.63	(6)
65	339.06	(6)	415.04	(5)	369.30	(6)	392.36	(6)	371.95	(5)	393.11	(6)
66	334.15	(3)	340.57	(6)	341.81	(7)	358.01	(7)	340.52	(7)	362.50	(6)
EMS = 156.03			df = 107									
					3.0 Year							
63	375.35	(8)	403.05	(7)	395.27	(7)	434.44	(9)	397.87	(7)	382.53	(3)
64	362.37	(9)	414.59	(5)	361.74	(6)	411.64	(4)	365.14	(11)	431.89	(7)
65	370.43	(3)	396.89	(6)	388.28	(5)	381.02	(7)	375.35	(4)	399.45	(8)
66	413.09	(7)	367.86	(5)	370.00	(7)	372.85	(5)	374.54	(7)	379.72	(7)
EMS = 279.29			df = 130									
					3.5 Year							
63	389.01	(8)	403.37	(7)	401.11	(7)	435.95	(9)	426.05	(7)	406.72	(3)
64	407.73	(9)	457.22	(5)	400.67	(6)	467.20	(4)	409.14	(10)	499.71	(6)
65	382.15	(4)	435.07	(6)	402.34	(5)	418.21	(5)	383.85	(4)	439.66	(7)
66	385.55	(7)	373.65	(4)	370.97	(7)	404.15	(5)	384.80	(6)	400.78	(7)
EMS = 209.95			df = 124									
					4.0 Year							
63	412.39	(6)	380.74	(8)	421.19	(7)	417.68	(6)	419.25	(7)	421.84	(5)
64	395.92	(7)	444.52	(7)	423.14	(7)	435.72	(5)	409.37	(8)	462.67	(7)
65	416.74	(4)	408.23	(8)	414.66	(6)	397.65	(6)	414.76	(8)	411.99	(7)
EMS = 302.49			df = 101									
					4.5 Year							
63	475.14	(6)	422.49	(7)	475.14	(6)	469.47	(6)	482.32	(6)	468.11	(5)
64	398.51	(7)	460.07	(7)	419.57	(6)	468.34	(4)	408.80	(8)	480.81	(7)
65	427.51	(4)	445.49	(7)	434.32	(6)	430.91	(6)	425.53	(8)	449.38	(7)
66	461.76	(5)	456.62	(3)	517.55	(3)	474.86	(8)	439.21	(7)	480.64	(8)
EMS = 262.63			df = 123									

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

[d]Age at measurement.

TABLE XIV

AVERAGE CONDITION SCORE OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					140 Days[d]							
63	8.25	(8)	7.87	(8)	8.20	(10)	8.10	(10)	8.71	(7)	8.40	(5)
64	9.77	(9)	8.75	(8)	9.75	(8)	9.00	(6)	9.54	(11)	9.50	(10)
65	9.37	(8)	9.33	(9)	8.85	(7)	9.00	(9)	9.12	(8)	9.22	(9)
EMS = .1417			df = 132									
					240 Days							
63	7.25	(8)	6.87	(8)	9.87	(8)	8.90	(10)	12.85	(7)	10.80	(5)
64	7.77	(9)	8.50	(8)	10.50	(8)	9.16	(6)	12.00	(11)	12.00	(10)
65	6.87	(8)	6.66	(9)	9.28	(7)	9.88	(9)	12.12	(8)	11.33	(9)
EMS = .2014			df = 130									
					1.0 Year							
63	7.50	(8)	7.12	(8)	8.50	(8)	7.55	(9)	9.57	(7)	7.80	(5)
64	6.00	(9)	5.75	(8)	6.87	(8)	6.00	(6)	7.18	(11)	7.00	(10)
65	7.75	(8)	7.44	(9)	8.28	(7)	7.44	(9)	8.87	(8)	8.11	(9)
66	6.90	(10)	6.60	(10)	7.57	(7)	6.90	(10)	7.75	(8)	7.36	(11)
EMS = .0797			df = 179									
					1.5 Year							
63	10.25	(8)	11.25	(8)	10.87	(8)	11.66	(9)	11.00	(7)	11.20	(5)
64	8.55	(9)	9.37	(8)	9.00	(8)	9.83	(6)	8.90	(11)	10.30	(10)
65	9.87	(8)	10.44	(9)	10.14	(7)	10.44	(9)	10.75	(8)	10.44	(9)
66	9.00	(10)	9.00	(10)	9.00	(7)	9.00	(10)	9.00	(8)	9.00	(11)
EMS = .0838			df = 179									
					2.0 Year							
63	7.00	(6)	7.00	(3)	6.60	(5)	7.00	(3)	7.00	(5)	6.33	(3)
64	7.75	(8)	8.25	(4)	8.25	(8)	8.33	(3)	7.63	(11)	8.33	(6)
65	6.50	(6)	7.00	(6)	7.00	(6)	7.28	(7)	6.66	(6)	7.00	(7)
66	7.00	(3)	8.33	(6)	7.57	(7)	9.44	(9)	7.14	(7)	9.33	(6)
EMS = .1429			df = 117									
					2.5 Year							
63	6.16	(6)	8.00	(3)	6.40	(5)	8.33	(3)	7.20	(5)	8.00	(3)
64	8.50	(6)	10.25	(4)	8.71	(7)	9.00	(3)	8.40	(10)	10.16	(6)
65	8.33	(6)	8.80	(5)	9.00	(6)	9.00	(6)	8.80	(5)	9.00	(6)
66	8.00	(3)	7.83	(6)	7.71	(7)	7.85	(7)	7.85	(7)	7.66	(6)
EMS = .0963			df = 107									
					3.0 Year							
63	7.37	(8)	8.00	(7)	7.25	(8)	8.44	(9)	7.42	(7)	7.33	(3)
64	6.77	(9)	7.40	(5)	6.83	(6)	7.00	(4)	6.72	(11)	7.57	(7)
65	8.00	(3)	7.66	(6)	7.80	(5)	7.66	(6)	8.00	(4)	8.00	(8)
66	9.00	(7)	8.00	(5)	8.00	(7)	7.60	(5)	7.57	(7)	8.57	(7)
EMS = .2418			df = 130									
					3.5 Year							
63	9.00	(8)	9.28	(7)	9.14	(7)	9.66	(9)	9.28	(7)	9.33	(3)
64	8.88	(9)	9.20	(5)	9.00	(6)	9.50	(4)	8.90	(10)	9.66	(6)
65	8.25	(4)	8.66	(6)	8.60	(5)	8.80	(5)	8.75	(4)	9.28	(7)
66	8.14	(7)	7.25	(4)	7.00	(7)	7.20	(5)	7.16	(6)	6.85	(7)
EMS = .1137			df = 124									
					4.0 Year							
63	7.00	(6)	6.87	(8)	7.00	(7)	6.85	(7)	7.28	(7)	7.40	(5)
64	9.14	(7)	9.71	(7)	9.71	(7)	9.40	(5)	9.50	(8)	9.85	(7)
65	8.25	(4)	7.12	(8)	8.16	(6)	7.00	(6)	8.25	(8)	8.28	(7)
66	8.80	(5)	8.33	(3)	8.50	(2)	8.28	(7)	8.00	(7)	8.00	(8)
EMS = .2053			df = 128									
					4.5 Year							
63	9.16	(6)	8.28	(7)	9.16	(6)	9.00	(6)	9.16	(6)	8.80	(5)
64	8.71	(7)	8.85	(7)	8.83	(6)	9.00	(4)	8.62	(8)	9.14	(7)
65	8.50	(4)	7.42	(7)	8.83	(6)	6.83	(6)	8.25	(8)	8.00	(6)
66	7.40	(5)	7.00	(3)	9.00	(3)	7.37	(8)	6.42	(7)	7.62	(8)
EMS = .1965			df = 122									

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

[d] Age at measurement.

TABLE XV

AVERAGE CIRCUMFERENCE OF HEART GIRTH (CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n
					140 Days[d]							
63	118.84	(8)	117.22	(8)	119.76	(10)	120.90	(10)	126.05	(7)	117.80	(5)
64	120.17	(9)	118.01	(8)	122.17	(8)	119.04	(6)	122.28	(11)	121.08	(10)
65	118.87	(8)	121.66	(9)	119.70	(7)	119.77	(9)	119.12	(8)	120.48	(9)
EMS = 3.0766			df = 132									
					240 Days							
63	124.26	(8)	118.90	(8)	131.54	(9)	130.27	(10)	145.28	(7)	134.46	(5)
64	129.76	(9)	127.79	(8)	138.96	(8)	131.95	(6)	143.34	(11)	138.30	(10)
65	127.79	(8)	127.05	(9)	136.32	(7)	134.67	(9)	141.19	(8)	137.24	(9)
EMS = 3.4708			df = 131									
					1.0 Year							
63	144.90	(8)	132.55	(8)	149.54	(8)	141.42	(9)	153.85	(7)	141.78	(5)
64	142.07	(9)	137.00	(8)	148.52	(8)	139.27	(6)	148.22	(11)	143.66	(10)
65	142.55	(8)	141.16	(9)	146.84	(7)	144.80	(9)	149.47	(8)	145.03	(9)
66	137.89	(10)	134.87	(10)	145.72	(7)	139.62	(10)	147.22	(8)	143.90	(11)
EMS = 3.9180			df = 179									
					1.5 Year							
63	162.78	(8)	159.89	(8)	166.17	(8)	164.78	(9)	167.93	(7)	163.98	(5)
64	161.88	(9)	160.24	(8)	165.06	(8)	163.32	(6)	165.63	(11)	166.31	(10)
65	159.25	(8)	158.94	(9)	160.09	(7)	161.31	(9)	160.55	(8)	161.82	(9)
66	161.84	(10)	157.02	(10)	164.99	(7)	162.58	(10)	165.22	(8)	164.26	(11)
EMS = 3.3083			df = 179									
					2.0 Year							
63	159.97	(6)	160.35	(3)	165.25	(5)	161.71	(3)	163.22	(5)	158.75	(3)
64	163.98	(8)	165.29	(4)	166.94	(8)	163.66	(3)	165.74	(11)	164.88	(6)
65	155.53	(6)	159.59	(6)	159.21	(6)	162.37	(7)	159.38	(6)	160.45	(7)
66	159.93	(3)	153.96	(6)	161.10	(7)	161.54	(9)	157.22	(7)	160.69	(6)
EMS = 5.7822			df = 117									
					2.5 Year							
63	161.62	(6)	163.57	(3)	165.25	(5)	165.60	(3)	164.08	(5)	165.10	(3)
64	159.21	(6)	170.75	(4)	162.81	(7)	164.50	(3)	160.14	(10)	168.23	(6)
65	158.53	(6)	166.57	(5)	163.95	(6)	167.04	(6)	164.23	(5)	164.97	(6)
66	161.96	(3)	155.19	(6)	157.95	(7)	160.45	(7)	158.31	(7)	160.10	(6)
EMS = 4.4635			df = 107									
					3.0 Year							
63	166.56	(8)	170.97	(7)	167.98	(8)	176.53	(9)	169.56	(7)	169.41	(3)
64	163.94	(9)	170.68	(5)	165.65	(6)	168.33	(4)	164.77	(11)	173.91	(7)
65	163.40	(3)	168.52	(6)	167.89	(5)	167.08	(6)	162.49	(4)	167.67	(8)
66	168.98	(7)	161.08	(5)	162.74	(7)	164.49	(5)	164.51	(7)	165.06	(7)
EMS = 6.6537			df = 130									
					3.5 Year							
63	168.71	(8)	170.83	(7)	169.12	(7)	174.38	(9)	172.93	(7)	170.01	(3)
64	171.13	(9)	177.95	(5)	170.30	(6)	175.13	(4)	170.78	(10)	179.53	(6)
65	162.62	(4)	171.11	(6)	166.67	(5)	167.23	(5)	160.90	(4)	169.12	(7)
66	164.37	(7)	157.16	(4)	158.75	(7)	162.81	(5)	162.56	(6)	164.37	(7)
EMS = 5.8949			df = 124									
					4.0 Year							
63	168.48	(6)	159.41	(8)	170.97	(7)	169.49	(7)	171.81	(7)	171.95	(5)
64	167.93	(7)	175.26	(7)	174.17	(7)	176.22	(5)	171.10	(8)	179.03	(7)
65	172.21	(4)	169.95	(8)	170.94	(6)	170.51	(6)	170.30	(8)	169.38	(7)
66	175.66	(5)	174.07	(3)	178.18	(2)	174.78	(7)	170.57	(7)	175.35	(8)
EMS = 8.4527			df = 128									
					4.5 Year							
63	176.23	(6)	169.30	(7)	177.12	(6)	175.51	(6)	179.83	(6)	175.86	(5)
64	165.24	(7)	173.62	(7)	170.51	(6)	173.73	(4)	166.46	(8)	176.56	(7)
65	166.68	(4)	169.81	(7)	168.91	(6)	168.48	(6)	167.64	(8)	169.27	(7)
66	172.36	(5)	172.97	(3)	182.45	(3)	180.08	(8)	170.36	(7)	175.32	(8)
EMS = 9.6860			df = 123									

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

[d]Age at measurement.

TABLE XVI

AVERAGE HEIGHT AT WITHERS (ACTUAL IN CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n
					140 Days[d]							
63	86.13	(8)	87.82	(8)	88.79	(10)	89.05	(10)	88.90	(7)	87.02	(5)
64	85.48	(9)	86.83	(8)	84.58	(8)	87.12	(6)	85.18	(11)	87.40	(10)
65	88.39	(8)	90.90	(9)	89.87	(7)	90.62	(9)	89.02	(8)	90.56	(9)
EMS = 1.3286			df = 132									
					240 Days							
63	93.28	(8)	90.39	(8)	94.54	(9)	95.65	(10)	99.49	(7)	96.52	(5)
64	93.95	(9)	94.17	(8)	95.69	(8)	95.63	(6)	96.70	(11)	97.56	(10)
65	93.40	(8)	94.48	(9)	98.29	(7)	98.55	(9)	98.01	(8)	97.59	(9)
EMS = 1.1370			df = 131									
					1.0 Year							
63	98.45	(8)	95.69	(8)	97.94	(8)	98.55	(9)	100.91	(7)	99.77	(5)
64	99.25	(9)	99.72	(8)	101.02	(8)	101.26	(6)	101.76	(11)	103.32	(10)
65	99.91	(8)	100.44	(9)	104.06	(7)	102.75	(9)	102.29	(8)	103.80	(9)
66	98.93	(10)	96.79	(10)	102.28	(7)	99.49	(10)	106.17	(8)	103.42	(11)
EMS = 2.1877			df = 179									
					1.5 Year							
63	110.42	(8)	109.31	(8)	109.85	(8)	112.26	(9)	109.69	(7)	112.26	(5)
64	108.71	(9)	108.68	(8)	108.58	(8)	110.23	(6)	108.68	(11)	111.53	(10)
65	107.47	(8)	109.47	(9)	109.87	(7)	110.09	(9)	108.01	(8)	111.19	(9)
66	107.56	(10)	107.92	(10)	109.11	(7)	109.75	(10)	111.60	(8)	111.80	(11)
EMS = 1.2254			df = 179									
					2.0 Year							
63	111.80	(6)	110.82	(3)	112.77	(5)	111.50	(3)	110.43	(5)	110.91	(3)
64	110.23	(8)	113.03	(4)	110.49	(8)	113.70	(3)	109.91	(11)	112.60	(6)
65	109.98	(6)	113.49	(6)	112.01	(6)	114.62	(7)	111.92	(6)	114.30	(7)
66	112.18	(3)	110.06	(6)	110.05	(7)	111.30	(9)	111.25	(7)	113.41	(6)
EMS = 2.2120			df = 117									
					2.5 Year							
63	113.87	(6)	111.92	(3)	114.85	(5)	115.65	(3)	112.82	(5)	112.60	(3)
64	111.20	(6)	114.30	(4)	112.59	(7)	115.31	(3)	111.02	(10)	113.28	(6)
65	112.39	(6)	115.51	(5)	113.32	(6)	114.42	(6)	113.08	(5)	113.91	(6)
66	110.23	(3)	109.55	(6)	110.01	(7)	112.37	(7)	112.88	(7)	112.81	(6)
EMS = 2.4394			df = 107									
					3.0 Year							
63	115.41	(8)	116.73	(7)	114.93	(8)	117.60	(9)	114.44	(7)	115.31	(3)
64	114.13	(9)	117.04	(5)	112.60	(6)	118.68	(4)	112.79	(11)	119.99	(7)
65	113.87	(3)	117.22	(6)	115.11	(5)	116.96	(6)	112.58	(4)	117.03	(8)
66	115.24	(7)	113.38	(5)	111.90	(7)	112.67	(5)	115.09	(7)	114.91	(7)
EMS = 1.9556			df = 130									
					3.5 Year							
63	115.57	(8)	116.36	(7)	114.37	(7)	118.02	(9)	115.64	(7)	115.40	(3)
64	112.18	(9)	116.94	(5)	110.95	(6)	118.49	(4)	110.92	(10)	120.05	(6)
65	111.50	(4)	115.99	(6)	115.06	(5)	117.80	(5)	113.03	(4)	116.54	(7)
66	114.55	(7)	112.90	(4)	111.79	(7)	113.79	(5)	115.95	(6)	114.33	(7)
EMS = 2.1772			df = 124									
					4.0 Year							
63	118.23	(6)	115.82	(8)	117.23	(7)	119.30	(7)	117.56	(7)	119.78	(5)
64	114.37	(7)	118.32	(7)	114.48	(7)	118.26	(5)	114.83	(8)	120.61	(7)
65	115.50	(4)	117.31	(8)	117.68	(6)	118.78	(6)	114.33	(8)	117.74	(7)
66	116.68	(5)	115.40	(3)	118.61	(2)	116.11	(7)	116.36	(7)	117.82	(8)
EMS = 2.3825			df = 128									
					4.5 Year							
63	118.15	(6)	116.29	(7)	115.95	(6)	118.19	(6)	117.34	(6)	118.82	(5)
64	113.21	(7)	116.94	(7)	114.34	(6)	117.85	(4)	113.85	(8)	120.75	(7)
65	115.12	(4)	117.05	(7)	117.00	(6)	117.64	(6)	114.58	(8)	117.60	(7)
66	117.80	(5)	117.26	(3)	119.63	(3)	118.80	(8)	116.36	(7)	118.80	(8)
EMS = 2.2775			df = 123									

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

[d]Age at measurement.

TABLE XVII

AVERAGE WIDTH AT HOOKS (CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					140 Days[d]							
63	27.68	(8)	27.94	(8)	28.93	(10)	29.38	(10)	29.82	(7)	28.04	(5)
64	27.79	(9)	29.74	(8)	27.62	(8)	27.89	(6)	27.68	(11)	27.76	(10)
65	28.16	(8)	29.68	(9)	27.97	(7)	28.75	(9)	28.67	(8)	29.35	(9)
EMS = .3774			df = 132									
					240 Days							
63	30.28	(8)	29.46	(8)	32.08	(9)	32.86	(10)	35.37	(7)	33.62	(5)
64	32.59	(9)	32.67	(8)	34.44	(8)	33.57	(6)	34.75	(11)	34.69	(10)
65	32.38	(8)	32.48	(9)	33.78	(7)	33.35	(9)	34.32	(8)	34.65	(9)
EMS = .3466			df = 131									
					1.0 Year							
63	36.70	(8)	34.57	(8)	38.48	(8)	36.49	(9)	39.40	(7)	37.54	(5)
64	36.37	(9)	35.52	(8)	37.02	(8)	35.68	(6)	37.56	(11)	36.72	(10)
65	38.03	(8)	37.56	(9)	38.53	(7)	37.53	(9)	39.37	(8)	38.77	(9)
66	35.48	(10)	34.84	(10)	36.75	(7)	35.94	(10)	38.03	(8)	37.08	(11)
EMS = .3483			df = 179									
					1.5 Year							
63	42.13	(8)	41.14	(8)	42.76	(8)	44.08	(9)	43.72	(7)	43.33	(5)
64	44.67	(9)	44.06	(8)	44.79	(8)	44.19	(6)	45.00	(11)	44.62	(10)
65	42.83	(8)	42.84	(9)	42.67	(7)	43.23	(9)	43.40	(8)	43.94	(9)
66	42.46	(10)	42.34	(10)	43.07	(7)	43.35	(10)	43.68	(8)	43.45	(11)
EMS = .3277			df = 179									
					2.0 Year							
63	42.29	(6)	43.18	(3)	43.48	(5)	44.36	(3)	42.97	(5)	43.68	(3)
64	45.37	(8)	47.37	(4)	46.45	(8)	47.66	(3)	46.25	(11)	46.48	(6)
65	43.09	(6)	44.32	(6)	43.98	(6)	44.59	(7)	44.15	(6)	45.06	(7)
66	44.19	(3)	42.62	(6)	43.90	(7)	44.39	(9)	44.30	(7)	44.49	(6)
EMS = .5620			df = 117									
					2.5 Year							
63	44.28	(6)	45.55	(3)	45.21	(5)	47.66	(3)	44.90	(5)	46.65	(3)
64	44.19	(6)	48.45	(4)	45.72	(7)	47.15	(3)	44.78	(10)	47.58	(6)
65	43.77	(6)	47.65	(5)	44.74	(6)	46.52	(6)	45.41	(5)	46.73	(6)
66	44.45	(3)	43.30	(6)	43.76	(7)	44.95	(7)	45.21	(7)	45.04	(6)
EMS = .6413			df = 107									
					3.0 Year							
63	46.67	(8)	49.89	(7)	47.02	(8)	52.77	(9)	48.29	(7)	48.85	(3)
64	46.73	(9)	49.47	(5)	46.60	(6)	48.76	(4)	46.96	(11)	49.63	(7)
65	46.05	(3)	48.38	(6)	46.88	(5)	47.41	(6)	46.60	(4)	47.84	(8)
66	48.47	(7)	46.63	(5)	46.01	(7)	47.80	(5)	47.31	(7)	47.93	(7)
EMS = .8156			df = 130									
					3.5 Year							
63	47.18	(8)	48.91	(7)	47.67	(7)	51.81	(9)	48.55	(7)	49.36	(3)
64	48.14	(9)	51.40	(5)	48.64	(6)	51.81	(4)	48.38	(10)	53.12	(6)
65	46.10	(4)	50.03	(6)	46.58	(5)	48.97	(5)	46.73	(4)	49.23	(7)
66	46.84	(7)	40.95	(4)	44.88	(7)	43.63	(5)	46.65	(6)	47.17	(7)
EMS = 1.5793			df = 124									
					4.0 Year							
63	48.21	(6)	47.46	(8)	48.15	(7)	49.82	(7)	49.05	(7)	49.78	(5)
64	47.38	(7)	50.03	(7)	49.02	(7)	49.47	(5)	48.35	(8)	50.40	(7)
65	50.80	(4)	50.64	(8)	49.06	(6)	49.74	(6)	49.11	(8)	50.21	(7)
66	50.85	(5)	48.93	(3)	49.78	(2)	50.14	(7)	48.73	(7)	50.76	(8)
EMS = .7150			df = 128									
					4.5 Year							
63	49.74	(6)	48.94	(7)	50.37	(6)	56.76	(6)	50.88	(6)	51.76	(5)
64	46.91	(7)	50.47	(7)	47.96	(6)	49.84	(4)	47.43	(8)	50.98	(7)
65	49.02	(4)	50.40	(7)	48.26	(6)	49.82	(6)	47.59	(8)	50.11	(7)
66	50.74	(5)	50.03	(3)	49.95	(3)	50.92	(8)	49.67	(7)	51.49	(8)
EMS = 1.5951			df = 123									

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

[d]Age at measurement.

TABLE XVIII

AVERAGE LENGTH OF RUMP (PHOTOGRAPHIC IN CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus	140 Hereford	240[b] Angus	240 Hereford	240C[c] Angus	240C Hereford
Year Born	X̄ n	X̄ n	X̄ n	X̄ n	X̄ n	X̄ n
			140 Days[d]			
63	30.00 (8)	27.94 (8)	28.64 (9)	27.46 (8)	31.02 (7)	28.89 (4)
64	29.52 (8)	29.57 (7)	29.21 (7)	29.46 (5)	29.71 (10)	29.21 (9)
65	27.46 (8)	28.64 (9)	27.39 (7)	28.30 (9)	27.39 (7)	29.06 (9)
66	25.71 (8)	26.96 (7)	28.12 (7)	27.94 (9)	28.41 (8)	29.62 (11)
EMS = .7275		df = 165				
			240 Days			
63	29.52 (8)	28.98 (8)	32.16 (8)	30.19 (9)	31.20 (7)	29.46 (5)
64	29.63 (9)	30.79 (8)	33.43 (8)	30.48 (6)	33.65 (10)	32.51 (8)
65	28.89 (8)	29.49 (9)	31.93 (7)	32.96 (9)	33.43 (8)	32.73 (9)
66	30.68 (10)	30.48 (10)	31.85 (7)	32.51 (10)	33.11 (8)	34.82 (11)
EMS = .8359		df = 176				
			1.0 Year			
63	32.70 (8)	30.89 (8)	33.14 (10)	30.19 (9)	31.20 (7)	36.83 (5)
64	30.33 (9)	33.74 (7)	29.84 (8)	31.96 (6)	32.21 (11)	34.74 (10)
65	32.06 (8)	29.63 (9)	34.10 (7)	34.14 (9)	32.22 (8)	33.16 (9)
66	34.41 (10)	32.33 (10)	34.72 (7)	33.93 (10)	35.19 (7)	36.32 (11)
EMS = 1.3868		df = 179				
			1.5 Year			
63	35.87 (8)	34.92 (8)	34.43 (9)	35.84 (9)	33.02 (6)	33.52 (5)
64	32.48 (9)	34.29 (8)	33.33 (8)	35.34 (6)	32.28 (11)	34.16 (10)
65	35.33 (8)	35.70 (9)	33.78 (6)	35.49 (8)	35.02 (8)	35.27 (9)
66	36.95 (10)	36.57 (10)	36.28 (7)	37.97 (10)	37.46 (8)	38.44 (11)
EMS = .9562		df = 177				
			2.0 Year			
63	35.56 (6)	35.98 (3)	36.49 (6)	38.94 (3)	35.43 (4)	38.77 (3)
64	33.65 (8)	36.83 (4)	37.33 (8)	30.48 (3)	34.98 (11)	34.92 (6)
65	36.40 (6)	36.22 (5)	35.62 (4)	37.14 (4)	35.56 (5)	36.51 (4)
66	35.13 (3)	34.92 (6)	35.56 (7)	36.54 (9)	34.43 (7)	37.88 (6)
EMS = 2.4132		df = 107				
			2.5 Year			
63	34.62 (6)	35.56 (3)	35.56 (6)	38.10 (3)	33.68 (5)	35.56 (3)
65	31.32 (6)	36.06 (5)	33.44 (6)	36.61 (6)	35.05 (5)	34.71 (6)
66	35.39 (3)	35.34 (6)	36.83 (7)	36.10 (7)	34.50 (6)	37.78 (4)
EMS = 1.6872		df = 75				
			3.0 Year			
63	35.81 (8)	39.55 (7)	34.13 (8)	39.08 (9)	33.20 (7)	35.13 (3)
64	34.29 (4)	37.84 (5)	34.29 (6)	38.10 (4)	35.05 (10)	38.64 (7)
65	34.29 (3)	37.59 (6)	34.54 (5)	39.15 (6)	32.06 (4)	36.83 (8)
66	38.82 (7)	38.10 (5)	33.05 (7)	40.69 (5)	34.29 (7)	39.00 (7)
EMS = 1.7159		df = 124				
			3.5 Year			
63	38.35 (8)	39.40 (7)	39.11 (7)	40.16 (9)	36.68 (7)	37.08 (3)
64	36.26 (9)	38.10 (5)	36.83 (6)	39.37 (4)	36.90 (10)	39.58 (6)
65	37.46 (4)	37.04 (6)	36.83 (5)	38.60 (5)	34.92 (4)	37.84 (7)
66	36.46 (7)	37.46 (4)	34.10 (7)	35.05 (5)	35.64 (6)	36.83 (7)
EMS = 1.4710		df = 124				
			4.0 Year			
63	37.38 (6)	39.18 (7)	38.10 (7)	39.51 (7)	36.46 (7)	39.92 (5)
64	35.01 (7)	37.19 (7)	33.74 (7)	41.04 (5)	34.60 (8)	37.73 (7)
65	35.43 (4)	36.48 (8)	38.25 (5)	38.90 (6)	36.51 (8)	34.68 (7)
66	40.13 (5)	38.52 (3)	38.10 (2)	41.18 (7)	36.10 (7)	41.75 (8)
EMS = 2.1991		df = 126				
			4.5 Year			
63	37.04 (6)	38.42 (7)	37.80 (6)	37.84 (5)	35.56 (6)	39.11 (5)
64	34.76 (7)	39.55 (7)	34.92 (6)	38.10 (4)	38.10 (8)	41.29 (7)
65	34.22 (4)	38.10 (7)	35.98 (6)	39.15 (6)	35.87 (8)	36.83 (6)
66	35.61 (5)	35.98 (3)	38.94 (3)	37.27 (8)	37.70 (7)	38.44 (8)
EMS = 1.5301		df = 121				

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

[d] Age at measurement.

TABLE XIX

AVERAGE LENGTH OF BODY (PHOTOGRAPHIC IN CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					140 Days[d]							
63	61.30	(8)	61.59	(8)	61.80	(9)	64.70	(8)	63.68	(7)	61.91	(4)
64	63.50	(8)	62.41	(7)	62.77	(7)	62.73	(5)	63.62	(10)	64.91	(9)
65	64.45	(8)	66.74	(9)	62.95	(7)	63.58	(9)	63.31	(7)	65.19	(9)
66	65.24	(8)	60.34	(7)	65.67	(7)	62.37	(9)	65.56	(8)	67.49	(11)
EMS = 2.0938			df = 165									
					240 Days							
63	64.48	(8)	62.48	(8)	67.97	(8)	62.59	(9)	64.33	(7)	69.08	(5)
64	69.85	(9)	67.24	(8)	70.32	(8)	71.03	(6)	75.86	(10)	69.37	(8)
65	71.27	(8)	68.58	(9)	74.20	(7)	72.10	(9)	74.93	(8)	72.95	(9)
66	71.57	(10)	69.54	(10)	77.94	(7)	73.53	(10)	75.40	(8)	75.85	(11)
EMS = 2.9937			df = 176									
					1.0 Year							
63	70.29	(8)	69.94	(8)	72.89	(10)	69.70	(9)	78.84	(7)	74.16	(5)
64	76.20	(9)	73.11	(7)	78.26	(8)	74.21	(6)	77.81	(11)	78.25	(10)
65	74.54	(8)	77.89	(9)	77.65	(7)	75.77	(9)	79.21	(8)	77.55	(9)
66	76.14	(10)	75.94	(10)	80.62	(7)	78.15	(10)	82.29	(7)	79.94	(11)
EMS = 2.7312			df = 179									
					1.5 Year							
63	88.36	(8)	85.66	(8)	87.23	(9)	87.91	(9)	89.32	(6)	91.23	(5)
64	84.61	(9)	82.55	(8)	82.96	(8)	85.97	(6)	84.83	(11)	87.63	(10)
65	85.09	(8)	87.57	(9)	85.85	(6)	89.05	(8)	85.97	(8)	91.60	(9)
66	80.49	(10)	81.28	(10)	84.90	(7)	83.26	(10)	81.75	(8)	83.24	(11)
EMS = 2.7162			df = 177									
					2.0 Year							
63	91.60	(6)	87.20	(3)	91.01	(6)	92.28	(3)	91.94	(4)	93.13	(3)
64	87.63	(8)	87.94	(4)	82.55	(8)	89.32	(3)	85.50	(11)	86.78	(6)
65	83.60	(6)	89.81	(5)	89.40	(4)	86.36	(4)	88.29	(5)	91.12	(4)
66	84.66	(3)	82.12	(6)	91.91	(7)	83.11	(9)	89.44	(7)	86.36	(6)
EMS = 5.2962			df = 107									
					2.5 Year							
63	86.69	(6)	86.78	(3)	88.18	(6)	89.32	(3)	88.64	(5)	90.67	(3)
65	82.97	(6)	86.61	(5)	84.24	(6)	87.54	(6)	87.12	(5)	85.93	(6)
66	88.05	(3)	83.10	(6)	89.37	(7)	85.63	(7)	87.20	(6)	83.50	(4)
EMS = 3.7216			df = 75									
					3.0 Year							
63	90.26	(8)	88.64	(7)	90.17	(8)	91.94	(9)	92.45	(7)	95.25	(3)
64	93.66	(4)	94.38	(5)	89.53	(6)	95.25	(4)	94.31	(10)	96.19	(7)
65	94.40	(3)	92.62	(6)	94.23	(5)	90.17	(6)	94.93	(4)	91.12	(8)
66	93.03	(7)	90.01	(5)	94.30	(7)	88.74	(5)	92.27	(7)	92.20	(7)
EMS = 3.9388			df = 124									
					3.5 Year							
63	90.93	(8)	93.25	(7)	93.00	(7)	96.46	(9)	92.92	(7)	95.25	(3)
64	85.73	(9)	90.93	(5)	83.82	(6)	93.21	(4)	89.91	(10)	94.74	(6)
65	87.94	(4)	92.96	(6)	90.06	(5)	90.17	(5)	92.71	(4)	89.37	(7)
66	92.41	(7)	88.26	(4)	90.20	(7)	93.47	(5)	92.96	(6)	91.07	(7)
EMS = 3.3119			df = 124									
					4.0 Year							
63	96.30	(6)	93.21	(7)	96.26	(7)	99.16	(7)	97.28	(7)	94.38	(5)
64	93.43	(7)	93.72	(7)	93.61	(7)	93.98	(5)	93.50	(8)	97.79	(7)
65	97.40	(4)	95.47	(8)	97.02	(5)	93.26	(6)	95.88	(8)	94.59	(7)
66	91.44	(5)	92.28	(3)	95.88	(2)	93.25	(7)	96.15	(7)	94.29	(8)
EMS = 4.2572			df = 126									
					4.5 Year							
63	91.44	(6)	88.90	(7)	90.59	(6)	96.01	(5)	91.86	(6)	88.39	(5)
64	92.02	(7)	94.27	(7)	90.84	(6)	95.75	(4)	91.28	(8)	93.79	(7)
65	93.15	(4)	96.15	(7)	96.81	(6)	92.92	(6)	95.47	(8)	98.42	(6)
66	96.67	(5)	93.13	(3)	98.21	(3)	96.29	(8)	94.01	(7)	97.69	(8)
EMS = 3.7329			df = 121									

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

[d] Age at measurement.

TABLE XX

AVERAGE DISTANCE FROM CHEST TO FLOOR (PHOTOGRAPHIC IN CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n
					140 Days[d]							
63	46.03	(8)	46.03	(8)	44.16	(9)	46.99	(8)	46.01	(7)	45.40	(4)
64	43.49	(8)	43.83	(7)	43.18	(7)	46.22	(5)	42.29	(10)	43.03	(9)
65	45.56	(8)	45.43	(9)	44.45	(7)	45.80	(9)	44.45	(7)	46.14	(9)
66	44.13	(8)	42.81	(7)	42.81	(7)	43.18	(9)	43.81	(8)	43.87	(11)
EMS = .7715			df = 165									
					240 Days							
63	41.91	(8)	42.86	(8)	43.11	(8)	44.67	(9)	42.81	(7)	44.60	(5)
64	46.00	(9)	46.19	(8)	46.22	(8)	46.90	(6)	44.95	(10)	46.99	(8)
65	44.92	(8)	47.13	(9)	47.53	(7)	47.41	(9)	46.35	(8)	47.55	(9)
66	43.81	(10)	43.56	(10)	43.90	(7)	44.14	(10)	45.08	(8)	45.48	(11)
EMS = .4328			df = 176									
					1.0 Year							
63	44.06	(8)	46.19	(8)	43.43	(10)	45.72	(9)	43.72	(7)	43.18	(5)
64	49.05	(9)	50.07	(7)	47.62	(8)	51.13	(6)	47.33	(11)	51.05	(10)
65	46.03	(8)	47.27	(9)	46.99	(7)	48.68	(9)	45.72	(8)	49.24	(9)
66	43.56	(10)	43.25	(10)	44.26	(7)	43.96	(10)	44.59	(7)	45.11	(11)
EMS = .5879			df = 179									
					1.5 Year							
63	50.32	(8)	50.41	(8)	50.03	(9)	50.80	(9)	49.10	(6)	51.20	(5)
64	48.62	(9)	50.48	(8)	48.26	(8)	52.49	(6)	48.14	(11)	51.13	(10)
65	49.46	(8)	49.47	(9)	49.95	(6)	50.41	(8)	49.21	(8)	49.81	(9)
66	47.11	(10)	50.16	(10)	47.53	(7)	49.02	(10)	48.89	(8)	49.59	(11)
EMS = .5676			df = 177									
					2.0 Year							
63	50.96	(6)	51.22	(3)	50.92	(6)	50.37	(3)	52.07	(4)	50.80	(3)
64	49.68	(8)	53.34	(4)	49.53	(8)	53.76	(3)	50.33	(11)	52.49	(6)
65	49.31	(6)	50.69	(5)	55.24	(4)	50.80	(4)	49.53	(5)	51.11	(4)
66	52.49	(3)	53.34	(6)	50.98	(7)	52.21	(9)	54.42	(7)	52.62	(6)
EMS = 1.5169			df = 107									
					2.5 Year							
63	53.12	(6)	53.76	(3)	53.34	(6)	54.18	(3)	52.32	(5)	51.64	(3)
65	52.70	(6)	54.86	(5)	54.01	(6)	53.34	(6)	50.80	(5)	53.55	(6)
66	53.84	(3)	56.30	(6)	53.92	(7)	56.24	(7)	55.66	(6)	58.42	(4)
EMS = 1.2558			df = 75									
					3.0 Year							
63	52.95	(8)	53.70	(7)	51.27	(8)	53.76	(9)	52.25	(7)	53.34	(3)
64	47.62	(4)	51.05	(5)	48.47	(6)	52.38	(4)	48.59	(10)	52.25	(7)
65	53.34	(3)	53.04	(6)	54.86	(5)	52.28	(6)	53.34	(4)	53.97	(8)
66	50.69	(7)	51.66	(5)	48.76	(7)	50.69	(5)	51.96	(7)	51.67	(7)
EMS = 1.1476			df = 124									
					3.5 Year							
63	51.27	(8)	53.44	(7)	50.61	(7)	53.14	(9)	50.07	(7)	50.37	(3)
64	50.32	(9)	53.49	(5)	49.31	(6)	53.97	(4)	50.29	(10)	53.46	(6)
65	54.92	(4)	56.93	(6)	56.03	(5)	57.65	(5)	54.92	(4)	56.89	(7)
66	49.38	(7)	51.11	(4)	45.35	(7)	51.30	(5)	50.80	(6)	49.71	(7)
EMS = 1.4583			df = 124									
					4.0 Year							
63	51.64	(6)	53.34	(7)	50.80	(7)	53.88	(7)	51.16	(7)	53.23	(5)
64	51.88	(7)	52.97	(7)	50.25	(7)	56.13	(5)	51.68	(8)	55.51	(7)
65	50.92	(4)	53.43	(8)	52.83	(5)	53.46	(6)	50.41	(8)	52.61	(7)
66	49.27	(5)	49.95	(3)	50.16	(2)	52.25	(7)	50.43	(7)	52.38	(8)
EMS = 1.2718			df = 126									
					4.5 Year							
63	52.49	(6)	53.52	(7)	51.64	(6)	53.84	(5)	50.37	(6)	53.34	(5)
64	54.61	(7)	55.15	(7)	52.62	(6)	56.19	(4)	51.27	(8)	56.78	(7)
65	44.95	(4)	52.43	(7)	47.07	(6)	53.97	(6)	43.81	(8)	51.64	(6)
66	51.35	(5)	51.64	(3)	51.05	(3)	50.64	(8)	51.92	(7)	52.73	(8)
EMS = 1.1600			df = 121									

[a] 140-day weaned.
[b] 240-day weaned.
[c] Creep-fed 240-day weaned.
[d] Age at measurement.

TABLE XXI

AVERAGE HEIGHT AT WITHERS (PHOTOGRAPHIC IN CM) OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n	X̄	n
					140 Day[d]							
63	87.09	(8)	89.05	(8)	86.86	(9)	89.78	(8)	89.62	(7)	86.04	(4)
64	88.42	(8)	89.00	(7)	88.35	(7)	89.66	(5)	87.75	(10)	89.83	(9)
65	89.85	(8)	91.18	(9)	89.37	(7)	90.31	(9)	89.98	(7)	90.17	(9)
66	89.47	(8)	85.81	(7)	89.62	(7)	85.51	(9)	91.12	(8)	90.70	(11)
EMS = 1.2960			df = 165									
					240 Day							
63	89.21	(8)	87.31	(8)	92.39	(8)	91.44	(9)	93.18	(7)	93.98	(5)
64	95.25	(9)	94.77	(8)	99.85	(8)	96.09	(6)	98.67	(10)	98.10	(8)
65	93.82	(8)	94.77	(9)	98.98	(7)	98.21	(9)	97.79	(8)	98.21	(9)
66	93.34	(10)	91.89	(10)	96.33	(7)	95.37	(10)	99.85	(8)	97.67	(11)
EMS = 1.2887			df = 176									
					1.0 Year							
63	97.47	(8)	94.45	(8)	98.50	(10)	96.09	(9)	100.51	(7)	97.53	(5)
64	103.43	(9)	100.87	(7)	105.41	(8)	104.69	(6)	105.29	(11)	104.39	(10)
65	98.42	(8)	99.70	(9)	102.07	(7)	101.74	(9)	100.64	(8)	103.51	(9)
66	98.72	(10)	96.34	(10)	103.08	(7)	99.59	(10)	103.16	(7)	102.13	(11)
EMS = 1.5564			df = 179									
					1.5 Year							
63	111.31	(8)	108.90	(8)	111.70	(9)	111.42	(9)	111.97	(6)	111.50	(5)
64	107.04	(9)	107.47	(8)	107.15	(8)	110.27	(6)	106.68	(11)	108.53	(10)
65	107.31	(8)	107.32	(9)	108.79	(6)	108.68	(8)	107.98	(8)	108.93	(9)
66	105.28	(10)	106.62	(10)	107.40	(7)	107.13	(10)	108.58	(8)	108.29	(11)
EMS = 1.3632			df = 177									
					2.0 Year							
63	111.16	(6)	110.06	(3)	113.91	(6)	111.76	(3)	113.22	(4)	110.74	(3)
64	109.37	(8)	110.49	(4)	109.22	(8)	110.91	(3)	108.87	(11)	110.49	(6)
65	106.46	(6)	109.37	(5)	113.22	(4)	110.80	(4)	108.76	(5)	110.17	(4)
66	112.18	(3)	111.25	(6)	110.85	(7)	112.18	(9)	112.95	(7)	112.18	(6)
EMS = 2.3098			df = 107									
					2.5 Year							
63	110.70	(6)	110.49	(3)	112.39	(6)	112.60	(3)	110.99	(5)	110.91	(3)
65	108.79	(6)	112.52	(5)	110.70	(6)	112.39	(6)	108.86	(5)	111.33	(6)
66	111.33	(3)	111.76	(6)	110.96	(7)	113.93	(7)	112.60	(6)	114.93	(4)
EMS = 1.9591			df = 75									
					3.0 Year							
63	112.71	(8)	112.77	(7)	111.60	(8)	115.14	(9)	112.66	(7)	113.03	(3)
64	107.95	(4)	112.01	(5)	108.16	(6)	113.66	(4)	110.61	(10)	116.04	(7)
65	113.45	(3)	115.14	(6)	115.57	(5)	114.08	(6)	113.03	(4)	114.61	(8)
66	113.06	(7)	110.08	(5)	109.32	(7)	110.18	(5)	112.23	(7)	111.65	(7)
EMS = 2.0671			df = 124									
					3.5 Year							
63	113.12	(8)	113.68	(7)	111.94	(7)	115.28	(9)	114.59	(7)	112.86	(3)
64	110.06	(9)	113.28	(5)	109.00	(6)	114.61	(4)	110.49	(10)	114.30	(6)
65	113.98	(4)	115.99	(6)	116.58	(5)	117.85	(5)	113.34	(4)	117.31	(7)
66	111.79	(7)	109.53	(4)	107.95	(7)	110.99	(5)	113.03	(6)	111.57	(7)
EMS = 1.9536			df = 124									
					4.0 Year							
63	112.18	(6)	113.75	(7)	114.40	(7)	116.58	(7)	114.84	(7)	114.55	(5)
64	114.40	(7)	117.02	(7)	113.39	(7)	117.85	(5)	111.91	(8)	119.56	(7)
65	113.53	(4)	115.41	(8)	116.28	(5)	115.90	(6)	112.64	(8)	114.51	(7)
66	115.57	(5)	113.45	(3)	116.20	(2)	116.47	(7)	115.57	(7)	115.50	(8)
EMS = 1.8076			df = 126									
					4.5 Year							
63	114.30	(6)	112.77	(7)	112.60	(6)	116.07	(5)	114.30	(6)	114.04	(5)
64	112.84	(7)	116.58	(7)	113.66	(6)	117.15	(4)	112.71	(8)	119.38	(7)
65	110.55	(4)	114.66	(7)	114.72	(6)	116.62	(6)	110.55	(8)	114.93	(6)
66	114.45	(5)	114.30	(3)	115.99	(3)	115.66	(8)	116.33	(7)	115.25	(8)
EMS = 2.0199			df = 121									

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

[d] Age at measurement.

TABLE XXII

AVERAGE HEIGHT AT HOOKS (PHOTOGRAPHIC IN CM) FOR COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					140 Day[d]							
63	85.24	(8)	89.85	(8)	86.86	(9)	90.32	(8)	89.08	(7)	88.58	(4)
64	85.88	(8)	88.17	(7)	85.92	(7)	89.15	(5)	85.47	(10)	89.18	(9)
65	87.66	(8)	91.80	(9)	89.66	(7)	91.44	(9)	89.19	(7)	91.72	(9)
66	87.47	(8)	86.72	(7)	87.63	(7)	86.07	(9)	89.05	(8)	89.66	(11)
EMS = 1.8525			df = 165									
					240 Day							
63	88.04	(8)	85.59	(8)	89.94	(8)	92.56	(9)	90.46	(7)	94.38	(5)
64	92.00	(9)	93.66	(8)	96.52	(8)	94.95	(6)	95.37	(10)	95.40	(8)
65	93.75	(8)	94.40	(9)	95.72	(7)	97.93	(9)	96.61	(8)	98.07	(9)
66	92.96	(10)	92.32	(10)	95.61	(7)	96.52	(10)	97.79	(8)	98.13	(11)
EMS = 1.4595			df = 176									
					1.0 Year							
63	92.39	(8)	93.34	(8)	96.26	(10)	96.66	(9)	96.62	(7)	97.28	(5)
64	100.83	(9)	99.35	(7)	102.33	(8)	102.15	(6)	101.83	(11)	104.74	(10)
65	97.94	(8)	99.70	(9)	99.24	(7)	100.75	(9)	100.01	(8)	102.87	(9)
66	96.79	(10)	96.57	(10)	101.74	(7)	98.52	(10)	99.60	(7)	100.88	(11)
EMS = 1.4287			df = 179									
					1.5 Year							
63	106.83	(8)	106.87	(8)	108.17	(9)	109.22	(9)	109.00	(6)	110.38	(5)
64	104.50	(9)	107.50	(8)	104.55	(8)	110.27	(6)	105.98	(11)	109.47	(10)
65	106.04	(8)	106.76	(9)	107.23	(6)	108.52	(8)	106.77	(8)	106.25	(9)
66	103.37	(10)	105.86	(10)	104.32	(7)	107.01	(10)	105.88	(8)	108.94	(11)
EMS = 1.5539			df = 177									
					2.0 Year							
63	108.62	(6)	108.79	(3)	110.36	(6)	111.33	(3)	110.36	(4)	113.03	(3)
64	107.31	(8)	111.12	(4)	106.68	(8)	110.74	(3)	106.44	(11)	110.27	(6)
65	103.71	(6)	107.49	(5)	108.45	(4)	110.17	(4)	109.52	(5)	108.14	(4)
66	109.64	(3)	109.43	(6)	107.76	(7)	109.78	(9)	109.94	(7)	110.91	(6)
EMS = 3.2888			df = 107									
					2.5 Year							
63	109.43	(6)	110.91	(3)	110.40	(6)	115.40	(3)	110.49	(5)	111.33	(3)
65	106.68	(6)	114.04	(5)	109.85	(6)	113.24	(6)	108.71	(5)	111.76	(6)
66	105.83	(3)	107.44	(6)	106.68	(7)	109.87	(7)	106.25	(6)	113.34	(4)
EMS = 1.9591			df = 75									
					3.0 Year							
63	109.37	(8)	111.76	(7)	108.26	(8)	114.01	(9)	110.41	(7)	110.91	(3)
64	106.68	(4)	110.74	(5)	105.41	(6)	111.76	(4)	107.13	(10)	112.84	(7)
65	109.22	(3)	112.94	(6)	111.50	(5)	116.20	(6)	111.12	(4)	113.18	(8)
66	109.29	(7)	109.52	(5)	107.58	(7)	110.54	(5)	109.29	(7)	111.86	(7)
EMS = 2.7264			df = 124									
					3.5 Year							
63	109.98	(8)	113.42	(7)	110.30	(7)	114.72	(9)	111.14	(7)	115.57	(3)
64	108.03	(9)	111.04	(5)	106.25	(6)	110.80	(4)	106.55	(10)	112.73	(6)
65	108.26	(4)	112.60	(6)	109.22	(5)	112.52	(5)	108.26	(4)	111.39	(7)
66	109.58	(7)	109.85	(4)	106.13	(7)	108.71	(5)	109.22	(6)	111.76	(7)
EMS = 2.3812			df = 124									
					4.0 Year							
63	107.52	(6)	108.96	(7)	109.58	(7)	112.48	(7)	110.67	(7)	115.46	(5)
64	109.58	(7)	111.50	(7)	108.78	(7)	113.69	(5)	108.26	(8)	114.77	(7)
65	109.60	(4)	112.61	(8)	111.81	(5)	112.94	(6)	109.37	(8)	110.88	(7)
66	110.13	(5)	110.06	(3)	110.49	(2)	112.66	(7)	109.76	(7)	113.82	(8)
EMS = 2.6431			df = 126									
					4.5 Year							
63	114.08	(6)	112.66	(7)	110.49	(6)	116.48	(5)	110.91	(6)	117.09	(5)
64	108.31	(7)	112.48	(7)	106.68	(6)	113.03	(4)	106.36	(8)	114.84	(7)
65	109.85	(4)	112.66	(7)	111.76	(6)	113.03	(6)	109.85	(8)	112.60	(6)
66	109.52	(5)	109.22	(3)	112.43	(3)	112.23	(8)	110.52	(7)	113.06	(8)
EMS = 2.3590			df = 121									

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

[d] Age at measurement.

TABLE XXIII

AVERAGE SEX, AGE[a], AND CROSSBRED CORRECTED WEANING WEIGHT (KG) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	151.8	(6)	153.9	(3)	147.2	(6)	148.8	(3)	150.9	(5)	147.4	(3)
'64	179.5	(6)	162.5	(4)	172.4	(7)	169.9	(3)	167.7	(9)	170.8	(6)
'65	156.0	(6)	167.8	(5)	162.2	(6)	148.7	(6)	158.5	(5)	149.4	(6)
'66	159.6	(3)	123.2	(6)	160.8	(7)	130.6	(7)	152.7	(7)	121.5	(6)
EMS = 60.7845	df = 107											
					Calf Crop 2							
'63	215.4	(8)	189.1	(7)	199.5	(8)	188.6	(9)	198.6	(7)	166.4	(3)
'64	195.1	(9)	184.5	(5)	191.4	(6)	184.3	(4)	188.7	(10)	173.7	(6)
'65	164.9	(4)	171.8	(6)	162.0	(5)	179.5	(5)	167.1	(4)	167.0	(7)
'66	178.9	(8)	145.0	(4)	180.6	(6)	158.0	(5)	169.0	(7)	156.9	(7)
EMS = 74.9510	df = 126											
					Calf Crop 3							
'63	224.0	(6)	192.0	(7)	234.4	(6)	187.0	(6)	224.8	(6)	177.4	(5)
'64	191.9	(7)	178.1	(7)	193.4	(6)	167.5	(4)	186.2	(8)	175.2	(7)
'65	180.1	(4)	170.9	(7)	196.8	(6)	174.9	(6)	188.2	(8)	150.5	(7)
'66	200.0	(5)	196.2	(3)	204.9	(2)	206.1	(7)	194.9	(7)	201.2	(8)
EMS = 96.6700	df = 121											

[a]Corrected to 205 days of age.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXIV

AVERAGE 140 DAY WEIGHT (KG) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	125.8	(6)	119.4	(3)	120.3	(6)	117.2	(3)	122.1	(5)	122.8	(3)
'64	125.6	(6)	115.9	(4)	130.6	(7)	120.7	(3)	115.4	(10)	109.8	(6)
'65	115.5	(6)	109.1	(5)	121.9	(6)	106.5	(6)	102.0	(5)	97.5	(6)
'66	107.4	(3)	96.6	(6)	104.7	(7)	98.1	(7)	104.3	(7)	109.4	(6)
EMS = 71.8863		df = 112										
					Calf Crop 2							
'63	139.4	(8)	118.3	(4)	138.4	(8)	126.3	(9)	133.9	(7)	105.1	(3)
'64	165.2	(9)	127.4	(5)	143.7	(6)	136.4	(4)	148.4	(10)	125.7	(5)
'65	114.9	(4)	125.3	(5)	127.5	(4)	119.0	(5)	127.9	(4)	126.6	(7)
'66	119.6	(8)	117.1	(4)	110.0	(6)	101.9	(5)	114.6	(7)	102.5	(7)
EMS = 45.4534		df = 116										
					Calf Crop 3							
'63	161.8	(5)	147.4	(7)	150.0	(6)	150.0	(6)	154.0	(6)	128.7	(5)
'64	142.2	(7)	134.3	(6)	142.1	(6)	125.5	(4)	135.9	(8)	134.1	(7)
'65	99.7	(4)	110.0	(7)	125.4	(6)	113.1	(6)	125.5	(8)	99.2	(7)
'66	135.8	(5)	132.5	(3)	146.3	(2)	121.0	(6)	144.9	(6)	136.5	(8)
EMS = 60.6125		df = 117										

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

TABLE XXV

AVERAGE 140 DAY CONDITION SCORE OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{\bar{X}}$	n	$\bar{\bar{X}}$	n	$\bar{\bar{X}}$	n	$\bar{\bar{X}}$	n	$\bar{\bar{X}}$	n	$\bar{\bar{X}}$	n
					Calf Crop 1							
'63	8.6	(5)	7.0	(3)	8.5	(6)	9.0	(3)	8.4	(5)	8.3	(3)
'64	8.8	(6)	9.4	(5)	9.0	(6)						
'65	9.0	(5)	8.8	(5)	9.6	(5)	8.7	(3)	8.2	(5)	8.2	(6)
'66	9.3	(3)	8.5	(6)	9.0	(7)	9.0	(6)	8.7	(7)	8.3	(4)
EMS = .2497	df = 83											
					Calf Crop 2							
'63												
'64	8.8	(9)	10.0	(5)	9.2	(6)	9.8	(4)	8.9	(9)	9.4	(5)
'65	9.3	(3)	9.2	(5)	9.0	(3)	9.4	(5)	9.0	(3)	9.0	(7)
'66	8.0	(8)	8.0	(4)	7.7	(6)	7.4	(5)	7.8	(6)	8.0	(6)
EMS = .0899	df = 107											
					Calf Crop 3							
'63	9.4	(5)	9.0	(7)	9.2	(5)	9.0	(6)	9.2	(6)	8.0	(5)
'64	9.3	(7)	9.7	(6)	9.3	(6)	9.3	(4)	9.1	(8)	9.3	(7)
'65	9.5	(2)	9.0	(5)	6.0	(6)	6.6	(5)	6.0	(8)	5.1	(7)
'66	8.6	(5)	7.7	(3)	9.5	(2)	7.3	(6)	8.8	(6)	7.6	(8)
EMS = .1462	df = 107											

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

TABLE XXVI

AVERAGE 140 DAY CIRCUMFERENCE OF HEART GIRTH (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	121.8	(5)	121.8	(3)	120.2	(6)	119.0	(3)	121.0	(3)	121.6	(3)
'64	113.4	(6)	112.8	(5)	111.8	(6)						
'65	112.5	(6)	110.1	(5)	115.4	(6)	110.9	(6)	113.0	(5)	107.3	(6)
'66	115.1	(3)	104.5	(6)	111.7	(7)	105.1	(6)	109.9	(7)	107.4	(4)
EMS = 6.0162	df = 88											
					Calf Crop 2							
'63												
'64	122.5	(9)	117.6	(5)	122.4	(6)	118.1	(4)	116.3	(9)	119.0	(5)
'65	112.7	(3)	111.5	(5)	116.3	(4)	114.7	(5)	116.4	(3)	114.7	(7)
'66	114.3	(8)	108.6	(4)	109.9	(6)	104.1	(5)	111.3	(6)	105.4	(6)
EMS = 4.6624	df = 113											
					Calf Crop 3							
'63	124.3	(5)	121.0	(7)	127.5	(5)	119.0	(6)	126.3	(6)	116.5	(5)
'64	124.1	(7)	117.3	(6)	120.8	(6)	116.6	(4)	119.3	(8)	117.0	(7)
'65	113.7	(2)	108.7	(5)	112.8	(6)	111.5	(5)	113.5	(8)	105.4	(7)
'66	114.6	(5)	113.5	(3)	117.2	(2)	108.1	(6)	114.3	(6)	104.1	(8)
EMS = 14.3382	df = 107											

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

TABLE XXVII

AVERAGE 140 DAY HEIGHT AT WITHERS[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	90.5	(5)	85.9	(3)	88.6	(6)	88.8	(3)	87.2	(5)	90.7	(3)
'64	86.3	(6)	85.1	(5)	83.3	(6)						
'65	82.3	(6)	82.8	(5)	83.9	(6)	812.	(6)	83.4	(5)	80.9	(6)
'66	80.2	(3)	79.4	(6)	82.9	(7)	80.5	(6)	79.6	(7)	80.1	(4)
EMS = 2.1387 df = 88												
					Calf Crop 2							
'63												
'64	85.5	(9)	88.0	(5)	85.0	(6)	87.0	(4)	84.6	(9)	88.2	(5)
'65	82.7	(3)	85.2	(5)	84.1	(4)	84.9	(5)	82.9	(3)	86.4	(7)
'66	83.5	(8)	83.2	(4)	79.3	(6)	81.7	(5)	82.1	(6)	79.6	(6)
EMS = 2.1951 df = 113												
					Calf Crop 3							
'63	88.6	(4)	88.4	(7)	88.7	(5)	87.9	(6)	87.9	(6)	85.2	(5)
'64	86.3	(7)	84.2	(6)	87.9	(6)	84.6	(4)	85.6	(8)	86.0	(7)
'65	83.2	(2)	82.9	(5)	83.9	(6)	83.4	(5)	84.2	(8)	80.5	(7)
'66	86.1	(5)	86.5	(3)	88.9	(2)	87.1	(6)	89.1	(6)	89.2	(8)
EMS = 2.4722 df = 107												

[a]Actual measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXVIII

AVERAGE 140 DAY WIDTH AT HOOKS (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	30.9	(5)	28.7	(3)	30.0	(6)	30.0	(3)	30.8	(5)	30.6	(30
'64	28.0	(6)	27.2	(5)	27.6	(6)						
'65	26.1	(6)	26.2	(5)	26.8	(6)	26.2	(6)	25.8	(5)	25.1	(6)
'66	26.5	(3)	25.0	(6)	25.8	(7)	26.3	(6)	25.2	(7)	26.1	(4)
EMS = .5255		df = 88										
					Calf Crop 2							
'63												
'64	28.6	(9)	28.0	(5)	29.1	(6)	27.7	(4)	29.3	(9)	29.7	(5)
'65	27.7	(3)	27.6	(5)	27.6	(4)	27.6	(5)	27.1	(3)	26.8	(7)
'66	26.1	(8)	25.2	(4)	24.5	(6)	25.0	(5)	25.5	(6)	24.3	(6)
EMS = .4193		df = 113										
					Calf Crop 3							
'63	29.8	(4)	29.3	(7)	30.0	(5)	28.9	(6)	30.8	(6)	27.5	(5)
'64	27.7	(7)	28.9	(6)	27.5	(6)	27.0	(4)	27.5	(8)	27.5	(7)
'65	25.5	(2)	26.0	(5)	26.1	(6)	25.6	(5)	26.4	(8)	24.1	(7)
'66	27.4	(5)	27.1	(3)	28.1	(2)	26.7	(6)	28.2	(6)	27.4	(8)
EMS = .5342		df = 107										

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

TABLE XXIX

AVERAGE 140 DAY LENGTH OF RUMP[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	28.6	(6)	28.4	(3)	27.3	(6)	30.9	(3)	27.7	(5)	30.9	(3)
'64	26.2	(5)	27.0	(4)	26.5	(6)	27.1	(3)	26.7	(9)	27.1	(6)
'65	25.8	(6)	25.9	(5)	26.7	(6)	26.7	(6)	25.8	(3)	24.8	(6)
'66	25.8	(3)	26.9	(6)	27.9	(7)	26.0	(6)	26.5	(7)	26.7	(5)
EMS = .7696	df = 108											
					Calf Crop 2							
'63	28.1	(7)	28.8	(6)	27.4	(7)	28.6	(9)	26.9	(7)	28.4	(3)
'64	28.2	(9)	28.2	(5)	27.6	(6)	27.6	(4)	27.5	(9)	28.8	(4)
'65	25.8	(3)	27.9	(5)	27.2	(4)	27.6	(5)	27.1	(3)	29.2	(5)
'66	28.3	(8)	29.5	(4)	26.5	(6)	26.7	(5)	27.7	(6)	26.7	(6)
EMS = .7025	df = 108											
					Calf Crop 3							
'63	28.2	(5)	28.2	(7)	29.2	(5)	28.2	(6)	29.2	(6)	27.4	(5)
'64	29.2	(7)	29.0	(6)	29.0	(6)	28.9	(4)	27.8	(8)	29.2	(7)
'65	29.2	(2)	27.2	(5)	29.6	(6)	27.4	(5)	28.9	(8)	27.0	(7)
'66	26.8	(5)	28.8	(3)	30.5	(2)	27.5	(6)	28.6	(6)	26.5	(8)
EMS = 1.2956	df = 108											

[a]Photographic measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXX

AVERAGE 140 DAY LENGTH OF BODY[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
Calf Crop 1												
'63	65.2	(6)	61.4	(3)	64.8	(6)	68.2	(3)	65.8	(5)	62.2	(3)
'64	62.7	(5)	58.6	(4)	62.2	(6)	59.7	(3)	62.7	(9)	59.7	(6)
'65	61.6	(6)	58.2	(5)	59.9	(6)	55.5	(6)	60.5	(3)	55.2	(6)
'66	59.3	(3)	53.3	(6)	58.1	(7)	54.0	(6)	58.8	(7)	56.9	(5)
EMS = 3.0574	df = 108											
Calf Crop 2												
'63	65.5	(7)	61.0	(6)	67.8	(7)	63.9	(9)	63.4	(7)	60.1	(3)
'64	64.6	(9)	63.5	(5)	64.8	(6)	66.7	(4)	61.1	(9)	61.3	(4)
'65	58.8	(3)	60.2	(5)	58.9	(4)	61.0	(5)	61.8	(3)	60.7	(5)
'66	61.0	(8)	61.6	(4)	59.1	(6)	61.0	(5)	59.3	(6)	58.8	(6)
EMS = 2.6295	df = 108											
Calf Crop 3												
'63	67.8	(5)	65.0	(7)	68.3	(5)	64.6	(6)	64.3	(6)	62.5	(5)
'64	65.6	(7)	61.4	(6)	65.6	(6)	58.4	(4)	61.9	(8)	61.3	(7)
'65	61.6	(2)	59.9	(5)	63.3	(6)	59.7	(5)	64.9	(8)	57.7	(7)
'66	62.5	(5)	62.2	(3)	69.9	(2)	62.2	(6)	66.6	(6)	63.2	(8)
EMS = 3.3044	df = 108											

[a]Photographic measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXI

AVERAGE DISTANCE FROM CHEST TO FLOOR[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	44.6	(6)	42.8	(3)	43.8	(6)	44.9	(3)	43.7	(5)	43.2	(3)
'64	43.4	(5)	43.5	(4)	41.1	(6)	42.8	(3)	41.6	(9)	42.5	(6)
'65	41.7	(6)	41.2	(5)	42.1	(6)	41.7	(6)	42.8	(3)	41.7	(6)
'66	40.6	(3)	42.5	(6)	42.5	(7)	41.9	(6)	42.5	(7)	42.9	(5)
EMS = .9690		df = 108										
					Calf Crop 2							
'63	41.7	(7)	42.8	(6)	41.2	(7)	42.6	(9)	41.9	(7)	43.2	(3)
'64	43.9	(9)	43.4	(5)	43.6	(6)	43.5	(4)	41.9	(9)	44.5	(4)
'65	41.1	(3)	43.9	(5)	42.5	(4)	43.2	(5)	40.9	(3)	43.4	(5)
'66	413.	(8)	42.2	(4)	39.8	(6)	41.2	(5)	40.0	(6)	39.8	(6)
EMS = .9278		df = 108										
					Calf Crop 3							
'63	43.7	(5)	44.1	(7)	44.2	(5)	42.8	(6)	43.0	(6)	43.2	(5)
'64	43.0	(7)	41.5	(6)	43.0	(6)	42.6	(4)	43.8	(8)	42.1	(7)
'65	40.6	(2)	39.4	(5)	40.4	(6)	41.9	(5)	39.2	(8)	41.9	(7)
'66	43.4	(5)	43.9	(3)	43.2	(2)	44.0	(6)	45.7	(6)	45.6	(8)
EMS = 1.1715		df = 108										

[a]Photographic measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXII

AVERAGE HEIGHT AT WITHERS[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	91.0	(6)	89.3	(3)	88.0	(6)	90.2	(3)	90.4	(5)	92.3	(3)
'64	85.3	(5)	84.8	(4)	85.6	(6)	83.4	(3)	84.4	(9)	84.0	(6)
'65	82.1	(6)	82.3	(5)	85.3	(6)	81.7	(6)	83.4	(3)	81.3	(6)
'66	83.0	(3)	84.2	(6)	84.0	(7)	82.6	(6)	82.0	(7)	84.1	(5)
EMS = 2.3780	df = 108											
					Calf Crop 2							
'63	88.1	(7)	86.4	(6)	85.5	(7)	88.2	(9)	87.9	(7)	82.6	(3)
'64	88.3	(9)	86.4	(5)	87.5	(6)	85.1	(4)	85.9	(9)	86.7	(4)
'65	84.7	(3)	87.9	(5)	86.7	(4)	87.4	(5)	84.7	(3)	88.6	(5)
'66	86.0	(8)	83.2	(4)	80.4	(6)	82.6	(5)	84.5	(6)	81.5	(6)
EMS = .4714	df = 108											
					Calf Crop 3							
'63	89.7	(5)	88.4	(7)	89.9	(5)	86.4	(6)	88.5	(6)	85.6	(5)
'64	88.2	(7)	87.0	(6)	89.3	(6)	83.8	(4)	87.9	(8)	85.6	(7)
'65	85.7	(2)	83.3	(5)	84.7	(6)	85.6	(5)	85.7	(8)	82.7	(7)
'66	86.6	(5)	85.8	(3)	88.6	(2)	86.1	(6)	88.9	(6)	89.5	(8)
EMS = 2.1624	df = 108											

[a]Photographic measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXIII

AVERAGE HEIGHT AT HOOKS[a] (CM) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	90.0	(6)	88.5	(3)	88.9	(6)	90.2	(3)	88.1	(5)	90.8	(3)
'64	85.8	(5)	85.7	(4)	85.9	(6)	85.5	(3)	84.8	(9)	84.7	(6)
'65	81.9	(6)	83.6	(5)	83.8	(6)	83.4	(6)	83.4	(3)	81.8	(6)
'66	79.6	(3)	84.5	(6)	82.2	(7)	83.2	(6)	80.7	(7)	84.8	(5)
EMS = 2.3585		df = 108										
					Calf Crop 2							
'63	87.0	(7)	87.8	(6)	86.8	(7)	90.9	(9)	87.6	(7)	86.4	(3)
'64	87.0	(9)	87.6	(5)	87.5	(6)	90.0	(4)	83.5	(9)	87.0	(4)
'65	80.4	(3)	86.4	(5)	83.7	(4)	86.9	(5)	82.1	(3)	88.1	(5)
'66	84.5	(8)	85.1	(4)	81.1	(6)	82.8	(5)	84.7	(6)	80.7	(6)
EMS = 1.7475		df = 108										
					Calf Crop 3							
'63	88.8	(5)	91.1	(7)	88.1	(5)	90.0	(6)	88.5	(6)	87.1	(5)
'64	86.4	(7)	86.0	(6)	85.7	(6)	85.7	(4)	85.4	(8)	86.4	(7)
'65	83.8	(2)	83.8	(5)	85.3	(6)	85.3	(5)	82.6	(8)	813.	(7)
'66	87.4	(5)	89.2	(3)	85.5	(2)	86.9	(6)	87.3	(6)	89.2	(8)
EMS = 2.8140		df = 108										

[a]Photographic measurement.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXIV

AVERAGE BIRTH DATE[a] OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.–Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	99.3	(6)	140.3	(3)	104.8	(6)	104.7	(3)	100.8	(5)	110.0	(3)
'64	71.0	(6)	72.0	(4)	87.7	(7)	83.0	(3)	87.9	(9)	84.8	(6)
'65	75.0	(6)	106.0	(5)	83.8	(6)	104.3	(6)	72.8	(5)	85.0	(6)
'66	76.7	(3)	82.3	(6)	86.7	(7)	87.3	(7)	73.1	(7)	85.2	(5)
EMS = 63.0687		df = 106										
					Calf Crop 2							
'63	88.3	(8)	93.1	(7)	83.6	(8)	84.2	(9)	95.9	(7)	115.0	(3)
'64	84.3	(9)	87.2	(5)	87.3	(6)	74.3	(4)	98.1	(10)	86.8	(6)
'65	73.0	(4)	80.0	(6)	83.3	(4)	83.4	(5)	101.0	(4)	87.0	(7)
'66	71.5	(8)	70.7	(3)	68.5	(6)	92.8	(5)	81.1	(7)	83.0	(7)
EMS = 59.9913		df = 124										
					Calf Crop 3							
'63	93.8	(6)	94.7	(7)	93.7	(6)	83.0	(6)	93.3	(6)	81.4	(5)
'64	72.9	(7)	77.7	(7)	74.7	(6)	82.3	(4)	79.4	(8)	73.3	(7)
'65	101.3	(4)	87.7	(7)	86.0	(6)	79.0	(6)	80.6	(8)	82.0	(7)
'66	86.2	(5)	103.3	(3)	75.5	(2)	94.1	(7)	103.3	(6)	92.1	(8)
EMS = 80.3409		df = 120										

[a]Day of the year.

[b]140-day weaned.

[c]240-weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXV

AVERAGE BIRTH WEIGHT (KG) OF CALVES FROM COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	27.5	(6)	31.0	(3)	27.1	(5)	28.6	(3)	28.5	(6)	28.0	(3)
'64	24.9	(6)	28.6	(4)	26.7	(7)	30.9	(3)	24.8	(9)	29.8	(8)
'65	25.7	(6)	25.5	(4)	25.7	(6)	26.5	(6)	28.0	(5)	27.4	(6)
'66	25.7	(3)	25.4	(5)	23.7	(7)	25.7	(7)	25.6	(7)	25.8	(6)
EMS = .3163	df = 105											
					Calf Crop 2							
'63	30.1	(8)	25.2	(8)	27.4	(7)	28.0	(3)	30.5	(7)	31.2	(9)
'64	29.2	(9)	29.7	(5)	29.2	(10)	29.0	(4)	29.9	(4)	30.6	(6)
'65	25.5	(4)	27.3	(4)	25.5	(4)	29.0	(6)	27.2	(5)	29.9	(7)
'66	25.0	(8)	21.9	(6)	21.7	(7)	21.2	(3)	24.0	(5)	22.0	(7)
EMS = 1.9669	df = 122											
					Calf Crop 3							
'63	32.0	(5)	34.0	(5)	34.0	(6)	34.7	(7)	31.5	(6)	31.3	(5)
'64	30.8	(7)	32.7	(6)	32.0	(8)	34.1	(7)	32.8	(4)	33.4	(7)
'65	22.7	(4)	26.8	(6)	28.6	(8)	27.9	(7)	26.5	(6)	24.3	(7)
'66	25.9	(2)	29.3	(6)	30.9	(5)	33.3	(3)	32.4	(7)	34.2	(8)
EMS = 2.7288	df = 118											

[a] 140-day weaned.

[b] 240-day weaned.

[c] Creep-fed 240-day weaned.

TABLE XXXVI

AVERAGE PERCENT CALF CROP[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	75.0	(8)	37.5	(8)	66.7	(9)	44.4	(9)	85.7	(7)	80.0	(5)
'64	88.9	(9)	50.0	(8)	100.0	(8)	66.7	(6)	100.0	(11)	80.0	(10)
'65	87.5	(8)	90.0	(9)	100.0	(7)	87.5	(8)	75.0	(8)	77.8	(9)
'66	40.0	(10)	60.0	(10)	100.0	(7)	90.0	(10)	100.0	(8)	54.6	(11)
EMS = 243.33	df = 17											
					Calf Crop 2							
'63	100.0	(8)	87.5	(8)	100.0	(8)	100.0	(9)	100.0	(7)	60.0	(5)
'64	100.0	(9)	74.4	(7)	75.0	(8)	83.3	(6)	100.0	(11)	80.0	(10)
'65	87.5	(8)	77.8	(9)	85.7	(7)	100.0	(8)	50.0	(8)	88.9	(9)
'66	90.0	(10)	70.0	(10)	85.7	(7)	100.0	(10)	100.0	(8)	62.6	(11)
EMS = 198.56	df = 17											
					Calf Crop 3							
'63	75.0	(8)	100.0	(8)	75.0	(8)	77.8	(9)	100.0	(7)	100.0	(5)
'64	77.8	(9)	100.0	(7)	87.5	(8)	83.3	(6)	81.8	(11)	88.9	(9)
'65	50.0	(8)	100.0	(8)	100.0	(6)	85.7	(7)	100.0	(8)	77.8	(9)
'66	66.7	(9)	37.5	(8)	42.9	(7)	80.0	(10)	100.0	(7)	72.7	(11)
EMS = 431.62	df = 17											

[a]Percent of cows to give birth to calves.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXVII

AVERAGE PERCENT CALF CROP[a] OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[b] Angus		140 Hereford		240[c] Angus		240 Hereford		240C[d] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	75.0	(8)	37.5	(8)	66.7	(9)	33.3	(9)	71.4	(7)	60.0	(5)
'64	88.9	(9)	50.0	(8)	100.0	(8)	50.0	(6)	100.0	(11)	60.0	(10)
'65	75.0	(8)	66.7	(9)	85.7	(7)	75.0	(8)	75.0	(8)	77.8	(9)
'66	30.0	(10)	60.0	(10)	100.0	(7)	80.0	(10)	87.5	(8)	54.6	(11)
EMS = 257.34	df = 17											
					Calf Crop 2							
'63	100.0	(8)	87.5	(8)	100.0	(8)	100.0	(9)	100.0	(7)	60.0	(5)
'64	100.0	(9)	74.4	(7)	75.0	(8)	66.7	(6)	100.0	(11)	60.0	(10)
'65	50.0	(8)	66.7	(9)	714.	(7)	87.5	(8)	50.0	(8)	88.9	(9)
'66	80.0	(10)	40.0	(10)	85.7	(7)	50.0	(10)	100.0	(8)	63.6	(11)
EMS = 105.58	df = 8											
					Calf Crop 3							
'63	75.0	(8)	100.0	(8)	75.0	(8)	77.8	(9)	100.0	(7)	100.0	(5)
'64	77.8	(9)	100.0	(7)	87.5	(8)	83.3	(6)	72.7	(11)	77.8	(9)
'65	50.0	(8)	100.0	(8)	100.0	(6)	85.7	(7)	100.0	(8)	77.8	(9)
'66	55.6	(9)	37.5	(8)	28.6	(7)	80.0	(10)	100.0	(7)	77.7	(11)
EMS = 238.03	df = 17											

[a]Percent of cows to give birth to live calves.

[b]140-day weaned.

[c]240-day weaned.

[d]Creep-fed 240-day weaned.

TABLE XXXVIII

AVERAGE PERCENT CALF CROP WEANED OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	75.0	(8)	37.5	(8)	66.7	(6)	33.3	(9)	71.4	(7)	60.0	(5)
'64	66.7	(9)	50.0	(8)	87.5	(8)	50.0	(6)	90.9	(11)	60.0	(10)
'65	75.0	(8)	55.6	(9)	85.7	(7)	75.0	(8)	62.5	(8)	66.7	(9)
'66	30.0	(10)	60.0	(10)	100.0	(7)	70.0	(10)	87.5	(8)	54.6	(11)
EMS = 232.49	df = 17											
					Calf Crop 2							
'63	100.0	(8)	87.5	(8)	100.0	(8)	100.0	(9)	100.0	(7)	60.0	(5)
'64	100.0	(9)	71.4	(7)	75.0	(8)	66.7	(6)	90.9	(11)	60.0	(10)
'65	50.0	(8)	66.7	(9)	71.4	(7)	62.5	(8)	87.5	(8)	44.4	(9)
'66	80.0	(10)	40.0	(10)	85.7	(7)	50.0	(10)	87.5	(8)	63.6	(11)
EMS = 168.98	df = 17											
					Calf Crop 3							
'63	75.0	(8)	87.5	(8)	75.0	(8)	66.7	(9)	85.7	(7)	100.0	(5)
'64	77.8	(9)	100.0	(7)	75.0	(8)	66.7	(6)	72.7	(11)	87.5	(8)
'65	50.0	(8)	87.5	(8)	100.0	(6)	85.7	(7)	100.0	(8)	77.8	(9)
'66	55.6	(9)	37.5	(8)	28.6	(7)	70.0	(10)	100.0	(7)	72.7	(11)
EMS = 298.78	df = 17											

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

TABLE XXXIX

AVERAGE 24 HOUR MILK PRODUCTION OF COWS FED DIFFERENT LEVELS OF PREWEANING NUTRITION

Trt.-Brd.	140[a] Angus		140 Hereford		240[b] Angus		240 Hereford		240C[c] Angus		240C Hereford	
Year Born	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n	$\bar{X}$	n
					Calf Crop 1							
'63	2.4	(6)	2.8	(3)	3.4	(5)	3.2	(3)	2.6	(6)	2.1	(3)
'64	4.1	(6)	3.4	(4)	4.1	(7)	4.1	(3)	4.0	(10)	3.9	(6)
'65	3.6	(6)	3.8	(5)	4.0	(6)	3.5	(6)	3.3	(5)	3.0	(6)
'66	4.1	(3)	3.3	(5)	4.5	(7)	7.2	(7)	2.0	(7)	3.4	(7)
					Calf Crop 2							
'63	6.4	(8)	6.1	(7)	5.4	(7)	5.6	(8)	5.4	(8)	2.6	(4)
'64	5.4	(9)	3.8	(5)	5.1	(6)	4.5	(4)	4.6	(10)	3.8	(6)
'65	2.9	(4)	4.4	(6)	4.6	(5)	4.4	(5)	4.1	(4)	5.9	(6)
'66	4.1	(7)	3.5	(4)	3.9	(7)	4.5	(5)	4.0	(7)	3.9	(7)
					Calf Crop 3							
'63	6.6	(6)	4.9	(7)	7.4	(5)	5.6	(5)	6.5	(7)	4.5	(5)
'64	6.1	(7)	5.6	(7)	6.1	(6)	5.4	(4)	6.2	(8)	4.8	(7)
'65	3.8	(4)	3.6	(7)	5.0	(6)	4.0	(6)	4.5	(8)	4.1	(7)
'66	6.2	(5)	4.1	(3)	6.0	(2)	11.7	(9)	6.1	(7)	5.5	(5)

[a]140-day weaned.

[b]240-day weaned.

[c]Creep-fed 240-day weaned.

VITA[1]

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Candicate for the Degree of

Master of Science

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