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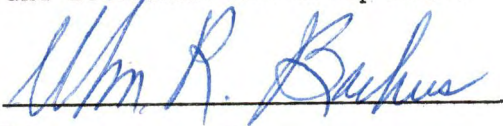
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I am submitting herewith a thesis written by Stanley F. Stansbury entitled "The Effects of Induced Abortion on the Feedlot Performance of Beef Heifers Fed Urea and Cottonseed Meal, With and Without Hay." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.



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Graduate Studies and Research

THE EFFECTS OF INDUCED ABORTION ON THE FEEDLOT PERFORMANCE
OF BEEF HEIFERS FED UREA AND COTTONSEED MEAL,
WITH AND WITHOUT HAY

A Thesis
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Stanley F. Stansbury

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ABSTRACT

There were three objectives in this study. The first objective was to determine the effects of abortion on the performance of medium grade, yearling heifers showing some evidence of beef breeding. Secondly, the effects of adding good quality alfalfa hay to feeder cattle rations were to be identified. A third objective of this study was to determine the relative effects of using a high level urea supplement in comparison to cottonseed meal (CSM).

One hundred and seventy-two medium grade, possibly pregnant, yearling heifers showing evidence of beef breeding were involved in a three-year study at the Greeneville Tobacco Experiment Station. The heifers were pregnancy checked before being placed on feed, and those determined to be pregnant were intermuscularly injected with 100 milligrams of diethylstilbestrol (DES) in an attempt to cause abortion. In 1967, half of the heifers determined to be non-pregnant were given 100 mg of DES in order to identify the effects of this one-time, intermuscular injection.

The heifers were lotted into light and heavy weight groups. Each treatment contained two lots of from six to eight heifers per lot each of the three years. One lot contained heavy heifers; the other lot contained light heifers. Pregnant heifers were uniformly distributed throughout all subclasses. There were two general phases of feeding each year. During the first phase, the heifers were given corn silage ad libitum with five pounds of ground ear corn and one pound of protein

supplement for an average of 113 days. Following the high silage phase was the concentrate phase, during which each heifer consumed a maximum amount of ground ear corn and either one pound of urea supplement or 1.26 pounds of CSM. The concentrate period lasted an average of 58 days.

There was a highly significant ($P \leq .01$) difference in the total average daily gain of the open heifers (1.65 pounds per day) as compared to those determined to be pregnant (1.54 pounds per day), for the three years studied. Heifers fed hay gained at a significantly faster rate ($P \leq .05$) than heifers not fed hay; 1.64 versus 1.55 pounds per day, respectively. Results of the cottonseed meal (CSM) treatments versus urea treatments showed that rate of gain for heifers fed urea were very highly significantly lower than for the CSM fed groups during the silage feeding phase. However, gains made during the concentrate feeding phase were such that the total average daily gains were different only at the 10 percent level of probability in favor of CSM. Total average daily gains for light heifers (1.65 pounds per day) were highly significantly ($P \leq .01$) different from total average daily gains for heavy heifers (1.54 pounds per day).

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CHAPTER I

INTRODUCTION

One problem in the feeder cattle area is that of how to handle medium grade, yearling heifers which may have been mismanaged or inadvertently bred. Smithson et al. (1969) report that producers often receive as much as \$5.00 per hundredweight (cwt) discount for such animals because they are likely to be pregnant. Pregnancy lowers ultimate carcass quality in several economically important characteristics.

Heifers do not gain as rapidly or efficiently as steers or bulls. Unpublished data collected by the University of Tennessee shows that approximately one-third of the heifers over one year of age, found in appreciable numbers on the market during the fall season, are likely to be gestating. As a result steers are preferred as feeders, usually bringing higher prices. In spite of these disadvantages, medium grade, possibly pregnant, yearling heifers showing some evidence of beef breeding can be profitable for the feedlot operator.

Heifers can be bought for less than prevailing feeder steer prices. Medium grade heifers which are sold on a guaranteed open basis sell for \$3-4.00 per cwt. more than comparable heifers not so guaranteed. Therefore, heifers which do not carry an open guarantee provide a favorable buying margin. Heifers fitting into the latter category are often older, larger animals.

Older heifers having a larger frame should have the capacity to utilize larger amounts of cheap, home grown forages than younger and smaller animals. Increased rumen capacity, therefore, should favor larger heifers for low cost production.

The risk of buying pregnant heifers must be weighed against these and other advantages offered by such animals to the feeder. Heifers attain a marketable weight and grade in a shorter period of time and generally with lower requirements for expensive high energy finishing feeds than steers. Moreover, the feedlot operator may expect open heifers to produce high quality carcasses.

Diethylstilbestrol (DES) administered intermuscularly, has been shown to abort heifers successfully within two to six weeks after treatment. This suggests that such heifers may be aborted shortly after purchase. With the cost of DES treatment at less than ten cents per head, all animals may be treated economically while convalescing from shipping stress well in advance of being placed on feed.

Related to the economic feasibility of feeding lower quality, sometimes pregnant medium grade heifers is an additional problem. Previous results have indicated that hay does not improve gains made on high silage rations. However, on high concentrate rations, limited amounts of good quality legume hay have been shown to significantly improve rate and economy of gain. Such improvement due to limited hay feeding would appear to be especially pronounced in the case of larger animals.

A third aspect of this study was to evaluate the relative merit of urea and cottonseed meal (CSM) as supplemental nitrogen sources.

Older ruminant animals should be expected to utilize urea more efficiently than younger animals due to the action of a more highly developed rumen bacterial flora. Pregnant and open animals were uniformly distributed throughout the four basic treatments in each of the three years of the study.

CHAPTER II

REVIEW OF LITERATURE

Heifers Versus Steers

J. C. Meiske and R. D. Goodrich (1969), using steers, bulls, and heifers sired by the same bull and out of similarly bred dams, found that at weaning bull calves were significantly heavier than heifers, with the steers intermediate. Post weaning gains in the feedlot showed that heifers gained slower and less efficiently than either steers or bulls of this study.

Smithson et al. (1969), in comparing steers and heifers, found that heifers gained slower than steers when fed and managed similarly. However, costs of production were lower for heifers due to a lower initial purchase price, and, as a result, heifers returned slightly more than steers when sold direct to the packer. The animals used in this study were placed on ryegrass pasture for 72 days after weaning. They were then fed two pounds of protein supplement, 6 pounds of ground shelled corn and silage ad libitum for 68 days. After the 68 day feed-lot period, the animals were returned to the ryegrass pasture for 51 days of additional grazing. At this point the heifers had made lower total gain than the steers (307 versus 330 lbs.). Had the animals been sold as feeder calves, the steers would have brought substantially more than the heifers (\$183.68 versus \$140.87). However, because they were marketed as slaughter cattle, the heifers returned more than steers (\$31.05 versus \$23.31) primarily because of a lower initial cost (\$77.76 versus \$92.16).

Peters (1933) showed average daily gains for steers on a high energy ration was 2.35 pounds per day whereas for heifers on the same ration, daily gains were 2.27 pounds per day. Trowbridge (1932) showed that on a high silage ration with 8.0 pounds of shelled corn, steers gained 2.16 pounds per day and heifers 1.94 pounds per day. Feeding approximately one-half of a full feed of grain in the winter followed in the summer with a full feed of grain on grass, Trowbridge showed that steers gained 1.84 pounds per day while heifers gained 1.64 pounds per day. These three studies show from \$0.40 to \$2.00 per hundred pounds advantage in favor of the steers in gross return.

Value of Hay in Feeder Cattle Rations

According to Snapp and Newman (1965), satisfactory gains may be expected from a high silage ration with shelled corn and a protein supplement. However, Snapp and Newman report that feeding experiments have shown that a small amount of dry forage such as hay or straw results in a slight improvement in rate of feeder cattle gain. The results of two experiments conducted by the Indiana Experiment Station, cited by Snapp and Newman (1965), are shown in Table I.

Corrick (1968, unpublished data) found, during a 140 day feed test involving a high level of silage intake, that adding two pounds of alfalfa hay did not improve average daily gains. O. G. Hall, C. S. Hobbs, and T. W. High (1961) reported that during an 86 day finishing experiment, steers fed a limited amount of good quality alfalfa hay gained significantly faster and were more efficient than steers fed a similar amount of good orchard grass hay.

TABLE I
VALUE OF A DRY ROUGHAGE WITH A HEAVY SILAGE RATION¹

Ration		Silage Per Pound of Gain	ADG
Indiana (2 year olds)	Shelled corn, CSM, corn silage	12.66	2.37
Indiana (2 year olds)	Shelled corn, CSM, clover hay, corn silage	11.16	2.45
Indiana (2 year olds)	Shelled corn, CSM, corn silage, clover hay	10.37	2.41
Indiana (2 year olds)	Shelled corn, CSM, corn silage, oat straw	10.59	2.45
Illinois (calves)	Shelled corn, CSM, corn silage	7.49	2.03
Illinois (calves)	Shelled corn, CSM, alfalfa hay, and corn silage	4.64	2.20

¹R. R. Snapp and A. L. Newman, Beef Cattle (5th edition) (New York: John Wiley and Sons, Inc.), 1965.

Other work to evaluate the effects of using high quality hay in conjunction with a high energy diet was conducted by Nebraska and Illinois Experiment Stations. The results are shown in Table II.

TABLE II
THE VALUE OF ROUGHAGE IN THE RATION OF FULL-FED CATTLE¹

	Rations					
Alfalfa hay level	2.7	0	3.2	0	2.0	0
Ground grain	16.3	16.9	19.5	19.2	11.3	12.0
Corn silage (air dry wt.)	0	0	0	0	14.1	0
Average daily gain	1.97	1.88	3.15	2.69	2.45	1.63

¹R. R. Snapp and A. L. Newman, Beef Cattle (5th edition) (New York: John Wiley and Sons, Inc.), 1965.

K. M. Barth, J. C. McConnell, and H. C. Wang (1968), in a study to test a high urea supplement against CSM in a 2 X 2 factorial model with and without hay, found that hay significantly improved the percent crude protein digestibility of the ration used in one of the two trials but not in the case of the other trial. Hay did not improve the TDN or the dry matter digestibility in either the urea or CSM treatments.

Urea Versus Cottonseed Meal as Nitrogen Sources

Work by Essig and Smithson (1969) showed that calves on a high sorghum silage ration gained more when the protein supplement was

cottonseed meal than when the supplement was urea, both being fed at iso-nitrogenous levels (91 day gains were 92.3 pounds for CSM versus 45.5 pounds for urea). Comparing CSM with a complex protein supplement containing 63.5 percent CSM with 15.0 percent dehydrated alfalfa meal and 5.0 percent urea, J. H. Clark, O. G. Hall, and J. H. Felts (1967) found essentially no difference in rate or economy of gains made by feeder calves.

Barth, McConnell, and Wang (1968), comparing a high urea level protein supplement with CSM in digestion and metabolism experiments, found that the TDN values were higher in the urea ration. Barth also found that nitrogen utilization was approximately the same when a high concentrate ration was fed. When a high silage ration was fed, however, steers fed urea retained significantly less of the absorbed nitrogen than steers fed CSM.

J. A. Corrick and C. S. Hobbs (1968), postulating that 20 pounds of urea added per ton of corn silage should remove the need for supplemental CSM nitrogen, designed an experiment to test the relative effects of three urea levels in corn silage. Calves fed corn silage with ten pounds of urea added per ton gained as well as calves fed corn silages treated with 15 or 20 pounds of urea per ton.

M. C. Bell, J. A. Odom, and R. A. Reynolds (1957) found that cattle fed a fattening ration supplemented with CSM gained 0.29 pounds more per day than cattle fed an identical ration but supplemented with urea. However, cattle fed the urea ration, supplemented with ten milligrams of stilbestrol per head per day, gained slightly more than the CSM-fed cattle.

Diethylstilbestrol (DES) as a Growth Promoter and an Abortifacient

W. E. Dinusson, F. N. Andrews, and W. M. Beeson (1950) found that 42 mg. of DES implants improved gains made by beef heifers from 2.07 to 2.32 pounds per day. Hall in 1962 found that a 24 mg. implantation improved gains made by feeder heifers 19 percent (2.55 versus 2.14 pounds per day). Hall also found that the treated heifers of this study required 14 percent less feed per unit of gain. In two of the three years of this work, Hall found that the final condition grade was one-third of a grade higher for DES heifers. For the cost of 25 to 30 cents per head for the treatment, implanted heifers of this study returned about \$5.00 more per head than the controls.

Hill and Pierson (1958) found that DES could be used successfully to abort feedlot heifers. Using 649 pregnant heifers in 29 Colorado feedlots, treated at five levels (75, 100, 125, 150, and 175 mg.) of DES, Hill and Pierson found that 80 percent of the pregnancies of less than 150 days aborted with a single 100 mg. injection. Eighty-nine percent of 123 heifers in this study, pregnant 120 to 210 days, aborted after a single injection of 150 mg. The 175 mg. dosage level used in this work did not increase the percentage of abortions in heifers pregnant 150 days or more.

CHAPTER III

PROCEDURE

The Experimental Animals

To describe the heifers used in this study, the term medium grade is used. The heifers used were yearling animals which showed some evidence of beef breeding and were bought without regard to pregnancy status. This is in contrast to heifers sold almost exclusively through feeder calf sales and which must qualify in the following ways:

1. They must carry an open guarantee, and in the event of a pregnancy, a 20 percent refund is made on the initial purchase price.
2. They must be sired by a registered bull.
3. They must be out of a beef type cow.

Heifers sold through feeder calf sales have usually been bred and managed more carefully in order to attract higher prices than heifers purchased from auction yard sales such as were used in this study.

Purchasing and Lotting

One hundred and seventy-two heifers were purchased in East Tennessee during 1965, 1966, and 1967 for this study. (Hereafter, the year in which the heifers were purchased will be used to designate particular heifers under consideration.) The experiment was conducted at the University of Tennessee Tobacco Experiment Station (TES) at

Greeneville. The heifers used in this study were typical of the medium (standard if bought from a stockyard) grade yearling heifers available for further feeding from stockyards, especially in the fall season.

The heifers were purchased during October and November and were placed on pasture and given access to hay, fresh water, salt, and minerals. The heifers were observed daily in order to detect and treat any shipping fever, disease, or stress-related disturbances. In the second week of December, the heifers were pregnancy checked, given a 24 mg ear implant of DES, weighed on two consecutive days, allotted to treatment, and given a full feed of corn silage. In 1965 and 1966, heifers which were pregnant were given a 100 mg intermuscular injection of DES in 4 cc's of an oil carrier solution. In 1967, all pregnant animals were treated as in previous years. In addition, one-half of the non-pregnant heifers were injected with 100 mg so that the effects of the 100 mg intermuscular injection could be partitioned from abortion effects for statistical analysis.

With the routine pregnancy determination, an estimate was made of the stage of gestation to provide a means of identifying any interaction between abortifacient (chemical used to cause abortion) level, heifer body size, and fetal development. In 1965, approximately one-fourth of the heifers were determined to be pregnant; in 1966 and 1967, about one-third were pregnant.

The experimental design for the three year study is shown in Tables III and IV.

Each treatment was divided into two weight groups based on the two-day, average initial feedlot weight. By dividing the heifers into

TABLE III

DISTRIBUTION OF HEIFERS IN 1965, 1966, AND 1967
AT THE START OF THE EXPERIMENT EACH YEAR
BY PREGNANCY DETERMINATION

	Hay		No Hay		Total
	Pregnant	Open	Pregnant	Open	
Urea	14*	30	12	30	86
CSM	16	28	12	30	86
Sub total	30	58	24	60	
Total		88		84	Grand Total 172

*Number of animals.

TABLE IV

DISTRIBUTION OF 1967 HEIFERS BY PREGNANCY
DETERMINATION AND DES TREATMENT

	Hay			No Hay			Total
	Pregnant DES	Open DES	Open Untreat.	Pregnant DES	Open DES	Open Untreat.	
Urea	5	4	5	4	6	4	28
CSM	6	4	4	4	6	4	28
Sub total	11		17	8		20	
Total		28			28		Grand total 56

light and heavy groups on initial weights (484 pounds for light heifers versus 578 pounds for heavy heifers, were the three-year averages), the effects of size (weight) on forage and nitrogen utilization and on abortificant response were identifiable. Heavy heifers were generally 100 pounds heavier than light heifers.

Feeding

The feeding trials were divided into two general phases. In the first phase, beginning the second week of December and lasting until March, the heifers were given high quality corn silage free choice, five pounds of ground ear corn, and one pound of protein supplement. Lots which received hay were given two pounds of good quality alfalfa hay daily per animal. Feeding was done once per day during the first phase. With the exception of the corn silage, the dietary constituents were held constant throughout the first phase. At the start of the forage period, the heifers consumed 15-20 pounds of silage per day. As their digestive capacity increased and the rumen microflora adapted to the feed, the silage component was increased gradually, and toward the end of the forage feeding, the heifers were consuming approximately 30 pounds of corn silage per head per day. The treatments are presented in Table V.

Following the forage feeding period, a transition interval of 4-6 days was taken to change the heifers from a high roughage diet to a high concentrate ration. Feeding during the concentrate period was done twice per day. After the transition to grain feeding, consumption was from ten to fifteen pounds of concentrate (including

TABLE V
EXPERIMENTAL DESIGN, THREE YEAR SUMMARY

	Hay		No Hay	
	Light	Heavy	Light	Heavy
Urea	3 lots*	3 lots	3 lots	3 lots
CSM	3 lots	3 lots	3 lots	3 lots

*Each lot contained 6-8 heifers.

the protein supplement) per head per day. This increased to nearly 20 pounds of grain per head per day by the conclusion of the experiment. The heifers were marketed when it was estimated that the majority would grade high, good, or low choice.

Crude protein equivalent was supplied from two sources, urea and CSM. The urea was mixed in a complex supplement described in Table VI. Heifers which received the urea supplement were given one pound of the complex mixture throughout the forage and concentrate periods. During the forage phase, the urea supplement was mixed in a ratio of five parts of ground ear corn to one part of the supplement. Each heifer received six pounds of concentrate per day. During the concentrate phase, the protein equivalency level was maintained; and as before, the urea premix was fed in the concentrate mixture.

TABLE VI
UREA SUPPLEMENT FORMULATION

Ingredient	Percent of Supplement	Pounds Per Animal Per Day
Ground ear corn	68.0	.680
Urea	15.0	.150
Dicalcium phosphate	10.0	.100
Limestone	6.0	.060
Vitamin A premix (4 million units per lb.)	.5	.005
Trace mineral premix ¹	.5	.005
Total	100.0	1.000

(Thirty pounds of salt was added per ton of premix.)

¹Trace mineral premix (minimum percentages): Manganese, 4.4%; iron, 6.6%; copper, 1.3%; cobalt, 0.2%; iodine, 0.3%; zinc, 12.0%; and magnesium, 20.0%.

Heifers which received the CSM supplement were given six pounds of concentrate mixed as one part of CSM to five parts of ground ear corn during the forage phase. However, it was necessary to increase the consumption of CSM to 1.26 pounds per head per day during the concentrate period to provide uniform crude protein intake in the CSM groups.

Fresh water, salt, and a mineral mixture were available to the heifers at all times.

Weighing and Record Keeping

Before being placed in the feedlot, the initial weight was determined by weighing the heifers on two consecutive days. To minimize error due to shrink and fill, feed and water were available the preceeding day. Water and feed were then removed at 6 P.M. of the day preceeding weighing, and heifers weighed at 8 A.M. the following morning. The heifers were weighed every 28 days thereafter throughout the feeding trials. Changes in weight of the heifers were due to tissue gains and losses and to aborted materials in the case of pregnant animals. At the end of the concentrate period, the heifers were again weighed on two consecutive days. After the final weighing, the heifers were trucked immediately to the packing house (a distance of about 70 miles) to determine the amount of weight loss due to transit shrink and to previous fill. (This weight loss, denoted herein as drift, is expressed as a percentage of the final farm weight.)

At the packing house, the heifers were given their final condition score and were weighed. In order to facilitate the collection

of carcass data, each heifer was identified with a kill number. Examinations were made of the stomach lining and liver to detect any irritation and abscesses. The carcasses were weighed on the kill floor. These hot carcass weights were reduced by 2.5 percent, and these weights were used as the chilled carcass weights to calculate the dressing percentage. The carcasses were chilled 48 hours, and the following carcass data were taken: backfat thickness, loin-eye area (made with tracings in 1966 and 1967--the area arrived at with the use of a planimeter--and, in 1968, the area was taken with a plastic overlay grid), and the estimated percentage of kidney and pelvic fat. Also, after the 48 hour chill, the official U.S.D.A. carcass grades were obtained, and the maturity, marbling, and carcass conformation estimates were secured.

The buying, weighing, and feeding records were kept by the Tobacco Experiment Station personnel. Allotting, grading, and slaughter data were collected by Experiment Station personnel from the Knoxville Station.

The data used were programmed according to Harvey's Procedures and analyzed by the least squares method through the use of the University of Tennessee's digital computer. A Duncan's multiple range test was run to determine statistical significance among years and DES levels in 1967.

CHAPTER IV

RESULTS AND DISCUSSION

The results presented in Tables VII and VIII describe the eleven independent treatment effects on thirteen dependent feedlot and carcass variables studied in the Hatch 72-T8 phase of the forage evaluation project conducted at the Tennessee Tobacco Experiment Station during 1965, 1966, and 1967.

Since there were no significant interactions involving roughage x supplement, roughage x pregnancy, roughage x weight group, supplement x pregnancy, supplement x weight group, or pregnancy x weight group, the mathematical model used to describe the expected variation is given as follows:

$$\hat{Y} = \mu + Y + R + S + P + W + e,$$

where, $\hat{Y}$ is the expected or predicted performance,

and μ is μ , the overall mean,

and Y is the effect due to year,

and R is the effect due to the addition or deletion of two pounds of hay containing at least 30 percent alfalfa,

and S is the effect due to urea or CSM as nitrogen supplying compounds,

and P is the deviation due to pregnancy,

and W is the weight group effect,

and e is the normal variation expected between heifers treated alike within a subclass having the same genetic and biologic potential.

TABLE VII
LEAST SQUARES MEANS FOR AVERAGE DAILY GAINS,
INITIAL AND FINAL WEIGHTS AND DRIFT¹
(THREE YEAR ANALYSIS)

	Initial Weight	28F- ADG ²	P28F- ADG	TF-ADG	C-ADG	T-ADG	Final Weight	Drift
Mu ³	531	1.21	1.63	1.52	1.76	1.59	803	2.2
Year								
1965	536 ^d	1.31 ^b	1.33 ^a	1.32 ^a	2.08 ^a	1.55 ^a	786 ^d	2.4 ^a
1966	517	1.44	1.87	1.75	1.74	1.76	816	1.0
1967	540	0.87	1.70	1.49	1.45	1.48	806	3.1
Pregnancy status								
Pregnant	559 ^a	1.10 ^d	1.61	1.49	1.67 ^c	1.54 ^b	821 ^b	2.2
Open	503	1.32	1.65	1.56	1.85	1.65	785	2.1
Forage								
Hay	530	1.33 ^c	1.64	1.56 ^d	1.83 ^d	1.64 ^c	810	2.1
No hay	531	1.08	1.62	1.48	1.69	1.55	795	2.2
Protein								
CSM	529	1.36 ^c	1.68 ^c	1.61 ^a	1.72	1.63 ^d	807	2.1
Urea	533	1.06	1.58	1.44	1.80	1.56	798	2.2
Weight group								
Heavy	578 ^b	1.09 ^d	1.58 ^d	1.45 ^b	1.74	1.54 ^b	841 ^a	2.2
Light	484	1.32	1.68	1.59	1.78	1.65	765	2.1

Statistically significant variation among the independent treatment effects:

^aSignificantly different ($P \leq .001$).

^bSignificantly different ($P \leq .01$).

^cSignificantly different ($P \leq .05$).

^dSignificantly different ($P \leq .10$).

¹Drift is expressed as the percentage of the final farm weight lost in transit from Greeneville to Knoxville, Tennessee (approximately 70 miles).

²28F-ADG: Average daily gain made the first 28 days of feeding. P28F-ADG: Average daily gain made during the post 28 day period on forage feeding (29th day through the 112th day). TF-ADG: Total forage feeding period average daily gain. C-ADG: Average daily gain made on concentrate feeding. T-ADG: Total average daily gain.

³Mu: The overall, least squares mean.

TABLE VIII
LEAST SQUARES MEANS FOR FINAL CONDITION SCORES
AND CARCASS DATA (THREE YEAR ANALYSIS)

Source	Final Condition Score	Fat ¹ Thickness (mm)	Marbling ^{1,2} Score	Dressing Percentage	Carcass Grade
Mu	9.8	7.3	6.9	56.9	10.0
Year					
1965	9.5 ^b	7.1	8.6 ^a	57.0 ^c	10.8 ^c
1966	9.9	7.6	5.2	57.2	9.8
1967	9.9	---	---	56.4	9.3
Pregnancy status					
Pregnant	9.8	7.7	7.0	57.0	9.9
Open	9.8	7.0	6.8	56.7	10.0
Forage					
Hay	9.9 ^d	7.6	6.9	57.2 ^b	10.1
No hay	9.6	7.1	6.9	56.5	9.8
Protein					
CSM	10.0 ^c	7.3	6.4 ^c	56.8	9.9
Urea	9.6	7.4	7.4	56.9	10.0
Weight group					
Heavy	10.1 ^b	8.3 ^a	7.6 ^b	57.2 ^b	10.1 ^d
Light	9.4	6.4	6.2	56.5	9.8

^aSignificantly different ($P \leq .001$).

^bSignificantly different ($P \leq .01$).

^cSignificantly different ($P \leq .05$).

^dSignificantly different ($P \leq .10$).

¹1965 and 1966 only.

²Coded marbling scores:

traces-:1	slight-:4	small-:7
traces :2	slight :5	small :8
traces+:3	slight+:6	small+:9

In Table VII, the independent treatment effects giving rise to animal performance variations are listed down the left-hand margin. The dependent performance variables are given as column heads across the top margin. The overall least squares mean, μ , is given as the first figures in each column to compare each treatment effect and its deviation from the overall mean, a composite of treatment effects plus variation due to experimental error.

Year Effects

Table IX gives the experimental error effects due to variation among the years 1965, 1966, and 1967. Unpublished data collected by the University of Tennessee indicates that 1966 was an exceptional year for the production of corn silage due to favorable growing and harvesting seasons. Relatively, 1965 was a poor corn silage season due to dry weather, and 1967 represented a normal corn silage year. The variation in heifer feedlot performance during the silage feeding phase followed a similar pattern with corn silage production, 1966 being the best year for heifer gains followed in order by 1967 and 1965 (TF-ADG, Table IX).

The variation in initial weight had one statistically significant ($P \leq .05$) difference; this was in the case of the 1966 heifers which were lighter than the 1967 heifers (Table IX). (Due to T-ADG differences favoring the 1966 heifers, this difference in initial weight was lost in the final weight.) In 1967, there was a highly significant reduction in 28F-ADG as compared to the other two years. The number of heifers aborting in 1967 may have had a bearing on the low 28F-ADG. In 1967,

TABLE IX
VARIATION IN FEEDLOT AND CARCASS CHARACTERISTICS
AMONG THE THREE YEARS

Year	Initial Weight	28F-ADG	P28F-ADG	TF-ADG	C-ADG	T-ADG	Final Weight	Drift	Final Condition Score	Dressing Percentage	Carcass Grade
M ₁	531	1.21	1.63	1.52	1.76	1.59	803	2.2	9.8	56.9	9.9
1965	536 ^{a,b}	1.31 ^A	1.33 ^A	1.32 ^A	2.08 ^A	1.55 ^A	786 ^a	2.4 ^A	9.5 ^a	57.0 ^a	10.8 ^A
1966	517 ^b	1.44 ^A	1.87 ^B	1.75 ^B	1.74 ^B	1.76 ^B	816 ^b	1.0 ^B	9.9 ^b	57.2 ^a	9.8 ^B
1967	540 ^a	0.87 ^B	1.70 ^B	1.49 ^C	1.45 ^C	1.48 ^A	806 ^{a,b}	3.1 ^C	9.9 ^b	56.4 ^b	9.3 ^C

A,B,C Means within a column not followed by a common capital letter differ significantly ($P \leq .01$) as determined by Duncan's new multiple-range test.

a,b,C Means within a column not followed by a common small letter differ significantly ($P \leq .05$) as determined by Duncan's new multiple-range test.

there were 20 pregnant heifers; in 1965 and 1966, respectively, there were 15 and 19. Differences in P28F-ADG show that 1965 was lower than the other two years, a highly significant difference ($P \leq .01$). TF-ADG variation due to year effect follows the variation in corn silage production; the 1966 T-ADG was significantly higher than the other two years. Comparisons of the final weight variation in Table IX show that 1966 heifers were significantly heavier than 1965 heifers. This difference in final weight is partially explained by the T-ADG coefficient of determination (.3614) given in Table XIV (see Appendix) and by the correlation coefficient (.6012) given in Table XV (see Appendix).

The variation in drift due to year was highly significant ($P \leq .01$) in each comparison. The drift in 1966 was the lowest followed in order by 1965 and 1967. Since the highest and only significant correlation (Table XV, see Appendix) between drift and the other dependent variables studied was .1836 with dressing percentage, accounting for 3.37 percent (Table XIV, see Appendix) of the variation in these two variables, drift does not appear to be highly associated with the more important economic considerations of animals such as were used in this study.

Variation due to year effects on final condition given in Table IX indicates that the 1965 heifers had a significantly lower final condition score in comparison to the other two years. Other carcass data statistically affected by variation in years was dressing percentage, 1967 being significantly ($P \leq .05$) lower than the other

two years, and carcass grade which was highly significantly ($P \leq .01$) different each year. Because of the relationship between final condition score and dressing percentage, 10.69 percent of the variation in these variables may be explained. Likewise, the relation between carcass grade and final condition permits 15.99 percent of the variation to be explained. Table VIII, page 20, shows that 1965 carcasses had a highly significantly ($P \leq .01$) greater marbling score than 1966 carcasses, and since marbling accounted for 63.62 percent of the variation in carcass grade, the 1965 carcasses would have been expected to have graded higher.

Influence of Pregnancy

Considering the pregnant versus open comparisons given in Table VII, page 19, there was a highly significant difference ($P \leq .01$) in 28F-ADG in favor of the open controls. These results are in line with the work of Hill and Pierson (1958), who reported that abortions began three days after injection and increased in frequency until about the tenth or twelfth day diminishing to about the twenty-fifth day following the injection. Therefore, abortion effects are evidenced during the first month following an intermuscular injection of DES. Following the first 28 day weight period, there was no statistical difference in forage rate of gain, even at the 10 percent level of probability.

Table VII shows that the difference in C-ADG was statistically significant ($P \leq .05$) in favor of open heifers. This difference and the apparent difference in gradient of the open versus pregnant heifer

cumulative gain curves in Figure 1 suggest the possibility of a physiological after-effect of abortion on performance of aborted heifers.

In 1967 the heifers were handled as in preceding years with the exception that half of the open heifers were given a 100 mg intermuscular injection of DES as were heifers determined to be pregnant. By having an open treated group, the effects of a 100 mg injection of DES could be identified. Figure 1 shows the cumulative feedlot gain made by the three heifer treatments in 1967. Because no statistical difference between open non-treated and open-treated heifers occurred (Table X), the effects of a 100 mg injection of DES were considered not to affect rate of gain in feeder cattle such as were used in this experiment. Table X, however, does show some statistically significant differences. Pregnant heifers were highly significantly ($P \leq .01$) heavier than non-pregnant heifers at the start of the 1967 trial. There also was a statistical ($P \leq .05$) difference between open-treated and pregnant-treated groups in favor of the open-treated group in 28F-ADG. Partly because the C-ADG was significantly different ($P \leq .05$) favoring open controls over pregnant heifers, the T-ADG (correlation .5264) was highly significantly ($P \leq .01$) different. Final weight for pregnant heifers was significantly heavier than for open-treated heifers. It should be pointed out that a highly significant difference in initial weight was lost in these two groups largely due to the differences observed during the 28F period. Initial weight explained 59.10 percent of the final weight, and 28F-ADG explained 7.86 percent of the final weight, as shown in Table XV (see Appendix).

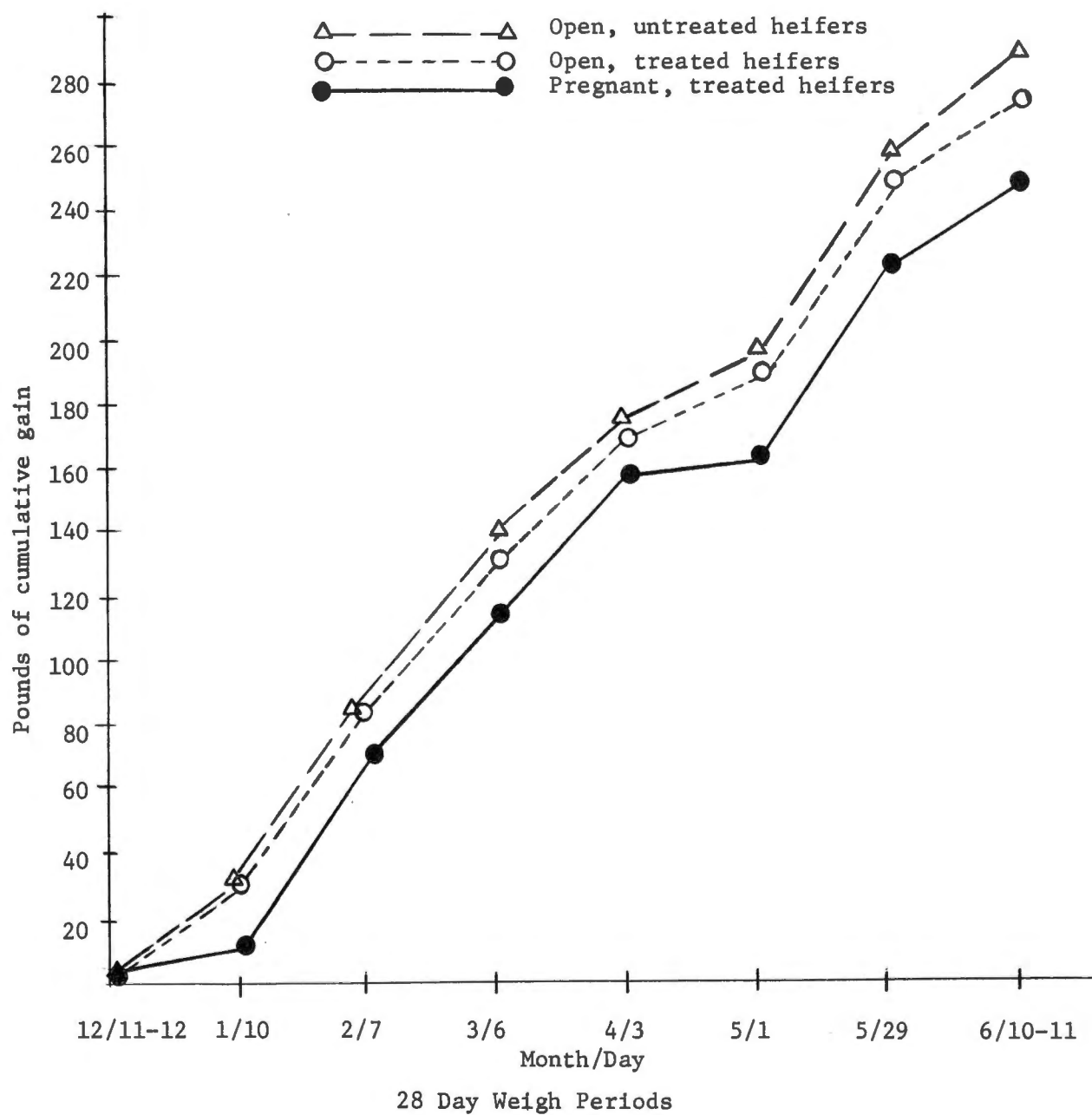


Figure 1. Cumulative gain of the 1967 heifers.

TABLE X

EFFECTS OF ABORTION AND OF 100 MILLIGRAMS OF DES (1967)

Heifers	Initial Weight	P28- ¹		TF-ADG	C-ADG	T-ADG	Final Weight	Drift	Dressing Percent	Final	
		28F-ADG	ADG							Condition Score	Carcass Grade
Pregnant-100 mg of DES	586 ^A	.58 ^a	1.53 ^a	1.40 ^a	1.32 ^a	1.37 ^A	833 ^a	3.4 ^a	56.9 ^a	9.9 ^a	9.2 ^a
Open-no DES	514 ^B	1.02 ^{a,b}	1.70 ^a	1.57 ^a	1.64 ^b	1.60 ^B	801 ^{a,b}	2.9 ^{a,b}	55.9 ^a	10.2 ^a	9.4 ^a
Open-100 mg of DES	492 ^B	1.12 ^b	1.60 ^a	1.54 ^a	1.50 ^{ab}	1.52 ^{A,B}	767 ^b	2.8 ^b	56.2 ^a	9.7 ^a	9.3 ^a

A,B,C Means within a column not followed by a common capital letter differ significantly ($P \leq .01$) as determined by Duncan's new multiple-range test.

a,b,c Means within a column not followed by a common small letter differ significantly ($P \leq .05$) as determined by Duncan's new multiple-range test.

¹P28-ADG is the post 28-day average daily gain referring to the rate of gain after the initial 28 days of feeding.

The difference in these two coefficients of determination is evidence of the effects of abortion.

Because there were no statistical differences due to the treatment effect of 100 mg of DES, all three years could be combined into a single analysis using only pregnant versus open (all pregnant heifers were treated) heifers.

Table XI gives the efficiency with which pregnant heifers were identified and aborted. Of the five pregnant heifers not aborted, one failed to receive a DES injection; two were determined to be open, and four failed to respond to treatment.

Hay Versus No Hay

Heifers which received two pounds of hay as compared to those receiving no hay, gained a quarter of a pound more per day during the first 28-day weigh period. This difference due to hay was statistically significant ($P \leq .05$). There was a slight improvement in the hay treatments during the entire forage phase which had significance at the 10 percent level of probability. Table VII, page 19, indicates a slightly significant ($P \leq .10$) favorable response to hay during the concentrate period. However, the combined effects of the forage and concentrate phases resulted in the total average daily gains being improved significantly ($P \leq .05$) by the addition of hay to the ration. With reference to the mathematical model, the slight increase in final weight of the heifers fed hay was non-significant.

Hay-fed heifers showed evidence of being somewhat fatter as indicated by the final condition score, a difference which was significant

TABLE XI

DATA ON INDIVIDUAL HEIFERS WHICH WERE PREGNANT
DURING THE FEEDING TRIALS

Year	Total Number	Total Pregnant	Percent Not Aborted	Identification of Heifers Not Aborted (Brand Number)	Starting Weight			Remarks
					Individual Pregnant Heifer	Average of All Pregnant Heifers	Total Average	
1965	60	15	13	64	537	536	525	Determined to be pregnant 3-4 weeks. Was given 100 mg of DES. Pregnant at slaughter.
				12	635	536	525	Determined to be 4 months pregnant. 35 pound calf born two weeks before slaughter. Was given 100 mg of DES.
1966	56	20	10	67	517	548	508	Determined to be open; not given 100 mg of DES. Eight month, 45 pound fetus at slaughter.
				54	690	548	508	Determined to be six months pregnant. Was given 100 mg of DES, calved two weeks before slaughter.
1967	56	20	5	83	725	585	531	Determined to be open but was lotted as a 1967 open treated heifer. Was given 100 mg of DES. Pregnant with full-term fetus at slaughter.

at the 10 percent level and by a slight, non-significant fat thickness (Table VIII, page 20). Hay did not result in an improvement in marbling scores or carcass grades. The difference in dressing percent, however, was highly significant.

There was no significant interaction between hay and weight group treatment. The average daily gain of heavy heifers fed hay during the concentrate phase of feeding was 0.34 pound more per day (Table XII). This difference, however, was non-significant.

Urea Versus Cottonseed Meal

Cottonseed meal significantly improved average daily gain during all the forage phases when compared to urea (Table VII, page 19). However, there was no significant differences in average daily gain made during the finishing period. T-ADG favored the heifers fed CSM compared to urea, a difference significant at the 10 percent level. These results are in agreement with many workers in the field. James S. Dinning, H. M. Briggs, and Willis D. Gallup (1949) showed urea nitrogen was most efficiently utilized on fattening rations than on maintenance rations in trials involving sheep and cattle. Work by H. M. Briggs, et al. in 1947 had shown a similar urea-energy relationship.

Analysis of the interaction between weight group and urea utilization showed no statistically significant variation although heavy heifers fed cottonseed meal gained 0.13 pounds more per day than heifers fed urea during the forage phase (Table XII). However, on concentrate feed, the heavy urea-fed heifers outgained those fed CSM by 0.11 pound per day. This result, although not statistically

TABLE XII
INTERACTION OF WEIGHT GROUPS WITH HAY
AND SUPPLEMENT TREATMENTS¹

Weight Group	Interaction		
	<u>Hay (expressed in average daily gain in pounds)</u>		
	<u>Hay²</u>	<u>No Hay</u>	<u>Improvement</u>
Heavy heifers	F-ADG 1.48	F-ADG 1.43	0.05
	C-ADG 1.86	C-ADG 1.52	0.34
	T-ADG 1.60	T-ADG 1.46	0.14
	44 observations	44 observations	
Light heifers	F-ADG 1.62	F-ADG 1.56	0.06
	C-ADG 1.86	C-ADG 1.77	0.09
	T-ADG 1.70	T-ADG 1.62	0.08
	44 observations	44 observations	
	<u>Protein Supplement</u>		
	<u>CSM</u>	<u>Urea</u>	<u>Balance</u>
Heavy heifers	F-ADG 1.52	F-ADG 1.39	0.13 CSM
	C-ADG 1.63	C-ADG 1.74	0.11 Urea
	T-ADG 1.54	T-ADG 1.51	0.03 CSM
	44 observations	44 observations	
Light heifers	F-ADG 1.67	F-ADG 1.51	0.16 CSM
	C-ADG 1.80	C-ADG 1.83	0.03 Urea
	T-ADG 1.71	T-ADG 1.61	0.10 CSM
	42 observations	42 observations	

¹None of these least squares mean values are statistically different.

²F denotes forage period.

C denotes concentrate period.

T denotes total period (forage and concentrate).

significant, is in line with the findings of others previously mentioned. The light, CSM-fed heifers outgained those fed urea by 0.16 pound per day during the forage phase. On concentrate feeding, the advantage was 0.03 pound per day for urea heifers, again emphasizing the need for high energy feeds when feeding urea for optimum urea utilization.

Weight Group Differences

The heifers were divided into light and heavy lots based on the initial weight. Generally, heavy heifers were a hundred pounds (578 versus 484) heavier than light heifers. As there were 27 light-pregnant and 27 heavy-pregnant heifers, the distribution of pregnant animals was uniform with respect to weight groups.

Light heifers had higher rates of gain throughout the feeding period than heavy heifers (Table VII, page 19). The increase in TF-ADG in favor of the light heifers was highly significant. The relationship between gains made on forage and the total gains (Table XV, see Appendix) explains 55.52 percent of the reason why light heifers had higher total average daily gains than heavy heifers, a highly significant difference.

Final condition scores and carcass differences were in favor of the heavy heifers (Table VIII, page 20). The average final condition scores, marbling scores, and dressing percentages were highly significantly different ($P \leq .01$) in favor of heavy heifers. Heavy heifers averaged 8.3 mm of fat at the 12th rib as compared to 6.4 mm for light heifers. This difference was significant at the 0.001 level of probability.

There was no significant interactions involving weight groups (Table XII, page 31).

Economic Considerations

Table XIII compares the cost of yearling heifers purchased at stockyard auction sales used in this study to those of similar weight and grade heifer calves purchased the same years through organized feeder calf sales. In order to qualify for feeder calf sales, heifers must be guaranteed open with a refund amounting to 20 percent of the initial cost in the event of pregnancy. In addition, feeder calves must be sired by a registered beef bull and out of a beef type cow.

TABLE XIII
FEEDER HEIFER PURCHASE PRICES

Year	Heifers Used in These Trials (\$ / cwt.)	Heifers Sold in Feeder Calf Sales (\$ / cwt.)	Difference
1965	\$15.75	\$20.08	\$4.33
1966	19.03	23.63	4.60
1967	18.20	23.05	4.85

¹Tennessee Department of Agriculture, "Tennessee Feeder Calf Sales," 1965, 1966, 1967, Summaries.

In the years 1965, 1966, and 1967, heifer calves of the same weight and grade sold through feeder calf sales averaged \$4.59 per hundred pounds more than the yearling beef heifers used in this study.

This differential gave an average advantage of \$23.91 per head in initial purchase price to the yearling heifers of this study. An analysis of the total rate of gain showed that pregnant yearling heifers gained 1.54 pounds per day as compared to 1.65 pounds for open yearling heifers. This gave 0.11 pound, ADG reduction to the pregnant heifers of this study. At 171 average total days of feeding, pregnant heifers gained 18.81 pounds ($171 \text{ days} \times 0.11 \text{ lb.} = 18.81$) less than the open heifers. At 24 cents per pound, \$5.64 was discounted against the pregnant heifers. Thus, \$23.91 (the financial advantage given to all yearling heifers in comparison to the cost of equivalent weight and grade heifer calves) less \$5.64 still leaves \$18.27 advantage in favor of yearling pregnant heifers showing evidence of beef breeding and purchased without regard to pregnancy status, on a per head basis and a \$23.91 advantage for those which were nonpregnant.

CHAPTER V

SUMMARY

There were three objectives in this study using medium grade yearling feeder heifers. The first objective was to determine the effects of abortion on the performance of such heifers. Secondly, the effects of adding good quality alfalfa hay to feeder cattle rations were to be identified. A third objective of this study was to determine the relative effects of using urea versus cottonseed meal in feeder heifer rations.

In 1965, 1966, and 1967, 172 heifers were purchased for this experiment conducted at the Tennessee Tobacco Experiment Station. During the second week of December in each year, a pregnancy determination was made on each heifer. At this time a 24 mg ear implant of DES was given each heifer along with a two-day average initial weighing. In addition, pregnant heifers were given an intermuscular, 100 mg injection of DES. The heifers were then allotted according to weight groups and pregnancy status. In 1967, approximately half of the open heifers received a 100 mg DES injection. Pregnant heifers were lotted uniformly to all subclasses. Each year approximately one-third of the heifers were pregnant.

The heifers were fed for an average of 171 total days. The total feeding period was divided into two phases. During the initial feeding (113 days), one half of the heifers received a ration consisting of a full feed of corn silage, one pound of protein supplement,

and five pounds of ground ear corn. The other half received the same ration plus two pounds of hay per head per day. Half of the heifers in each of these two groups (hay versus no hay) received the necessary additional protein from CSM while the other half were given a high urea supplement. In the second phase, after a 3-4 day transition period, they were full fed ground ear corn. The hay and protein source variables were continued in this phase lasting an average of 58 days.

The use of 100 mg of DES, injected intermuscularly, aborted approximately 92 percent of the heifers determined to be pregnant. This effect was reflected in a significant difference in the average daily gains during the first 28 days of feeding. However, there were no differences in average daily gains in the remainder of the forage feeding period. The heifers pregnant at the start of the experiment gained 0.11 pound less per day during the entire experimental feeding period (171 days). There was a significant increase in average daily gain when two pounds of hay per day was added to the ration in both the initial 28 day period and in the total feeding phase.

Heifers receiving CSM as a protein source gained at a significantly faster rate than heifers receiving the high urea supplement during the forage phase of feeding. However, no differences were observed in the concentrate phase of feeding.

This study shows that medium grade, yearling heifers with evidence of beef breeding can be successfully aborted and fed as feeder cattle producing carcasses grading average good and which are acceptable in the current market. Due to an initial price differential (\$4.59/cwt. in this study) when compared to heifer calves of similar weight and

grade, the heifers in this study proved to be profitable in spite of the fact that approximately one-third of the yearlings were pregnant when purchased.

The average daily gain during the forage phase were 1.75 (1966), 1.49 (1967), and 1.32 (1965). These differences were highly significant and they coincided with the quality of forage produced each year with 1966 being an above average year, 1967 being a near normal year, and 1965 being a poor corn silage year (unpublished data by the University of Tennessee).

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APPENDIX

TABLE XIV

COEFFICIENTS OF DETERMINATION

Item	28- ADG	P28- ADG	TF- ADG	C-ADG	T-ADG	Drift	Initial Weight	Final Condition Score	Carcass Grade	Dressing Percent	Marbling Score	Fat Thickness (mm)
28-ADG												
P28-ADG	.0032											
TF-ADG	.3156	.2535										
C-ADG	.0007	.3772	.0033									
T-ADG	.2165	.7254	.5552	.2771								
Drift	.0058	.0041	.0099	.0001	.0104							
Init. wt.	.0003	.0017	.0003	.0045	.0023	.0031						
Final wt.	.0786	.2637	.2137	.0813	.3614	.0004	.5910					
Final condition	.0651	.0250	.0566	.0027	.0703	.0143	.1217	.1992				
Carcass grade	.0033	.0070	.0113	.0041	.0123	.0060	.0349	.0487				
Dress percent	.0191	.0000	.0172	.0259	.0044	.0337	.0783	.0698	.0622			
Marbling score	.0133	.0089	.0285	.0098	.0186	.0022	.0227	.0460	.6362	.0007		
Fat thickness	.0744	.0048	.0519	.0428	.0088	.0001	.1056	.1628	.1093	.1186	.0486	

TABLE XV

SIMPLE CORRELATION COEFFICIENTS

Item	28-ADG	P28-ADG	F-ADG	C-ADG	T-ADG	Drift	Final			Fat
							Initial Weight	Final Weight	Condition Score	
Carcass Dressing Marbling Thickness										
Item	28-ADG	P28-ADG	F-ADG	C-ADG	T-ADG	Drift	Initial Weight	Final Weight	Condition Score	Carcass Dressing Marbling Thickness
28-ADG										
P28-ADG	-.0565									
TF-ADG	.5618 ^a	.5035 ^a								
C-ADG	-.0256	.6142 ^a	-.0579							
T-ADG	.4653 ^a	.8517 ^a	.7451 ^a	.5264 ^a						
Drift	.0763	.0638	.0994	-.0095	.1019					
Init. wt.	-.0179	-.0411	-.0168	-.0668	-.0481	-.0556				
Final wt.	.2804 ^a	.5135 ^a	.4623 ^a	.2852 ^a	.6012 ^a	.0212	.7688 ^a			
Final condition	.2553 ^a	.1583 ^b	.2380 ^a	.0516	.2651 ^a	-.1194	.3489 ^a	.4463 ^a		
Carcass grade	.0577	.0839	.1063	.0643	.1109	-.0775	.1869 ^b	.2206 ^a	.3999 ^a	
Dress percent	.1383	.0038	.1311	-.1608 ^b	.0661	.1836 ^b	.2798 ^a	.2642 ^a	.3269 ^a	.2495 ^a
Marbling score	.1152	.0944	.1687	.0988	.1363	-.0467	.1508	.2145 ^b	.3241 ^a	.7976 ^a -.0266
Fat thickness	.2727 ^a	-.0690	.2278 ^b	-.2069 ^b	.0938	-.0083	.3250 ^a	.3258 ^a	.4035 ^a	.1390 .3444 ^a .2204 ^b

^aHighly significant ($P \leq .01$).^bSignificant ($P \leq .05$).

VITA

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