August 17, 1973

To the Graduate Council:

I am submitting herewith a thesis written by Ben David Lee entitled "A Study of the Factors Affecting the Cost of Raising Replacement Beef Heifers." 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 Science.

George M. Mermon
Major Professor

We have read this thesis
and recommend its acceptance:

B. G. Hicks

E. R. Lidvall

Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

A STUDY OF THE FACTORS AFFECTING THE COST OF RAISING REPLACEMENT BEEF HEIFERS

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

Ben David Lee

December 1973

ACKNOWLEDGMENTS

The author wishes to express his sincere gratitude to the following persons:

Dr. George M. Merriman, major professor, who has given guidance, advice, and encouragement throughout the graduate program.

Professor Ed R. Lidvall for his suggestions and assistance in handling the data.

Dr. Bill G. Hicks for his valuable suggestions.

Miss K. R. Gilbert for typing and understanding during the preparation of this thesis.

Mr. and Mrs. Ben Lee, his parents, for their encouragement and aid during the graduate study.

Mr. Hugh Felts, Mr. Jack Martin, Mr. Bob Snyder, Mr. Joe High, Mr. Lawson Safley, and Mr. James Bryan, Station Superintendents who gave assistance in collecting the data.

Fellow graduate students who gave friendship and assistance throughout the study.

1117454

ABSTRACT

This study was conducted to examine the importance of various factors affecting the cost of raising replacement beef heifers under a variety of Tennessee conditions. It involved determining which factors were of the greatest importance and how these factors differed in determining the cost involved in raising a replacement.

The data for this study were taken from available records on the herds at seven of the University of Tennessee Experiment Stations. They were derived from personal interviews with the superintendents of the stations involved, and from Tennessee market reports published by the U.S.D.A. A four year period, 1969-1972, was studied. The factors investigated included productivity and fertility of the cow herd; breeding costs; death losses and illnesses in the herd; feeding costs; management practices of dehorning, vaccinating, and weaning; and finally labor costs.

After evaluating these factors, an investigation was made to determine whether, under given conditions, the rearing or purchasing of replacement heifers was more economical. Budgets set up in this study indicate that adding replacement heifers for calving as two-year-olds by purchasing them from Tennessee feeder calf sales is less economical than rearing them from birth. With the fluctuation of feed and beef prices, a producer must evaluate the cost factors shown in this study and decide which method of obtaining replacement beef heifers, by purchase or by on-the-farm rearing, would be most economical.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	LITERATURE REVIEW	3
	Size of Cow Herd	3
	Fertility	3
	Development and Breeding Techniques	4
	Death Losses and Illnesses	6
	Nutrition	9
	Management Practices	12
	Labor	13
III.	EXPERIMENTAL PROCEDURE	14
	Source of Data	14
	Experiment Station Herds and Management Practices	14
	Use and Organization of the Data	15
IV.	RESULTS AND DISCUSSION	16
	Productivity and Fertility of the Cow Herd	16
	Cost of Natural Breeding Service Per Calf	25
	Brood Cow Death Losses	27
	Costs Incurred by Illnesses Among Calves	27
	Feeding Costs	29
	Management Practices of Dehorning, Vaccinating, and Weaning	33
	Cost of Labor	35

CHAPTER PAGE

Budgets Comparing Raising to Buying Replacement Heifers on Hay or Silage Feeding Systems 36

V. SUMMARY AND CONCLUSIONS 41

LITERATURE CITED 43

APPENDIX 46

VITA 55

LIST OF TABLES

TABLE		PAGE
I.	Percentage of Conception Failures Among Beef Cows by Station and Year	17
II.	Birth Rate Percentages Among All Cows Bred by Station and Year	19
III.	Percentage of Viable Calves Born Based on Total Cows Bred and on Total Calves Born by Station and Year	20
IV.	Percentage of Calves Weaned Based on Cows Bred and on Total Calves Born by Station and Year	21
V.	Percentage of Heifers Kept as Replacements Based on Cows Bred by Station and Year	23
VI.	Number of Heifers Weaned and Number Kept as Replacements by Station and Year	24
VII.	Number of Calves Born, Calves Weaned, and Replacement Heifers Kept Per Bull on Highland Rim and Tobacco Experiment Stations by Years	26
VIII.	Number of Brood Cow Deaths by Station and Year	28
IX.	Pasture and Hay Requirement for 10-Cow Unit	31
X.	Average Total Annual Consumption of Feed Per Cow and Feed Per Heifer on the Experiment Stations	32
XI.	Average Tennessee Feed Costs, 1969-1972	34
XII.	Estimated Expenses for Raising from Birth Six Replacement Heifers in a Thirty-Cow Herd; Hay Fed as Roughage	37

TABLE PAGE

XIII. Estimated Expenses for Raising from Birth Six Replacement Heifers in a Thirty-Cow Herd; Silage Fed as Roughage 39

XIV. Number of Open Cows and Heifers by Station and Year . . 47

XV. Number of Cows Bred and Calves Born by Station and Year 48

XVI. Number of Calves Born and Viable Calves Born by Station and Year 49

XVII. Number of Calf Deaths and Calves Sold Pre-Weaning by Station and Year 50

XVIII. Number of Cows Bred and Number of Heifers Kept as Replacements by Station and Year 51

XIX. Number of Bulls Used for Natural Breeding on the Highland Rim and Tobacco Experiment Stations by Year . 52

CHAPTER I

INTRODUCTION

Beef cattle production is an important agricultural enterprise in Tennessee. According to the Agriculture Census, 1972, there are nearly two million beef cattle in the state with 1,243,000 of these being cows and heifers in breeding herds. Many of these are in cow-calf herds as part of a diversified farming operation. The total number of farms in Tennessee in 1970 with beef cows and calves was approximately 37,500, with almost 50 percent of these having between 20 and 50 head of cattle. This is a substantial decrease in the number of farms from 1960 and this trend has still not changed. Part-time operators run almost 50 percent of these farms and this percentage is increasing yearly as it has since 1960. Seventy-five percent of the farms in Tennessee with beef cattle are oriented toward the production of feeder calves and not to the feeding of cattle.

Since 1960, Tennessee's beef brood cow numbers have increased from 492,000 to 1,029,000 in 1972 and the heifer numbers have increased from 128,000 to 214,000. The total number of cows and heifers increased at an overall rate of 67 percent from 1962-1972. For the state to produce the same increase by say, 1980, the farmer must continue to improve his herd as well as increase its size by raising or buying replacements. There is a great need for economical replacements in Tennessee herds. Although there is no set turnover rate in the beef herds, a 20 percent replacement of brood cows is a minimum figure

suggested in order to maintain herd size and allow for a certain degree of culling or to improve herd quality.

Many Tennessee farmers sell their heifers as feeder calves and do not keep a very large percentage to use for replacements. This is a result of apparent profits obtained from the feeder calf sales in the state. Whether a farmer gains more from selling his heifers or keeping them and culling his cows is basically up to him and is regulated by his type of operation.

The objective of this study was to examine several cost factors involved in raising replacement beef heifers under a variety of Tennessee conditions. The total costs of raising these heifers has then been compared to the cost of buying replacement heifers as 450 pound calves at Tennessee feeder calf sales and raising them to first calving.

CHAPTER II

LITERATURE REVIEW

References found in the literature indicate the importance of various factors involved in raising replacement beef heifers. These are discussed in this review.

I. SIZE OF COW HERD

The size of a beef herd is dependent upon the amount of feed, land, labor, and capital available. The relative size of the herd is governed by many aspects which directly affect the number of replacement heifers raised and needed annually. The cost of raising these replacements differs from herd to herd and Tyrrell (1964) reports that the number of replacements raised is affected by the number of quality heifers born and that the number eventually used is dependent upon the quality of management and how well the herd is kept from year to year.

II. FERTILITY

The longer brood cows remain productive in a herd the fewer replacements will be needed, and thus the costs of growing out replacements to productive age will be reduced. However, the longer a cow remains in a herd the longer will be the generation interval which may reduce the rate of genetic improvement from selection (Snapp and Neumann, 1969). Franke (1973) reports that the economic return and fertility improvement in the beef herd is affected mostly by the

replacement of open cows. The reproductive rate in the cow herd is the most important single factor contributing to profit. Cows which do not rebreed in a controlled breeding season but which are allowed to remain in the herd are a liability because they cost money to maintain but do not yield anything in return. Franke also states that consistent culling of open cows will result in selling more pounds of beef per head as well as a greater concentration within the herd of highly fertile cows. The farmer, by consistent culling, not only gets rid of alternate-year breeders and/or problem breeders, but also eliminates some diseased cows and/or unadapted cows.

Tyrrell (1964) states that in Tennessee beef herds the greatest single factor determining profit or loss is the percentage calf crop. A breeder raising his calving percentage from 80 to 90 is accomplishing the same results as producing 50 pounds of additional weaning weight to the calves produced by each cow in his herd. Also each cow failing to have a calf in a given year takes the profits of 2 1/2 cows in the herd. According to Tyrrell, some of the leading causes of low calf crop percentages in a herd are: "Failure of a cow to conceive; lack of attention during the breeding season or at calving time; loss of calves by trampling, drowning, or attacks by dogs; a poor culling program; and disease."

III. DEVELOPMENT AND BREEDING TECHNIQUES

Management practices during the period from birth to first lactation may influence lifetime productivity as reported by Cole (1966). The development of the beef heifer is determined in part by

her inherent capacity for growth, and studies by Chambers (1954) indicated that a heifer should weigh a minimum of 600 pounds before she is bred. Heifers bred at this weight tend to have less trouble calving than do smaller heifers. Well-fed heifers reach this age as yearlings, but other factors may make it feasible to delay breeding beyond one year of age. Hobbs (1964) found that early research at Pennsylvania, Kansas, Oregon, and Montana that when heifers calve as two-year-olds, they must have made excellent growth prior to calving and have plenty of feed during the following year or they may be stunted and fail to produce properly in the future. Nutrition is an important aspect of the breeding program.

Results of tests at Oklahoma from 1948-55 indicate that although heifers calving as two-year-olds needed more assistance at first calvings and lose on the average of one more calf during their lifetime they produce on the average of about 0.7 more calf during their lifetime than do heifers calving as three-year-olds. This data is in agreement with information published by Tyrrell (1964) indicating that lifetime returns per female may be increased up to $100 by calving heifers as two-year-olds. These same studies indicate that with natural breeding, the heifers should be bred after the bull has settled the older cows to allow for more growth of the heifers. Because of the rapid bone growth occuring in heifers when being bred for calving at a 2 to 2 1/2 years of age, Hobbs (1964) recommends that if possible, a light-boned bull should be used to breed the heifers and the larger bulls used for the older cows.

In Tennessee, fall calving programs are not recommended for cows and heifers (Tyrrell, 1964). Fall calves have not been as

profitable as late winter and early spring calves. Slower gains, bad weather, and other factors oppose fall calving. Records from the Tennessee Beef Performance Testing Program show that winter and spring calves make the fastest rate of gain and that the lower costs of producing spring calves more than offsets the extra price average of fall calves.

Zmolek and Gay (1969) reported that although much less labor is required and management is not so critical when natural rather than artificial insemination (AI) service is used, it is essential that artificial insemination may be used. Ensminger (1965) reported that using AI increases the use of outstanding sires and makes it possible to overcome certain physical handicaps to mating. AI also lessens the sire cost and helps to control diseases possibly spread by natural mating. Although these advantages mentioned are impressive to the breeder, there are also limitations to AI. Ensminger also states that the use of AI requires skilled technicians and competent managerial ability to operate efficiently. AI also may accentuate the dangers of using a genetically inferior sire and its use must conform to physiological principles.

IV. DEATH LOSSES AND ILLNESSES

Beef cattle, unlike most other livestock, are subject to relatively few ailments and diseases that are likely to result in death (Snapp and Neumann, 1969). Losses among calves and yearlings are, of course, higher than for mature cattle, but even here they are far below those for young pigs and lambs. Merriman and Hobbs (1962)

as an adjunct to research with fluorides in beef cattle recorded calving difficulties which had no relationship to fluorine levels. Of a possible 331 gestations, there were 313 births and 283 (85 percent) of these calves survived to weaning age. Dystocia, exposure, scours, and congenital weakness frequently account for 10 to 15 percent of deaths of calves born (Tyrrell, 1964). In Tennessee herds, the loss of calves over one month old but under weaning age is usually small. Pneumonia, bloat and various accidents claim an occasional calf during this period of life according to Tyrrell (1964).

Merriman (1967) reported death losses among spring and fall calves over a five year period at seven University of Tennessee Experiment Station beef herds. Of the 3,712 spring parturitions, 93 percent of the calves were born alive, and 91 percent survived to weaning. In the fall calving seasons, a total of 765 calves were born and 92 percent of these calves survived to weaning. During the five years, 325 spring calves died and 75 percent of these deaths occurred at birth. Deaths among fall calves for all years combined totaled 59, with 42 percent of these occurring at birth. Hereford and Angus breeds were used and survival rates were nearly identical for the two breeds. These figures represent a loss of 384 calves from 4,477 births. These calves, had they lived to reach an average weaning weight of 450 pounds, could have been expected to gross a minimum of about $100 per head or a total of $38,400 as feeder calves. Snapp and Neumann (1969) state that the death losses should be added to the laid-in price of the cattle before final calculations of profit or loss are made.

Merriman (1970) reports that surveys conducted by Dr. Sam W. Woods, Jr. in 1969-70 in Rutherford County, Tennessee revealed that there was one confirmed death due to grass tetany per 1400 cows in that county. Based on these figures, tetany represents the largest single killer of mature cattle in Tennessee. Since the disease usually strikes cows within six weeks following calving, it also is responsible for many orphaned calves.

Calf scours is an infectious diarrhea of calves usually occurring within the first two weeks of life. This disease is among the major calf diseases and has proven to be costly to farmers in Tennessee (Merriman, 1973). Martin (1973) estimates that scours infect approximately 40 percent of the 200 or more calves in his calf crops annually.

Nearly every cattle operator who buys or sells a few animals every year is aware of the respiratory disease most frequently found in feeder calves 3 to 21 days after weaning or shipping. This is referred to as shipping fever and work conducted by the U.S.D.A. as quoted by Merriman (1973) has shown that calves are made susceptible to a bacteria by stress and by virus infection. This disease can spread rapidly through cattle and preventive measures should be taken to keep this costly disease from a herd (Merriman, 1973).

The above three diseases (grass tetany, calf scours, and shipping fever) have been found to be the most costly beef cattle diseases in Tennessee. A herd health program followed closely will help to reduce costs of treatment and save the farmer much time and money (Tyrrell, 1964).

V. NUTRITION

Publications by the U.S.D.A. in 1970 state that feeding of the first-calf heifer, calf birth weight, calving difficulty, and post partum reproduction of the heifer are all matters of mutual concern while she is pregnant. Some problems in calving can be avoided by providing adequate nutrition without overfeeding. Bellows (1970) and U.S.D.A. authors state that the first winter after a heifer is weaned may be the most important season of her life. Nutrition during that time can condition her to be a high or low lifetime producer. The same author found that a heifer probably will not conceive early in the breeding season if she is not in good condition. His research showed that a well-conditioned heifer settles early and continues to do so in following breeding seasons.

Dr. Bellows studied the effects of winter weight gains on 89 Angus-Hereford heifers. Wintering gains in three groups were held at 0.5, 1.0, and 1.5 pounds per day by adjusting feed levels. Marked differences were noted in heifers at breeding time. The high-conditioned group reached puberty at an average age of 388 days as compared with 434 days for low-conditioned heifers and 412 days for the middle group. Eighty-three percent of the high-conditioned heifers were in heat before the standard breeding season and the remaining 17 percent during the breeding season. This meant a possibility of a 100 percent calf crop. On the other hand, only 7 percent of the low-conditioned heifers were in heat before and 73 percent of them in heat during the breeding season. The other 20 percent did not come into heat until

after the breeding season. This meant a chance for only an 80 percent calf crop. The following calving season, 87 percent of the high-conditioned heifers proved to be pregnant while only 50 percent of the low-conditioned heifers were with calf.

Research on replacement heifers at the University of Florida showed a significant difference between the weights of heifers raised on different levels of protein. Warnick (1965) reporting on these experiments, confirmed that heifers raised on clover-grass pastures were 104 lbs. heavier at 30 months of age than those on straight grass pastures, while heifers receiving the high protein supplement were 40 lbs. heavier than the low protein group. The different programs had a significant effect ($P > 0.05$) on calving percent. The heifers raised on clover-grass pastures had a 96 percent calving rate as compared to 81 percent for heifers raised on grass pastures. The heifers raised on clover-grass weaned an 89 percent calf crop versus 76 percent for those raised on grass pastures. Heifers fed a high protein level had an 87 percent calving rate compared to 88 percent for those heifers on low protein level. The program under which replacement heifers were grown had no significant effect on age, daily gain, or slaughter grade of their calves at weaning.

Snapp and Neumann (1969) suggested that rations for heifer calves that are to be kept for herd replacements should be composed principally of the better quality roughages available on the farm. The level of gain desired depends upon whether the heifers are to drop their first calves at 2 or at 3 years of age. If the heifers calve first as two-year-olds, adequate winter development prior to

breeding the following summer is necessary. If the heifers are bred to calve as three-year-olds, they can be wintered differently. In either case the equivalent of 1.25 to 1.50 lbs. of high-level protein concentrate should be fed daily.

Snapp and Neumann (1969) report that in some respects silage is more useful for feeding heifer calves than for older animals because calves are fed for a much longer time and therefore have a greater need for variety and succulence in their rations. SaLoutos (1967) agrees with Ensminger (1962) in his views that a balanced ration for livestock can be made up mostly of home grown feed, both grains and roughages, supplemented with small amounts of high protein concentrate and minerals. Ensminger, in stating that three usages for grasses are pasture, hay, and silages, gives advantages of silage feeding. Among these are: (1) silage retains a higher percentage of the nutrients of plants than can be accomplished by hay making; (2) silage makes possible the maximum quantity of feed per acre of land; (3) silage requires less storage space per lb. of dry matter than dry hay; and (4) it is a better source of protein and certain vitamins than dried forages. On the other hand, silage may not be advantageous because it requires a silo and special equipment for best results, more tonnage must be handled as silage than as hay due to the high moisture content, and there is an added expense of perservatives.

Tyrrell (1964) suggests that the ration for bulls before the breeding season should be made up of grain mixture, protein supplement, and mineral mixture. The grain should contain one-half corn and one-half oats by actual weight, and be fed at the rate of 1/2 to 1 lb.

of grain for each 100 lbs. live weight of the bull. The protein supplement should be fed at the rate of 1 to 1 1/2 lbs. per day per bull and the mineral mixture always available. During the breeding season, grass alone should be sufficient to maintain the mature bull.

VI. MANAGEMENT PRACTICES

Clark et al. (1959) discussed important management practices that should affect the raising of all cattle. Among them are dehorning, branding, and marking. Calves are usually dehorned for the convenience of handling. Whatever method the cattleman uses, he will find that dehorned calves return more money per hundred-weight than horned calves.

Although methods of handling cattle have changed since the earliest days of cattle raising, branding and marking as means to identify cattle are still widely practiced. Early branding before the calf is weaned lessens the possibility of losses and marking the calves with tages or ear notches can aid in identification.

The American Veterinary Medical Association (1968) also recommends as part of a management system, a vaccination program that includes the use of blackleg and malignant edema bacterin. These should be given at 2 months of age and again at 4 months of age accompanied at the second treatment by IBR and PI-3 vaccines. The IBR and PI-3 should be repeated again at 5 months of age. Accurate and current records should be kept on all animals.

VII. LABOR

Beef cattle require little labor compared with dairy cattle and hogs or with cultivated crops occupying an equal area of land (Snapp and Neumann, 1969). Of the labor that is required, the largest part is needed during the winter and early spring when there is little demand for labor in the fields (Ray and Walch, 1973). Beef cattle farming thus tends to distribute the labor during the winter and lessening the summer demand for labor by using part of the tillable land for hay and pasture. Beef cattle farming can show greater profits by more efficient labor practices.

Part-time beef raisers may hire short term workers and Anderson (1971) states that the optimum number of beef heifers to feed is dependent upon not only the size of farm and predominant ration, but also upon the labor supply. When feeding systems including silage and hay-making are used, seasonal labor is sometimes required and this has been found to dictate the size of the operation to which a farmer could possibly expand.

Ray and Walch (1973) found in their research that labor requirements are proportional to the size of farm. Large numbers of livestock tend to justify more labor-saving equipment and larger machinery is normally used on farms with large crop acreages. Studies indicate that there is a greater number of man hours required in a hay feeding system than there is for a silage feeding system. Machinery costs differ according to size of farm.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF DATA

The data for this study were taken from information collected by personal interviews with experiment station personnel of seven sub-stations of the University of Tennessee Experiment Station, and from experiment station data kept at the Animal Science Department, University of Tennessee on herd sizes, replacement rates, fertility, productivity, and cow and calf losses for the years 1969-1972. A sample of the questionnaire that the superintendents were asked to complete is found in the Appendix.

Spring-born heifers were the basis of this study because the majority of calves born on the stations were of spring births and spring calving is recommended for beef producers in Tennessee by the University of Tennessee Animal Science Extension Department. Market reports were reviewed on feed prices and sales reports on feeder calf sales in Tennessee from 1969 to 1972.

II. EXPERIMENT STATION HERDS AND MANAGEMENT PRACTICES

The animals studied on the experiment stations consisted primarily of Angus and Herefords and a small number of Charolais and crossbreds. The stations are located across the state as follows: Main-Blount and Main-Alcoa near Knoxville; Tobacco near Greeneville; Plateua near Crossville; Middle Tennessee near Columbia; Highland Rim near Springfield;

and Ames Plantation near Grand Junction. During visits to the stations, observations were made by the author to aid in determining overall practices by the superintendents.

III. USE AND ORGANIZATION OF THE DATA

The information collected from visits to the stations, interviews, questionnaires, and herd data was reviewed and seven factors influencing the cost of raising a replacement beef heifer were considered. These related to areas of productivity and fertility of the cow herd, natural breeding, brood cow death losses, illnesses and deaths among calves, feeding, dehorning and marking, and labor. After analysing these factors, a total cost of raising a replacement heifer from birth to calving as a two-year-old was figured into a budget and these costs compared to those cost figures of buying a replacement at weaning (450 pounds) and raising her to calving age at two years.

CHAPTER IV

RESULTS AND DISCUSSION

A total of seven major factors affecting the cost of each replacement heifer raised was studied and the results reported herein. Because of incomplete information on fall calves, only spring-born calves are included in this study.

I. PRODUCTIVITY AND FERTILITY OF THE COW HERD

The total number of beef females in the breeding herds of the University of Tennessee Experiment Stations was tabulated for the years 1969-1972. Of a total of 4,745 cows and heifers bred, the total number of conception failures (open cows) was 725, a percentage of 15.3 percent, with a range of 3.6 percent at Blount in 1969 to 31.7 percent at Middle Tennessee in 1970 (Table I). These percentages vary because of different management practices, diseases, and undetermined causes. All of the Experiment Stations tend to breed a majority of their cows by natural services now because, according to information from the superintendents, they have had fewer open cows as compared to AI service. Because open cows cost money to maintain and do not yield anything in return, they are a liability (Franke, 1973). The station superintendents culled all open cows that did not conceive the previous calving season. This helps to reduce the number of non-producing cows. A small percentage of open cows results in a large percentage of calf births.

TABLE I

PERCENTAGE OF CONCEPTION FAILURES AMONG BEEF COWS BY STATION AND YEAR[a]

Experiment Station	1969	1970	1971	1972	Average
Main - Blount	3.6	10.3	15.3	5.8	8.8
Main - Alcoa	20.7	8.7	15.9	10.3	13.9
Tobacco	16.5	8.4	4.5	5.9	8.8
Plateau	20.6	15.6	19.3	12.3	17.0
Highland Rim	11.9	8.6	7.8	4.6	7.7
Middle Tennessee	30.7	31.7	27.5	19.0	27.2
Ames Plantation	14.9	17.5	24.4	15.7	18.1
Average (of Totals)	18.0	14.0	17.9	11.2	15.3

[a]Refer to Appendix, Table XIV for detailed figures on open cows.

There was a total of 3,984 full term births in the four year period studied. The overall birth rate percentage (Table II), based on all cows bred, was calculated for the seven herds and ranged from 96.4 percent at Blount in 1969 to 68.3 percent at Middle Tennessee in 1970 with an overall average of 84.4 percent. The Tobacco Station herd had an outbreak of Leptospirosis in 1969 and this lowered their percentage of calves born for that one year.

The total number of births at all stations was categorized into viable and non-viable calves. The viable calves were those living at least 36 hours post parturition and non-viable calves were those that died at birth or within 36 hours after birth. Those cows that conceived but failed to give birth either aborted, absorbed the fetus, or were misdiagnosed when examined for pregnancy. An overall figure of 92.7 percent viable calves was calculated for all herds studied (Table III). Merriman (1967) in earlier studies reported that on the same seven stations for five years, 93 percent of the calves were born alive and 91 percent survived to weaning. However, 75 percent of those deaths occurred at birth compared with 65.7 percent of the deaths occurring at birth in the present study.

Loss of calves from the herds by death or by selling prior to weaning was tabulated and the total percentage of calves weaned was calculated (Table IV). For the seven herds the overall percentage of calves weaned was 88.7 percent based on a total number of calves born and 74.8 percent based on a total number of cows bred. The percentage of calves weaned, based on total number of calves born ranged from 79.5 percent in 1969 at Alcoa to 96.2 percent at Ames

TABLE II

BIRTH RATE[a] PERCENTAGES AMONG ALL COWS BRED[b] BY STATION AND YEAR

Experiment Station	Year				Average
	1969	1970	1971	1972	
Main - Blount	96.4	87.9	84.7	92.3	90.3
Main - Alcoa	79.3	89.5	82.8	89.7	85.3
Tobacco	70.9	91.6	95.5	94.1	88.0
Highland Rim	88.1	90.5	90.4	95.4	91.1
Middle Tennessee	69.3	68.3	72.5	81.0	72.8
Ames Plantation	82.7	80.7	75.6	84.3	80.8
Average	80.9	84.6	83.1	89.2	84.4

[a]Includes viable and nonviable births.

[b]Refer to Appendix, Table XV for detailed numbers on birth rate.

TABLE III

PERCENTAGE OF VIABLE CALVES BORN BASED ON TOTAL COWS BRED AND ON TOTAL CALVES BORN BY STATION AND YEAR[a]

Experiment Station	1969		1970		1971		1972	
	Cows Bred	Calves Born	Cows Bred	Calves Born	Cows Bred	Calves Born	Cows Bred	Calves Born
Main - Blount	91.1	94.4	83.2	94.7	76.5	90.3	86.5	93.3
Main - Alcoa	68.8	86.7	91.1	90.6	79.6	95.0	81.9	90.9
Tobacco	68.4	96.2	81.9	89.5	92.1	96.5	85.1	93.2
Plateau	74.2	93.5	75.9	91.0	74.7	91.4	83.7	95.5
Highland Rim	83.5	94.8	81.9	90.5	82.6	91.3	86.9	91.9
Middle Tennessee	64.2	92.6	60.0	87.8	66.9	92.2	75.4	91.4
Ames Plantation	75.7	91.6	75.9	94.2	73.7	97.6	81.6	96.7
Average	75.1	91.5	77.1	91.2	78.0	93.5	83.0	93.3

[a]Viable calves are those living at least 36 hours post parturition. Refer to Appendix, Table XVI for detailed station figures.

TABLE IV

PERCENTAGE OF CALVES WEANED BASED ON COWS BRED AND ON TOTAL CALVES BORN, BY STATION AND YEAR[a]

Experiment Station	1969		1970		1971		1972	
	Cows Bred	Calves Born	Cows Bred	Calves Born	Cows Bred	Calves Born	Cows Bred	Calves Born
Main - Blount	83.9	87.0	73.8	90.4	72.3	85.7	81.0	88.0
Main - Alcoa	64.0	79.5	75.6	82.9	75.7	90.3	78.7	84.5
Tobacco	64.6	91.1	79.5	86.8	90.9	95.3	85.1	90.5
Plateau	65.6	86.5	71.7	85.9	69.1	86.1	80.3	91.6
Highland Rim	82.6	93.8	80.0	88.4	80.9	89.4	86.2	90.3
Middle Tennessee	59.9	86.3	58.3	85.4	63.9	87.1	71.6	87.8
Ames Plantation	74.6	89.8	74.1	91.8	72.0	96.2	79.7	94.5
Average	70.7	87.7	73.3	87.4	75.0	90.1	80.4	89.6

[a]Refer to Appendix, Table XVII for detailed numbers on calves sold and calf deaths.

Plantation in 1971. The majority of calves eliminated from the herds by sales were either in a production sale at Alcoa in the spring or at one on the Plateau Station in November. The other stations sell few calves before weaning, with most of those sold being cull calves. Late summer calves and those calves not reaching 400 pounds by weaning go into the cull calf category at most experiment stations.

Finally, viable calves at weaning were separated into bulls and heifers and the percentage of heifers kept as herd replacements based on the number of cows bred was calculated (Table V). An overall percentage of 20.3 percent was figured with a range of 12.1 percent at Blount in 1970 to 31.2 percent at Ames Plantation in 1969.

Of the 1,216 females weaned during the years 1969-1971, 695 were of replacement quality (Table VI). These represent 57.2 percent of the heifers weaned that were used as replacements, kept and bred to calve as two-year-olds. This figure is regulated by the superintendents and their practices in selecting replacements, culling, and overall herd management. Various criteria are used in selecting heifers to keep. Some station personnel are more selective than others. A replacement heifer at Blount and Alcoa farms has to have good growth and production records for her sire and dam, must weigh at least 400 pounds at weaning, and have characteristics of an above-average heifer for her breed. This differs with the selective method at Ames Plantation where weight is the sole factor. If a heifer does not weigh at least 650 pounds by breeding time, she is culled and sold. At Tobacco Experiment Station, a heifer is chosen on her adjusted weight at 12-13 months of age, her body measurements, soundness, and

TABLE V

PERCENTAGE OF HEIFERS KEPT AS REPLACEMENTS[a] BASED ON COWS BRED BY STATION AND YEAR

Experiment Station	1969	1970	1971	Average
Main - Blount	12.5	12.1	28.2	17.6
Main - Alcoa	29.7	15.7	17.8	21.1
Tobacco	20.3	28.9	27.0	25.4
Plateau	14.7	17.9	18.5	17.0
Highland Rim	22.9	18.1	18.3	19.8
Middle Tennessee	20.4	20.0	21.3	20.6
Ames Plantation	31.2	12.3	17.1	20.2
Average	21.7	17.9	12.2	20.3

[a]Information on 1972 heifers kept for replacements not available at time of publication. Refer to Appendix, Table XVIII for details on number of cows bred and number of heifers kept as replacements.

TABLE VI

NUMBER OF HEIFERS WEANED AND NUMBER KEPT AS REPLACEMENTS BY STATION AND YEAR

Experiment Station	1969		1970		1971	
	Heifers Weaned	Replacements	Heifers Weaned	Replacements	Heifers Weaned	Replacements
Main - Blount	47	14	38	13	31	24
Main - Alcoa	109	76	110	54	103	55
Tobacco	19	16	31	24	31	24
Plateau	69	37	78	38	70	43
Highland Rim	42	25	39	19	53	21
Middle Tennessee	40	28	35	24	53	34
Ames Plantation	75	63	69	26	74	37
Total	401	259	400	198	415	238

age at the breeding season. Overall, each superintendent has his own standards by which he selects his replacements and these affect the quality of the herd. Lasater (1972) agrees with this and states that a good culling program in the cow herd and a high percentage of quality replacements kept will increase the herd quality more rapidly than any other single factor. The current prices of feeder calves also affects the number of replacements kept.

II. COST OF NATURAL BREEDING SERVICE PER CALF

Five of the seven herds considered in this study used a combination of artificial insemination and natural service in such a way that these figures cannot be used in this aspect of studying the cost of raising a replacement heifer. The Highland Rim and Tobacco Experiment Stations used natural service exclusively during the years studied. The ratio of calves born per breeding bull over the four-year period ranged from 17.5: 1 at Highland Rim to 13.6: 1 at Tobacco Experiment Station (Table VII). The ratio of total calves weaned per bull ranged from 15.1: 1 at Highland Rim to 11.8: 1 at Tobacco for the years 1969-1972. During the same time period, the ratio of replacement heifers kept per bull ranged from 4.3: 1 at Tobacco to 3.8: 1 at Highland Rim.

Considering that 2.53 percent of a beef farm income is used to support a beef breeding bull (Ray and Walch, 1972), a beef producer can spread that cost over as many or as few weaned calves as the bull produces. The more calves this cost is spread over, the less it will cost to produce one calf.

TABLE VII

NUMBER OF CALVES BORN, CALVES WEANED, AND REPLACEMENT HEIFERS KEPT PER BULL[a] ON HIGHLAND RIM AND TOBACCO EXPERIMENT STATIONS BY YEARS

Category	1969		1970		1971		1972	
	H. R.	Tobacco	H. R.	Tobacco	H. R.	Tobacco	H. R.	Tobacco
Number of calves born per bull	19.2	11.2	15.8	15.2	17.3	17.0	17.7	11.9
Number of calves weaned per bull	18.0	10.2	14.0	13.2	15.5	16.0	16.0	10.8
Number of replacements kept per bull	5.0	3.2	3.2	4.8	3.5	4.8	-	-

[a]Refer to Appendix, Table XIX for number of bulls used for natural breeding.

The average number of services per conception for artificial insemination in Tennessee during the years 1969-1972 was 1.6 (DHI Letter, 1972). A cost per service can be figured by the beef breeder based upon the price of the semen and the inseminator's fee or labor involved and this total cost can be allocated among the calves. Because only 4.1 percent of the Tennessee beef cattle are bred artificially, this aspect is omitted in this study when figuring costs.

III. BROOD COW DEATH LOSSES

Results show that of the total of 4,745 brood cows in the four years studied, 91 died representing a 1.92 percent death loss (Table VIII). Among the major causes as reported from the survey are lightning, grass tetany, bloat, and plant poisoning in that order. These causes are found to be similar to those stated in the early 1960's by Tyrrell in his account of beef cattle in Tennessee. He points out that good herd management can reduce these deaths and thus save the producer money. Another cause of death was difficult parturition and although this number is relatively small on all stations, it is still important when considering overall death losses. Finally it should be emphasized that even the low death rate revealed in this study can cause significant financial loss. The 91 cows lost represent a total estimated 1973 dollar loss of approximately $18,837.

IV. COSTS INCURRED BY ILLNESSES AMONG CALVES

The cost involved in treatment of illnesses of calves is spread over all calves weaned. This cost includes labor involved in treatment,

TABLE VIII

NUMBER OF BROOD COW DEATHS BY STATION AND YEAR[a]

Experiment Station	1969	1970	1971	1972
Main - Blount	4 (112)[a]	1 (107)	3 (85)	2 (104)
Main - Alcoa	5 (256)	5 (344)	4 (309)	4 (310)
Tobacco	0 (79)	1 (83)	2 (89)	0 (101)
Plateau	3 (252)	2 (212)	3 (233)	2 (203)
Highland Rim	1 (109)	3 (105)	0 (115)	2 (130)
Middle Tennessee	5 (137)	1 (120)	4 (160)	6 (142)
Ames Plantation	7 (202)	9 (212)	11 (217)	6 (217)
Total	25	22	27	22

[a]Number in parentheses represents number of brood cows in the herd at the beginning of the breeding season.

all drugs and materials needed for treatment, and occasionally, professional veterinary service. The most common illnesses observed in this study, in order of importance were scours, shipping fever, preweaning pneumonia, footrot, and pinkeye.

All stations used local veterinarians and the charges made were considered normal. Blount and Alcoa Stations used, in addition to local veterinarians, the University veterinarian whose charges varied from theirs. An annual total of expenditures was submitted by each station, but because a large portion of this was used for the preparation of cattle for sales, a cost figure per head could not be calculated from this information. However, most beef farms spread the total cost of drugs and veterinary treatment for the entire herd over the total number of calves weaned. From this a cost in veterinary services can be figured to raise one calf. In budgets discussed by Ray and Walch (1973), a $3.00 charge per head is used as an average figure for veterinary services in a cow-calf operation in Tennessee. Producers can adjust this figure according to the situation at hand.

V. FEEDING COSTS

At all of the seven experiment stations studied, silage was the main roughage fed during the winter feeding period with a concentrate or protein supplement added. Corn and wheat were the predominant grains fed and the protein supplement was either cotton seed meal or urea mixed in the silage.

Alfalfa or lespedeza hay was fed on some of the stations and a heifer was found to consume approximately one ton per year or about 5.5 to 6.0 pounds per day with or without silage feeding. The quality of pasture and the length of growing season were found to be the largest factors governing the amount of hay fed per animal per year.

Pasture for the cow herd differed somewhat at the stations because of varying climatic and soil conditions. Permanent pastures were composed of fescue and orchard grass on most stations and the winter pastures varied from wheat at Ames Plantation to wheat and crimson clover at Alcoa. All stations used the winter pastures as long as they lasted, then began the silage feeding. Silage was fed an average of 105 days from December 15 to April 1. Tyrrell (1964) suggests roughage requirements for cattle with and without silage (Table IX). His program is designed for cows, but can be altered for replacement heifers. In this study the total tonnage of silage fed to mature cows closely followed Tyrrell's program while, for the replacement heifers, these requirements were cut approximately in half. The variations occurred because of soil fertility, yield, and other factors. An average total quantity of feed consumed per cow and/or heifer annually was figured from the information obtained from the station records (Table X). The range of gain by heifers on winter feed varied from 0.5 to 1.5 pounds per day at Highland Rim to 1.0 to 1.5 pounds at Plateau Experiment Station. These gains are regulated by the superintendents to obtain the desired weights of the heifers either at weaning or at breeding.

TABLE IX

PASTURE AND HAY REQUIREMENT FOR 10-COW UNIT[a]

Roughage	Crop	Acreage	Grazing, or Feed Furnished	Tons of Hay Equivalent
With Silage:				
Permanent Pasture	Orchard grass and Ladino plus	10-12 acres		
	Fescue & Ladino (for winter)	6-7 acres	8-10 mo.	26-34
Supplementary Pasture	Lespedeza, small grains, etc.	4-5 acres		
Hay	Alfalfa or	3-4 acres	10 tons	10
	Lespedeza	6-8 acres		
Silage	Corn or Corn and sorghum	1 1/2-2 acres	20 tons	7
Without Silage:				
Pasture Program A	Orchard grass and Ladino plus	15-18 acres	8-10 mo.	32-39
	Fescue & Ladino (for winter)	10-12 acres		
Or Program B	Orchard grass and Ladino plus	10-12 acres	8-10 mo.	32-39
	Fescue & Ladino plus	6-10 acres		
	Lespedeza (July 15-Sept. 15)	5-6 acres		
Hay for Program A or B	Alfalfa or	3-4 acres		
	Lespedeza	6-8 acres	10 tons	10
Total		28-38 acres		42-49 tons

[a]Tyrrell, W. P., Beef Cattle in Tennessee. 1964.

TABLE X

AVERAGE TOTAL ANNUAL CONSUMPTION OF FEED[a] PER COW AND FEED PER HEIFER ON THE EXPERIMENT STATIONS

Item	Silage as Roughage		Hay as Roughage	
	Amount Per Cow	Amount Per Heifer	Amount Per Cow	Amount Per Heifer
Pasture	1.5 acres	1.0 acres	1.5 acres	1.0 acres
Corn silage[b]	2.63 tons	2.3 tons	-	-
Corn concentrate[c]	300 lbs.	300 lbs.	300 lbs.	300 lbs.
Hay[d]	1.0 tons	1.0 tons	1.877 tons	1.77 tons

[a]From information obtained from superintendents.

[b]Silage fed for 105 days urea and limestone mixed with silage at 10# urea and 10# limestone per ton of silage.

[c]Fed on top of silage - 3#/day for 100 days.

[d]Fed from December 1 to April 1.

Feeding procedures were similar on all stations with silage either being trucked to feed bunks in the pastures or augered into troughs near the barns. The concentrate, if fed, was sprinkled over the top of the silage and salt licks and protein blocks were located near the feeding areas.

Because of the high fluctuation in feed prices, it is impossible to set a stable cost figure for feed purchased by the Experiment Stations. However, taking the average prices paid by the farmers for feed in Tennessee during the years 1969-1972 (Table XI), an evaluation of the overall cost of feeding an animal can be calculated. These quantities and costs for feeding a replacement heifer are reported in the budgets found at the end of this study. Silage was based on a charge of $8.40 per ton to produce and other figures were obtained from bulletins published by the U.S.D.A. Crop Reporting Board.

VI. MANAGEMENT PRACTICES OF DEHORNING, VACCINATING, AND WEANING

Vaccination, dehorning, and marking programs are carried out on most of the experiment stations. The dehorning programs vary from the use of caustic paste at Middle Tennessee to the use of a hot iron at Blount and Alcoa Stations. The paste method is used while the calves are under two weeks of age and the hot iron is used up until the calves reach three months of age. Marking or identification of the calves is also important and along with tatoos and ear tags some freeze branding is used. Because these two categories of marking and dehorning require little cost in materials, the labor for this will be classified under miscellaneous labor when calculating cost estimates.

TABLE XI

AVERAGE TENNESSEE FEED COSTS, 1969-1972

Ration Content	Price Per Cwt.	
	Silage Phase	Hay Phase
Urea - Limestone treated corn silage	$0.420	-
Ground shelled corn	2.600	2.600
Cottonseed meal	5.125	5.125
Alfalfa hay	2.710	2.710
Concentrate 30 percent protein and over	4.700	4.700

The vaccination programs are similar on all the stations. They comply with those recommendations of the University of Tennessee Animal Science Extension Service to vaccinate for blackleg and malignant edema, twice; once as calves at 3 months of age and again as weanlings or yearlings. Brood cows usually receive an annual leptospirosis booster. No specific vaccination program for shipping fever is employed. This respiratory disease is a large problem on some stations, and only the aspect of treatment of this is involved in the cost figures (See Section IV). Each individual station, because of variations in climate and environmental conditions, adjusts this basic program to fit its needs. A program of vaccinating against blackleg, malignant edema, and leptospirosis is used by most stations and an estimate of $3.00 per head is used for a treatment cost by advice from a veterinarian who treats two of the herds. This figure does not include labor involved in treatment.

Weaning costs, if any, are usually covered under the category of illnesses or feeding. From information gathered, the only cost involved would be the labor on the various stations incurred in separating the calves from the cows and, if it was needed, the trucking expenses. This cost category can be included by the farmer according to his method of weaning.

VII. COST OF LABOR

This category includes all labor expenditures involved in raising a replacement heifer and maintenance of the existing herd. This labor includes that for winter feeding, supplemental feeding in

the pasture, repair of buildings and fences, machine and equipment repair, and all labor not associated with categories previously mentioned. Excluded from this is labor in producing feed and labor for treating sick animals. It is rather difficult to arrive at a standard labor value because larger farms have more labor saving equipment. A study of labor requirements by the size of the farm was conducted by Anderson (1971) and his conclusions from his study showed that less hours are spent per head on raising a beef animal if the farm employes the minimum number of workers to raise a maximum number of animals. Ray and Walch (1973) agree with Anderson and state that a cow and calf operation with one hundred animals fed silage will require 2.7 hours less labor per head annually than a cow and calf operation of thirty head fed hay. These figures are used in the model farm plan in this study and were based on survey data and consultation with specialists. The labor coefficients that the producer might use may need to be adjusted to the particular farm in question.

VIII. BUDGETS COMPARING RAISING TO BUYING REPLACEMENT HEIFERS ON HAY OR SILAGE FEEDING SYSTEMS

The farm budgets (Tables XII and XIII) are based on information obtained from the study of experiment station operations and records. These plans are designed to aid the Tennessee beef producer in deciding which method of obtaining replacement heifers for his herd would be more economical. It is assumed that land and capital are not influencial on the costs, although with larger herds this may become a factor. Footnotes accompany the budgets to explain by what mean the figures

TABLE XII

ESTIMATED EXPENSES FOR RAISING FROM BIRTH SIX REPLACEMENT HEIFERS IN A THIRTY-COW HERD;[a] HAY FED AS ROUGHAGE

Item	Annual Quantity	Annual Amount
A. Variable Expenses		
Pasture[b]	1.5 acres/unit @ $20.14/acre	$151.05
Hay[c]	1.6 tons/unit @ $24.13/ton	193.04
Minerals & salt	1.0 unit/animal @ $.75/unit	3.75
Vet. & medicine	6 head @ $3.00/head	18.00
Labor[d]	12.0 man hrs./unit @ $1.30/hr.	78.00
Tractor, 40 DBH	1.5 hrs./unit @ $.72/hr.	5.78
Death losses	12% of calves/year	37.98
	Total Variable Expenses	$487.50
B. Fixed Expenses		
Depr. on bldgs. & equip.[e]	6 head @ $2.50/head	15.00
Depr. on bull[f]	6 head @ $.50/head	3.00
Tractor, 40 DBH	1.5 hr./head @ $.77/hr.	5.78
	Total Fixed Expenses	23.78
	Total Expenses	$511.28
	Two Year Expenses	$1,022.56
	Expense Per Heifer	$170.43
	Purchase Cost of 6 Heifers[g]	$842.70
	1.25 Years Expenses	607.57
	Total Expense	$1,450.27
	Expense Per Heifer	$241.71

[a]Six heifers are equivalent to five animal units. One cow or one bull equals one animal unit. Assumes an 85% calf crop and a 20% replacement rate.

[b]Pasture cost equals establishment and maintenance cost.

[c]Approximately 1.6 tons of mixed hay per animal will be fed throughout the year. Assumes sufficient clover to eliminate feeding a supplement.

[d]Minimum wage during 1969-1970 was $1.30/hr. for farm labor.

[e]Assumes one building for hay storage and sorting pen--100 sq. ft. at $1.50 per sq. ft.--depreciated over 20 years with repairs at 1% of the cost.

TABLE XII (continued)

[f]Assumes a $650 bull replaced every 4 years and sold for $375.

[g]Prices based upon those received at spring feeder calf sales in Tennessee for heifers averaging 450 lbs. during the years 1969-1972.

TABLE XIII

ESTIMATED EXPENSES FOR RAISING FROM BIRTH SIX REPLACEMENT HEIFERS IN A THIRTY-COW HERD; SILAGE FED AS ROUGHAGE[a]

Item	Annual Quantity	Annual Amount
A. Variable Expenses		
Pasture	1.5 acres/unit @ $20.14/acre	$151.05
Ground corn	300 lbs./unit @ $2.42/cwt.	36.30
Corn silage	1.5 tons/unit @ $8.40/ton	63.00
Minerals & salt	1.0 unit/animal @ $.75/unit	3.75
Hay	0.2 tons/unit @ $24.13/ton	24.13
Cottonseed meal	75 lbs./unit @ $5.12/cwt.	19.20
Vet. & medicine	6 head @ $3.00/head	18.00
Labor	9.3 man hrs./unit @ $1.30/hr.	60.45
Tractor, 40 DBH	1.5 hrs./head @ $.77/hr.	5.78
Death losses	12% of calves/year	37.98
	Total Variable Expenses	$419.64
B. Fixed Expenses		
Depr. on bldgs., equip. and silo[b]	6 head @ $2.50/head	21.00
Depr. on bull	6 head @ $.50/head	3.00
Tractor, 40 DBH	1.5 hr.head @ $.77/hr.	5.78
	Total Fixed Expenses	$ 29.78
	Total Expenses	$449.42
	Two Year Expenses	$898.84
	Expense Per Heifer	$149.81
	Purchase cost of 6 Heifers	$842.70
	1.25 Years Expense	530.13
	Total Expense	$1,372.83
	Expense Per Heifer	$228.81

[a]Silage will be fed from December 15 to April 1 at the rate of 30 lbs. per day per animal unit (100 days). Silage is treated with 100 lbs. urea and 10 lbs. limestone per ton.

[b]Assumes feed bunks, working corral, and concrete depreciation (Total $1,898) over 20 years with repairs at 1% of cost. Also trench silo cost ($1,500) depreciated out in 20 years, plus $30 per year for plastic covering.

were derived and assumptions made. The budgets are set up in such a way that the producer can substitute his cost figures for the existing figures and estimate total costs for any method and compare it to other methods. Prices for feed are based upon the four-year average paid by Tennessee farmers from 1969-1972. Prices paid for heifers are those obtained from the four-year average paid at Tennessee feeder calf sales.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the most advantageous method of obtaining replacement beef heifers. It was designed to study the various factors involved in raising and buying replacements, and also to point out the criteria that is important in selecting replacements for a herd.

The management programs of the sub-stations of the University of Tennessee Experiment Station were studied and the following factors were determined to be most important in raising replacements:

1. Productivity and fertility of the cow herd. The percent of conception failures determines how much of a liability will be carried in the form of irregularly producing cows. The fewer failures, the more calves and productivity and, most important in this study, the lower cost of production per calf.

2. Breeding costs. The bull-to-cow ratio is determined by biological limitations and by management practices. The greater the ratio, without loss of efficiency, the lower will be production cost per calf.

3. Death losses and illnesses in the herd. Decreasing the percent death losses means higher income per head at market time. Time and money expended in treating illnesses increases production cost per calf.

4. Feeding costs. Economically, home-grown feeds provide to be the best, with silage-feeding programs less expensive than hay-feeding programs. Because this is the number one cost factor in raising replacements, any progress made by the management in lowering feed costs is critical. Proper nutrition for heifers is influential on their productivity for life.

5. Labor costs. Presently, wages are rising for farm workers. It becomes, therefore, important for a manager to evaluate his operation and decide upon the most efficient man power situation and to evaluate all labor-saving techniques.

After evaluating the above factors, it is necessary to investigate the means by which replacement heifers are added to the herd and decide which method, purchase or rearing, is more economical. Budgets set up in this study indicate that adding replacement heifers for calving as two-year-olds, by purchasing them from Tennessee feeder calf sales is less economical than raising them from birth. With the fluctuation of feed and beef prices, a producer must evaluate the cost factors shown here and decide which method of obtaining replacement beef heifers, by purchase or by on-the-farm raising, would be most economical.

LITERATURE CITED

LITERATURE CITED

Anderson, J. M. and L. H. Keller. 1971. Beef feeding systems and optimum farm organizations in three areas of Tennessee. Univ. of Tenn. Agr. Exp. Sta. Bul. 480.

Bellows, R. A. 1970. Feeding the beef heifer. Agriculture Research. September 1970. 19:6.

Chambers, D., J. A. Whatley, Jr., and W. D. Campbell. 1954. A study of the calving performance of two-year-old Hereford heifers. Okla. Ag. Expt. Sta. Bul. MP 34.

Clark, R. T., A. L. Baker, and G. E. Whitmore. 1959. Dehorning castrating, branding, and marking. U.S.D.A. Farmer's Bul. 2141.

Cole, H. H. 1966. Introduction to livestock management. W. H. Freeman and Co., San Francisco.

Ensminger, M. E. 1970. The stockman's handbook. Interstate Printers and Publishers, Danville, Ill.

Franke, D. E. 1973. Replacing open beef cows. Notes from a lecture presented at Univ. of Tenn. Beef Cattle Conference, Knoxville, Tenn.

Freeman, D. A. Bovine respiratory disease supplement J.A.V.M.A. 152 (1968). No. 6 Part 2.

Hobbs, C. S. 1964. The influence of plane of nutrition on performance traits. Notes from a lecture presented to the American Angus Conference, Knoxville, Tenn.

King, G. J., F. N. Dickinson, C. A. Rampendall, A. H. Kienast, and M. K. Dixon. 1972. Artificial breeding report. D.H.I. Letter, 48:4.

Lasater, G. L. 1972. The Lasater philosophy of cattle raising. Texas Western Press, El Paso, Texas.

Martin, J. Unpublished data. University of Tenn. Animal Science Department. 1973.

Merriman, G. M. Personal communication, University of Tennessee, Department of Animal Husbandry-Veterinary Science (1973).

Merriman, G. M. 1967. Survival of pigs and calves. Tenn. Farm and Home Science.

Merriman, G. M. and C. S. Hobbs. 1962. Bovine fluorosis from soil and water sources. Tenn. Agr. Exp. Sta. Bul. 347.

Ray, R. M. and H. N. Walch. 1973. Farm planning manual. Univ. of Tenn. Press, Knoxville, 12 pp.

SaLoutos, Charles. 1967. Agri-Business Management H. D. Graphics, Baraboo, Wisc. 121 pp.

Snapp, R. R. and A. L. Neumann. 1969. Beef cattle. Wiley Co., New York.

Tennessee Crop Reporting Service. 1972. Tennessee Agriculture Statistics Annual Bulletin 1972. Nashville, Tennessee Crop Reporting Service.

Tyrrell, W. P. 1964. Beef cattle in Tennessee. Univ. of Tenn. Agr. Ext. Ser. Pub. 330.

Warnick, A. C., D. F. Mikoger, A. Martinez, and T. J. Cunha. 1965. Productivity of beef cows as influenced by pasture and winter supplement driving growth. Fla. Agr. Exp. Sta. Bul. 292.

University of Tennessee, Department of Extension Agriculture Economics. Results of Tennessee demonstrational feeder calf sales, 1969-1972, unpublished mimeographs.

University of Tennessee, Department of Extension Agriculture Economics. Results of Tennessee demonstrational feeder calf sales, spring 1972, unpublished mimeographs.

United States Department of Commerce, Bureau of the Census. 1972. Statistical Abstract of the United States 1972. Washington, U.S. Government Printing Office.

Zmolek, W. G. and Nelson Gay. 1969. Midwest farm handbook. Ames, Iowa State University Press.

APPENDIX

TABLE XIV

NUMBER OF OPEN COWS AND HEIFERS BY STATION AND YEAR

Experiment Station	1969		1970		1971		1972	
	Number	Number	Number	Number	Number	Number	Number	Number
Main - Blount	112	4	107	11	85	13	104	6
Main - Alcoa	256	53	344	30	309	49	310	32
Tobacco	79	13	83	7	89	4	101	6
Plateau	252	52	212	33	233	45	203	25
Highland Rim	109	13	105	9	115	9	130	6
Middle Tennessee	137	42	120	38	160	44	142	27
Ames Plantation	202	30	212	37	217	53	217	34
Total	1,147	207	1,183	165	1,208	217	1,207	136

TABLE XV

NUMBER OF COWS BRED AND CALVES BORN BY STATION AND YEAR

Experiment Station	1969		1970		1971		1972	
	No. Bred	No. Calves	No. Bred	No. Calves	No. Bred	No. Calves	No. Bred	No. Calves
Main - Blount	112	108	107	94	85	72	104	96
Main - Alcoa	256	203	344	308	309	259	310	278
Tabacco	79	56	83	76	89	85	101	95
Plateau	252	200	212	177	233	187	203	178
Highland Rim	109	96	105	95	115	104	130	124
Middle Tennessee	137	95	120	82	160	116	142	115
Ames Plantation	202	167	212	171	217	164	217	183

TABLE XVI

NUMBER OF CALVES BORN AND VIABLE CALVES BORN BY STATION AND YEAR

Experiment Station	1969 Calves		1970 Calves		1971 Calves		1972 Calves	
	Born	Viable	Born	Viable	Born	Viable	Born	Viable
Main - Blount	108	102	94	89	72	65	96	90
Main - Alcoa	203	176	308	279	259	246	278	254
Tobacco	56	54	76	68	85	82	95	86
Plateau	200	187	177	161	187	174	178	170
Highland Rim	96	91	95	86	104	95	124	113
Middle Tennessee	95	88	82	72	116	107	115	107
Ames Plantation	167	153	171	161	164	160	183	177

TABLE XVII

NUMBER OF CALF DEATHS AND CALVES SOLD PRE-WEANING BY STATION AND YEAR

Experiment Station	1969		1970		1971		1972	
	Calf Deaths	Calves Sold	Calf Deaths	Calves Sold	Calf Deaths	Calves Sold	Calf Deaths	Calves Sold
Main - Blount	14	0	9	23	10	2	11	4
Main - Alcoa	39	13	48	27	25	0	34	9
Tobacco	5	0	10	0	4	1	9	0
Plateau	22	37	25	0	26	0	15	0
Highland Rim	6	0	11	0	11	0	12	0
Middle Tennessee	13	0	12	0	13	2	13	1
Ames Plantation	16	1	14	0	6	6	10	0

TABLE XVIII

NUMBER OF COWS BRED AND NUMBER OF HEIFERS KEPT AS REPLACEMENTS BY STATION AND YEAR

Experiment Station	1969		1970		1971	
	Cows Bred	Replacements	Cows Bred	Replacements	Cows Bred	Replacements
Main - Blount	112	14	107	13	85	24
Main - Alcoa	256	76	344	54	309	55
Tobacco	79	16	83	24	89	24
Plateau	252	37	212	38	233	43
Highland Rim	109	25	105	19	115	21
Middle Tennessee	137	28	120	24	160	34
Ames Plantation	202	63	212	26	127	37

TABLE XIX

NUMBER OF BULLS USED FOR NATURAL BREEDING ON THE HIGHLAND RIM AND TOBACCO EXPERIMENT STATIONS BY YEAR

Experiment Station	1969	1970	1971	1972
Highland Rim	5	6	6	7
Tobacco	5	5	5	8

QUESTIONNAIRE FOR SUPERINTENDENTS

STATION:

SUPERINTENDENT:

1. What % of your open cows are culled from the breeding herd?

2. When do you cull and how do you go about selecting which calves to cull?

3. What is your rate of death loss from:

   a. Grass tetany and what do you do with these cows' calves?

   b. All other causes?

4. To what extent are your vet. services and how much of an expense is it?

5. What is the season for natural breeding?

6. Do you separate the cows from the heifers during breeding and calving seasons or all the time?

7. Do you use any A.I. and if so to what extent?

8. What feeding and management practices are followed with heifer calves from weaning until they are placed in breeding groups?

9. Do you use winter pasture for your calves?

10. If winter pasture is used, what does it consist of?

11. If supplemental feeding is used, what is an average amount fed/head/day?

12. What gains do you expect out of your calves:

    a. on winter pasture?

    b. on supplemental feeds?

13. What is the average experimental ration used here?

14. At what age do you sell heifers and/or feeder calves?

15. At what age and time of year do you buy heifers?

16. How many heifers do you approx. average/year buying and/or raising?

17. What is the content of your basic maintenance ration?

18. Do you use any creep feeding or flushing techniques?

19. What is your general feeding procedure?

20. In determining which of the weaned heifer calves will be added to the breeding herd as replacements, what criteria are used in making the selection?

VITA

Ben David Lee was born in Maryville, Tennessee, on April 23, 1949. He attended Sam Houston Elementary School and Maryville High School from which he graduated in 1967. He attended Emory and Henry College in Emory, Virginia from 1967 through 1971, graduating with a Bachelor of Arts degree in Biology.

In September 1971 he entered the Graduate School of The University of Tennessee, Knoxville, and in December 1973 he received the Master of Science degree with a major in Animal Science.