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Costs and Returns of Alternative Calf Wintering and Grazing Programs in Wyoming

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COSTS AND RETURNS OF ALTERNATIVE CALF WINTERING AND GRAZING PROGRAMS IN WYOMING

1962-1981

by
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INTRODUCTION

Wyoming's total cash receipts from agriculture averaged 435 million dollars per year for all commodities from 1970 to 1980, and cattle and calves provided an average of 303 million dollars per year or 70% of the total. (Wyoming Agriculture Statistics, 1976, 1979, 1981, p.11.) Beef calves produced in Wyoming are sold as weaner calves in October or November, short yearlings in April or May, long yearlings in September or October, and a few as fat cattle. There are still a few ranches selling steers at about 30 months of age.

Kearl (1972, p.1) suggests that extending ownership of young cattle for marketing as yearlings is a way to increase returns to land, labor and capital. A rancher who decides to retain his calves broadens his marketing alternatives but must consider feed and pasturing costs, cattle prices, and subsequent gains of cattle on grass forage or in the feedlot.

Objective of the study

The objective of this study was to evaluate alternative calf wintering and pasturing programs in Wyoming. Sub-objectives include:

1. Estimation of feed requirements and average daily gains for different feeding regimes common in Wyoming for wintering calves;
2. Estimation of summer gains in relation to winter gains;
3. Calculation of the costs and returns for each feeding regime and identification of the best programs for different situations.

Review of Literature

Calf Feeding Trials

Work by Pinney et al. (1962) in Oklahoma has shown that heifers wintered on a high plane of nutrition with gains of 1.0 to 1.25 lb. per day, had the best reproductive performance. Heifers which were fed at a low level and made no gain during the first winter produced a lower percentage calf crop and weaning weights were much lower than with either the moderate or high levels of nutrition. Because of the high costs involved at that time, they found that the moderate level producing winter gains of 0.50 lb. per day was most practical even though reproductive performance was reduced.

Rations high and low in protein and energy were fed to heifer calves in Nebraska (Clanton and Zimmerman, 1970). All calves were fed an average 10.23 lb. of feed per day from December 14 to May 2. Rations and results were:

1/ Based on a Master's Degree thesis by Joe A. Ross. The authors acknowledge the assistance of Dr. Conrad Kercher and Dr. Andrew Vanvig for their time, cooperation and helpful suggestions as members of the thesis committee.

Nutrient Levels			Average
Protein		Energy	daily gain (lb)
Low	-	low	0.22
Low	-	high	0.44
High	-	low	0.44
High	-	high	0.82

The heifers on the high protein-high energy ration reached their first estrus cycle approximately two months earlier than heifers in the other three groups.

Kercher et al. (1971, 1972) compared nutritive value of alfalfa hay fed ad libitum from bales, cubes or haylage. Results were as follows:

Item	1971	1972
Number of steers	63	65
Initial weight (lb.)	406	493

	Average daily gain (lb)	
Form of hay		
Baled	1.35	1.47
Cubes	1.65	1.89
Haylage	1.65	1.69

In both trials, calves fed cubes or haylage performed better than calves fed baled hay.

Kercher (1981) also compared large round bales in a self-feeder, chopped alfalfa, pelleted alfalfa, and the same three treatments with two lb. per day of barley. The trial used 69 Angus-Hereford crossbred calves (Angus bulls X Hereford cows, 13 Simmental X Hereford or Charolais X Hereford calves. Calves were weaned November 5 averaging 488 lb. and started on the 82 day test after a 28 day pre-conditioning. Results were as follows:

	Gains (lb.)	
Form of hay	Daily	Total
Baled	1.67	137
Chopped	1.46	120
Pellets	1.63	134

Economic Studies of Wintering Calves

Rogers and Malone (1967) analyzed four years of feeding trials in northern Nevada from 1959-63. The study analyzed the relationship between winter gains and subsequent summer gains on range or in the feedlot for finishing. Feed used was native grass hay, 3.0 lb. of alfalfa hay, and barley when required to achieve high rates of gain. An inverse relationship was found between winter and summer gains. The researchers concluded that winter gains between 0.75 and 1.25 lb. per day were best for the cattle returning to grass the following summer. Ranchers planning to winter calves for the sale in the spring should feed at rates of gain above 1.50 lb. and disregard summer gains.

Hewlett and Workman (1978) used linear programming to analyze production and marketing activities for ranches of 150 or 300 brood cows in Utah. Alternatives included calf sales November 1, short-yearling sales April 1, or long-yearling sales October 1. Three other alternatives allowed for additional calves purchased November 1 and sold April 1 or October 1, or calves purchased April 1 and sold October 1.

Based on average Utah cattle prices for 1970-1975, the optimum strategy was a combination of cow-calf and long yearling options. Heifer calves, except replacements, were to be sold at weaning time while the cow herd was reduced by approximately 25 percent to accommodate retention of all steer calves for 11 months after weaning.

In a Wyoming study, Kearl (1969) compared and evaluated nine livestock systems with budgeting and a simple form of simulation. Actual prices received for cattle, feed costs and cost indexes from 1946-1965 were used as they actually varied over the 20-year time span. Net ranch incomes for some of the systems were:

Livestock System	Net Ranch Income Total	Per AU
Cow-calf	$11,216	$22.34
Cow-yearling	13,092	25.72
Purchased stockers		
Nearby purchase		
Fall purchase (30 mi)		44.00
Spring purchase (100 mi)		82.54
Distant purchase		
Fall purchase (400 mi)		38.20
Spring purchase (1200 mi)		43.13

The stocker systems produced larger returns than cow-calf or cow-yearling systems. However, shrinkage and transportation costs of procuring stocker cattle from more distant locations, because of the limited supply of stockers available for purchase in Wyoming, can have a major impact on returns. The operator must also assume the market price risk between purchasing and resale. Returns can be quite variable among ranches using purchased stocker systems, depending on location with respect to stocker supplies, markets and the operator's ability to buy and sell.

Procedures

Budgeting and a simple form of simulation to make budgeting calculations were the analytical procedures used. Prices and costs were varied through the years. Specific data requirements included feed analyses, requirements for different types of rations, rates of winter and summer gains, and input and output prices and costs.

The feeding regimes selected for wintering calves were based on using alfalfa hay, grass hay, alfalfa-grass hay and corn silage. Barley was chosen for use as a concentrate with the roughages. The California Net Energy System (Lofgreen and Garrett, 1968) was used to determine the nutrient requirements for growing calves and for calculating feed requirements for various feeding programs.

Three logical marketing times are November for weaned calves, April for calves that are wintered, and October for cattle wintered and grazed on summer pasture. Cattle prices from the Billings, Montana auction and compiled by the USDA were used for this analysis.

Feed costs were based on prices received by Wyoming farmers and were compiled by the Wyoming Crop and Livestock Reporting Service.

Custom feeding costs reported by Gee (1969) and Madsen et al. (1979) along with costs per head fed calculated by Kearl (1969) were used to calculate the non-feed costs for the winter period. Non-feed costs for the summer grazing period were estimated using data from studies made by Kearl (1969) and Jacobs et al. (1982). A production index, in addition to these studies, was used to calculate the non-feed costs on a year-by-year basis.

More details on procedures, feeding programs, input and output prices are covered in the results section.

The results of feeding regimes selected were simulated over 19 production periods from 1962 through 1981, and are discussed in detail later.

FEED REQUIREMENTS AND RATIONS

The Net Energy System

The net energy system has become widely accepted and used in recent years, especially in feedlot conditions, to predict nutrient requirements as well as anticipated performance using a specified ration. Net energy is gross energy minus all the energy lost in fecal materials, urine, combustible gases and energy lost as heat as a result of nutrient

metabolism. The heat resulting from metabolism can have value during cold weather because it helps keep the animal warm. It is detrimental during hot weather because excessive heat will reduce feed intake and gains.

The net energy system considers net energy for maintenance (NEm), and net energy for gain (NEg) which is advantageous, allowing separate net energy calculations for maintenance and for gain.

Assumptions Underlying Use of Net Energy to Calculate Feed Requirements

A number of assumptions are implicit in the use of net energy to calculate feed requirements (Kearl 1977, p. XVI-7):

1. whatever feeds are supplied, all nutritional requirements are met;

2. temperature is not a critical factor, nor are other climatic factors; and

3. animals are in growing or finishing stages.

Nutritional Requirements

Alfalfa or other good quality legume hay will normally meet the nutritional requirements of beef cattle up to the maximum gain attainable on those feeds. Rations consisting largely of concentrates, corn silage or poor quality feed may be deficient in protein, vitamins and minerals. When the feed requirements using the net energy system are estimated, the nutritional requirements for protein, vitamins and minerals can be checked and requirements for supplements can be estimated to meet requirements.

Temperature and Climatic Factors

Nelms (1973) summarized some of the effects of cold stress upon cattle from research at the University of Alberta, Edmonton, Canada. The critical temperature of an animal is defined as the environmental temperature below which an animal must elevate its heat production in order to maintain body temperature. When exposed to temperatures below the critical level, animals must use some food energy to keep warm, or will use body tissues for that purpose, and thus lose weight. Critical temperatures are affected by feeding level, condition, acclimatization, air temperature and wind. Critical temperatures are also affected by animal characteristics such as breed and age which affect the animal's tissue insulation and the insulation of the hair coat.

> "The tissue insulation is the impedance to heat loss from an animal provided by the skin, subcutaneous fat and other tissues. Young animals tend to have thin skins and little fat, and therefore, have low insulation values. The insulation provided by the hair coat is primarily dependent upon the depth of the coat. However, high wind disrupts much of the insulation." (Nelms, 1973.)

Table 1 shows wind velocity and the critical temperature for 400-600 lb. heifers gaining 1.0 to 1.25 lb. per day. Light calves are much more susceptible to cold stress than heavier calves. Wind is a greater problem than cold weather itself, as indicated by the approximate 50° difference in critical temperature between 0 and 20 mph winds. Wet weather is also an important factor.

Animals on higher average daily gain (ADG) rations can withstand lower critical temperatures because of the heat energy "loss" of metabolizing the ration that produces higher gain.

Conversely, livestock on low rates of gain require significant amounts of additional feed to compensate for combined effects of cold, wind and wetness. The proportion of sunny or cloudy days is important too, as radiated energy is absorbed on sunny days by the livestock and offsets the effect of cold temperatures.

Table 1. Thermal Insulation and Critical Temperature for Growing Heifers Fed to Gain 1.0 to 1.25 lb. Per Day.

Wind MPH	Weight Lb.	Thermal Insulation	Critical Temp. °F
0	400	21	0
	500	22	-10
	600	23	-22
10	400	17	15
	500	18	6
	600	19	0
20	400	10	49
	500	12	42
	600	13	33

Source: Nelms, George, "Cold Stress in Cattle." 14th Annual Beef Cattle Short Course, University of Wyoming Extension Service and Animal Science Division, Laramie, Wyoming, Jan. 8-9, 1973.

Kercher (1979, p.2) reported on a three-year study conducted in northeastern California. Calves at an initial weight of 420 lb. were wintered in open feedlots without shelter or in lots with windbreaks for shelter. Chopped alfalfa (67%) and meadow hay (33%) was fed at the level the calves would consume before the next feeding. The mean ambient temperature was 34.2°F during the trials (middle of December to end of March). The mean wind run (wind speed times duration at that speed) for the three trials was 8.7 for the control lot and 4.2 for the lot with the windbreaks and sheds. The rate of gain was not significantly different among the calves. The calves without a windbreak consumed 11.4% more hay in total and 20.4% more per lb. gain than the calves protected with windbreaks six to eight feet high and with access to sheds. The additional feed was apparently used to maintain body temperature rather than produce gain.

Some type of windbreak or shelter, either man-made or natural, is essential for wintering calves in Wyoming. Bedding is of importance, especially for young, light weight animals, when there is wet or frozen ground.

Equations for Nutrient Requirements

Regression analysis is a statistical tool which takes into account the relationship between two or more quantitative variables so that one variable can be predicted from the other, or others. The usual application of regression estimates a dependent variable as a function of one or more independent variables. Regression is used here only to estimate equations to calculate various energy and nutritional requirements for steers and heifers. In a sense, the dependent and independent variables are reversed. Instead of treating performance as a function of nutrients supplied, the nutrient requirements are treated as functions of performance. This was done to obtain equations to predict nutrient requirements as a function of weight and rate of gain desired.

The general form of the equation used was:

$$Y_i = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_1^2 + b_4 X_2^2 + b_5 X_1 X_2 + e$$

where X_1 = weight; X_2 = gain per day; and Y_i = the separate components explained below.

The model was applied to obtain separate equations for estimation of the nutritional requirements of steers and heifers for components of the rations (Y_i) as follows:[2/]

1. minimum dry matter consumption,
2. percentage of roughage intake,
3. total protein,
4. digestible protein,
5. net energy for maintenance (NEm)
6. net energy for gain (NEg),
7. metabolizable energy,
8. total digestible nutrients (TDN),
9. calcium,
10. phosphorus,
11. vitamin A.

The regression coefficients for steers and heifers are shown in Appendix Tables 1 and 2.

The nutrient composition of the feeds together with these equations were the basis for calculating the rations that were used to produce the various possible rates of gain in this analysis.

Feed Analyses

Samples of feed from throughout Wyoming have been analyzed for nutritional contents by the Divisions of Animal Science and Biochemistry of the College of Agriculture, University of Wyoming. The average results of analyses are summarized in Table 2. According to Yates (1981), stockmen should consider providing supplemental phosphorus for their livestock because most forages from Wyoming that were tested were borderline in phosphorus.

A feed intake limit was used in calculating all rations. It is directly related to the TDN content of the roughage. Calves being fed a forage crop with a TDN content of 52% can consume about 2.8% of their average body weight daily for the feeding period. However, calves can consume up to 3% of their body weight of alfalfa at 61% TDN.[3/] Young, rapidly growing animals can consume a larger percentage of their body weight than older, fleshier animals. An exception is lactating cows which can consume forages at the upper limits.

Feeding Programs

The feeding programs evaluated were based on the types of feed normally raised and fed and type of programs commonly used in different parts of Wyoming. Feeding programs were specified using feeds or combinations as follows:

1. grass hay only, and with concentrates to provide two rates of gain;
2. alfalfa hay only, and with concentrates to achieve a high rate of gain;
3. grass and alfalfa hay in a 50/50 ratio, and with concentrates to provide two rates of gain; and
4. alfalfa hay and corn silage to provide two rates of gain.

2/ Data from Tables I and IA, p. 22-25, from Nutrient Requirements of Beef Cattle, 5th edition, and Tables 5 and 6; Net Energy Requirements of Growing Steers and Heifers, (Lofgreen and Garrett, 1968, p. 801) were used to estimate the equations.

3/ Personal communication with David Yates, formerly Assistant Professor, Division of Animal Science, University of Wyoming, 1981.

Each ration was calculated for both steers and heifers, using the net energy system and equations described previously. It was thought that approach would give reasonably accurate estimates which would be consistent between steers and heifers and among all rations. Experimental data from feeding trials, where they are available, would have experimental errors associated and be less consistent than the rations calculated. Also, experimental data are not available for some of the rations, particularly those using grass hay or mixtures. There is little experimental data for heifers on any rations.

There is a variation among ranching operations in Wyoming in weaning weights of calves produced and in feeding periods. For this study, 380 lb. and 400 lb. were used as the starting weight (weaning) for heifers and steers, respectively. It is believed that these starting weights are representative of the average weaning weights of calves in Wyoming. The length of the winter feeding period, 165 days (roughly Nov. 15 - May 1), was chosen to be representative for many Wyoming operations.

Table 2. Nutritional Contents of Feeds Used in Ration Calculations.

Item	Unit	Grass Hay	Alfalfa Hay	Corn Silage[d]	Alfalfa-Corn Silage[e]	Barley
Crude Protein[a]	Pct.	8.60	17.10	8.84	12.11	10.89
TDN[b]	Pct.	52.00	61.00	54.09	56.39	67.77
Calcium[a]	Pct.	0.49	1.71	0.37	0.87	0.06
Phosphorus[a]	Pct.	0.15	0.22	0.24	0.24	0.38
Vitamin A	1000 IU/lb.	19.00	16.70	2.98	7.54	
Mcal/lb.[c]						
NEm	Mcal	0.50	0.59	.52	0.54	0.78
NEg	Mcal	0.15	0.31	.20	0.23	0.52
Lb./Mcal						
NEm	Lb.	1.98	1.69	1.92	1.85	1.28
NEg	Lb.	6.48	3.19	5.00	4.40	1.92

Source: Based on the College of Agriculture's Division of Animal Science and Division of Biochemistry analysis of feed samples from throughout Wyoming.

[a] Percent, on a 90% dry matter basis.

[b] Percent, on a 100% dry matter basis.

[c] Estimated from the relationship shown between percentage TDN and Mcal, NEm and NEg based on United States - Canadian Tables of Feed Composition.

[d] Averaged 69.56% moisture (30.44% dry matter), but the contents are converted to 90% dry matter basis the same as hay.

[e] Based on 1/3 alfalfa and 2/3 corn silage on a 90% dry matter basis or about 85.5% corn silage and 14.5% alfalfa as fed.

Rations Using Grass Hay, Alfalfa and the Combination

Grass Hay

The ration that was calculated for steers and heifers being fed for maximum daily gain using grass hay only is shown in Table 3. The maximum daily gain, .28 lb. for heifers and .34 lb. for steers, is limited by the amount of feed of this quality that can be consumed. Calves on such low daily gains can be subjected to cold stress and the daily gains may actually be lower than those shown. Protection from wind and wetness would be especially important.

Grass hay required by the heifers amounts to 11.27 lb. daily and 1,860 lb. for the 165 day feeding period. Hay wasted is computed at 10% of the amount consumed for the season. Thus, 12.4 lb. of grass hay is needed daily and 2,046 lb. for the season for 403 lb. average weight heifers to gain 0.28 lb. daily. This ration provides adequate amounts of TDN, protein, minerals, and Vitamin A. Appendix Tables 3 and 4 show the nutrients required and the nutrients supplied in this and other rations used in this study.

Alfalfa Hay

Alfalfa hay comprised over 60% of the total hay produced in Wyoming in 1981 (Wyoming Agricultural Statistics, 1981, p. 59). It consistently yields more per acre, is very palatable, has higher protein and calcium content, and is higher in total digestible nutrients than most other roughages.

Rations using alfalfa hay are also shown in Table 3. Alfalfa hay contains more protein and energy for gain than grass hay. Thus, it is better than grass hay for wintering calves. Relatively good weight gains, up to 1.10 lb. and 1.24 lb. per day are attainable for heifers and steers, respectively. The intake limit, 3.0% as fed, is higher than calculated for grass hay. Alfalfa hay is more palatable and has a higher TDN percentage than grass hay, allowing better and more rapid digestion and consumption of larger amounts. Table 4 shows the relationship between body weight and consumption of alfalfa hay by steers.

Bloat may be a problem for some cattle when fed at the maximum intake limit so death loss could be greater at the higher rates of gain. Effects of cold stress are mitigated by higher rates of gain when feeding alfalfa hay. Provision for wind break protection would still be important to reduce feed consumption or improve gains.

Alfalfa-Grass Hay Mixture (50/50)

Wyoming ranchers often feed a combination of alfalfa and grass hay and a ration for such a mixture was used in this analysis. The nutritional content of the alfalfa-grass hay mixture used the average of the grass hay and alfalfa hay shown in Table 2 and is shown below:

Component	Percent
Crude Protein	12.85%
TDN	56.50%
Calcium	1.10%
Phosphorus	0.18%
Vitamin A IU/lb.	17,850

Net energy for maintenance and gain is:

	Mcal per lb.	Lb. hay per Mcal
NEm	0.54366	1.83940
NEg	0.20681	4.83530

The rations and performance possible on a 50/50 mixture of alfalfa and grass hay are shown in Table 3. Average daily gains of .57 lb. for heifers and .64 lb. for steers are achievable. Cold stress is likely to have an influence on the animals at these low gains. Shelter and bedding may also be needed to ensure healthy livestock and the gains described.

Table 3. Feed Requirements and Performance of Steer and Heifer Calves at Maximum Daily Gains Possible on Hay Rations (165 days).

Item	Grass Hay		Alfalfa Hay		Alfalfa-Grass Hay	
	Heifers	Steers	Heifers	Steers	Heifers	Steers
Average daily gain (lb.)	0.28	0.34	1.10	1.24	0.57	0.64
Initial weight (lb.)	380	400	380	400	380	400
Ending weight (lb.)	426	456	562	605	474	506
Average weight (lb.)	403	428	471	502	427	453
Intake limit, % as fed	2.80	2.80	3.00	3.00	2.90	2.90
Intake limit, lb. as fed	11.29	11.99	14.12	15.07	12.38	13.13
Daily requirements for:						
Net energy maint. (Mcal)	3.83	4.00	4.30	4.51	4.00	4.17
Net energy gain (Mcal)	0.39	0.44	1.70	1.85	0.79	0.86
Hay for NEm (lb.)	8.45	8.83	8.09	8.49	8.17	8.53
Hay for NEg (lb.)	2.83	3.16	6.02	6.55	4.24	4.60
Hay required (lb.)	11.27	11.99	14.12	15.04	12.41	13.13
Requirements for season:						
Hay consumed	1860	1978	2329	2482	2048	2166
Hay wasted (lb.)[a/]	186	198	233	248	205	217
Total hay (lb.)	2046	2176	2562	2730	2253	2383
Total hay daily (lb.)[b/]	12.40	13.19	15.53	16.55	13.65	14.44

a/ At 10% of total consumed.
b/ Includes waste.

Table 4. Relationship Between Body Weight and Consumption of Alfalfa Hay by Steers.

Body Weight		Dry Matter Consumption		Percent of Body Weight		
				D.M. Basis	As Fed Basis	As Fed Basis
Kg.	Lb.	Kg.	Lb.	percent	Lb.	percent
150	330	4.14	9.11	2.76	10.13	3.07
175	385	4.80	10.55	2.74	11.70	3.04
200	441	5.44	11.99	2.72	13.32	3.02
225	496	6.10	13.44	2.71	14.93	3.01
250	551	6.78	14.93	2.71	16.59	3.01
275	606	7.43	16.36	2.70	18.18	3.00
300	661	8.10	17.85	2.70	19.83	3.00

Source: Church, D.C., Livestock Feeds and Feeding, 1979., p. 140; Speth, C.F., 1974. Unpublished data. Nevada Expt. Sta., Reno, Nevada.

Corn Silage

Alfalfa and corn silage provides a good combination of feeds for wintering calves. Corn contains a high level of carotene, but beef cattle cannot convert the carotene to Vitamin A very efficiently. Corn silage is also low in protein so a protein supplement may be needed when the ration is mostly corn silage. Alfalfa hay, if provided in a large enough quantity, as in this ration, can provide for protein and minerals which may be deficient in the silage. Rations of corn silage and alfalfa hay required for medium and maximum daily gains are shown in Table 5.

Church (1979, p. 139) suggests that when only corn silage is fed, the animals intake is limited to 2.0 to 2.5% of the animals body weight on a dry matter (DM) basis due to the high moisture content of the silage. Kercher (1981b) suggests that calves will consume corn silage at the upper limits of alfalfa hay, 3.0% of their body weight if fed an adequate amount of hay with the silage. A hay equivalent method can then be used for estimating silage intake and quantity. An example illustrating this method and using 1/3 hay and 2/3 silage or 4.0 lb. hay and 8.0 lb. silage on a 90% DM basis is:

Table 5. Feed Requirements and Performance of Steer and Heifer Calves at Medium and Maximum Daily Gains Possible on 1/3 Alfalfa Hay and 2/3 Corn Silage (Dry Matter Basis) (165 days).

Item	Medium Gain		Maximum Gain	
	Heifers	Steers	Heifers	Steers
Average daily gain (lb.)	1.00	1.00	1.22	1.38
Initial weight (lb.)	380	400	380	400
Ending weight (lb.)	545	565	581	628
Average weight (lb.)	463	483	481	514
Intake limit, % as fed	6.91	6.91	6.91	6.91
Intake limit, lb. as fed	31.97	33.36	33.23	35.52
Daily requirements for:				
Net energy maint. (Mcal)	4.24	4.38	4.37	4.59
Net energy gain (Mcal)	1.51	1.42	1.94	2.11
Feed for NEm (lb. as fed)	15.67	16.17	16.12	16.95
Feed for NEg (lb. as fed)	13.27	12.53	17.04	18.54
Feed req. (lb. as fed)	28.94	28.70	33.16	35.50
Requirements for season:				
Silage consumed (lb.)	4084	4051	4679	5009
Hay consumed (lb.)	691	685	792	848
Silage wasted (lb.) [a]	408	405	468	501
Hay wasted (lb.) [a]	69	68	79	85
Total Silage (lb.) [b]	4492	4456	5147	5510
Total hay (lb.) [b]	760	753	871	933
Total daily use:				
Total silage (lb.) [b]	27.23	27.01	31.19	33.40
Total hay (lb.) [b]	4.60	4.57	5.28	5.65
Total feed (lb.)	31.83	31.58	36.47	39.05

[a] 10% of that consumed.
[b] Includes waste.

8 lb. corn silage x 0.90% DM
= 7.20 lb hay equivalent at 100% DM;

the hay equivalent divided by the DM content of the corn silage is

$\frac{7.2 \text{ lb.}}{0.3044}$ = 23.6531 lb. silage "as fed" based on a DM hay equivalent;

$\frac{23.6531 \text{ lb.}}{400 \text{ lb.}}$ = 5.9133% of body weight as corn silage "as fed".

The total feed intake limit then is 5.9133% for corn silage plus 1.0% of body weight of alfalfa hay "as fed", or 6.9133% of body weight total ration "as fed".

A ration composed of 1/3 alfalfa hay and 2/3 corn silage on a dry matter basis would consist of 85.535% corn silage and 14.465% alfalfa hay on an "as fed" basis using the moisture contents stated earlier. Combining the nutritional coefficients of alfalfa hay and corn silage cited previously on a 1/3-2/3 dry matter combination results in a ration containing the following nutrients:

Component	Percent
Crude Protein	12.11%
TDN	56.39%
Calcium	0.87%
Phosphorus	0.87%
Vitamin A IU/lb.	7,545

Net energy values are:

	Mcal per lb.	Lb. feed per Mcal
NEm	0.54147	1.84682
NEg	0.22741	4.39741

Rations Using Concentrates

Forages are often too low in digestible nutrients and net energy to meet the requirements for livestock to achieve high rates of gain. Whether calves should be fed concentrates during the winter depends on the amount and quality of the roughage being fed, the rates of gain that the operator is striving for and his future plans for his calves.

Barley, corn and oats are the major energy concentrates produced in Wyoming. Average feed grain production in Wyoming over the five-year period from 1976-1980 was 110,555 tons of barley for feed, 74,648 tons of corn for grain, and 39,146 tons of oats. In addition, some of the 93,877 tons of malting barley may be diverted to feed uses. Hence, feed barley accounts for about one-half or more of the feed grain concentrates produced in Wyoming with corn making up one-third and oats, one-sixth. In this study, for simplicity, barley was chosen to be the only concentrate used.

Corn contains more digestible nutrients and can produce much higher tonnage per acre than barley in areas where it is well-adapted. Hence, it is often preferred, both as a crop and as a feed.

Oats are commonly fed in Wyoming and are often included in a ration when calves are being started on feed. Because oats have a high fiber content and are comprised of about 30% hulls, they are lower in digestible nutrients and lack sufficient energy for gains as rapid as obtainable with barley or corn. Also, yields of oats in tons or pounds per acre are often much less than corn or barley.

Barley at 2.0 to 4.0 lb. per day may be fed in addition to hay if the calves are to be returned to pasture in the summer. If rapid gains are desired, 6.0 to 8.0 lb. of barley may be included in the ration. A ration of alfalfa hay with large amounts of barley may cause bloating, resulting in high death losses.

Calves consuming approximately 2.0 lb. of barley can maintain their maximum intake of grass hay, but cannot maintain maximum intake of alfalfa hay due to the nutritional composition of alfalfa and

its increased palatability over grass hay (Kercher, 1981b). As the level of barley is increased above 2.0 lb. in a ration, intake of any type of hay is reduced.

The intake limit was based upon the TDN percentage of the total ration based on information from Yates (1981).

Grass Hay and Barley

Grass hay of the quality and amount indicated in Table 3 produced maximum weight gains of 0.34 lb. for steers and 0.28 lb. for heifers. A ration including 2.0 lb. of barley in addition to the maximum allowable intake of grass hay will produce daily gains of 0.73 lb. and 0.66 lb. for steers and heifers (Table 6). Barley must be increased to 4.38 and 5.05 lb. for the steers and heifers, respectively, to achieve 1.0 lb. of daily gain, while intake of grass hay decreases.

Alfalfa-Grass Hay and Barley

A gain of 1.0 lb. per day requires 2.50 and 3.46 lb. of barley for steers and heifers, respectively, in addition to alfalfa-grass hay. Higher gains require considerably more barley. Heifers require 5.15 lb. of barley in addition to hay to gain 1.20 daily. Steers require 4.50 lb. in addition to hay to gain 1.25 pounds daily (Table 7).

Alfalfa Hay and Barley

Steers and heifers of the weights used in this study could gain 1.24 and 1.10 lb. if they consumed only alfalfa hay at their maximum intake level (Table 3). Barley was added to achieve the desired 1.50 lb. daily gain for both steers and heifers (Table 7). Note that the heifers require almost 2.0 lb. more barley than the steers to achieve this daily gain so barley comprises a much greater percentage of their ration. The level of barley could be increased to 25% of the ration for steers to produce higher gains than the 1.50 lb. shown here without having serious problems with bloat.

Summer Gains

Range or pasture forage is often the cheapest source of nutrients for cattle. The amount and nutritional quality of forage available to an animal varies due to growing conditions and stage of plant growth. These variations cause fluctuation in the growth rate of animals throughout the year. Typically, growth rates are closely related to forage quality. They are highest during the early months of the grazing season while forage is actively growing and of high quality, and decline in the later months.

Research at the Central Plains Experiment Range (Nunn, Colorado about 25 miles southeast of Cheyenne, Wyoming) illustrates the effect of gains and grazing intensity (Table 8). Gains at moderate or light use are very low in October, even though 60% to 80% of the forage is still unused. Research at Squaw Butte Experiment Station, Burns, Oregon and at the Northern Plains Experiment Range, Miles City, Montana show similar results.

Compensatory Gains

Compensatory gain refers to the tendency for animals to make faster gains when provided with an abundance of feed after experiencing a period of retarded growth. The concept is important when considering alternative calf feeding programs which result in different rates of winter gains.

Table 6. Feed Requirements and Performance of Steer and Heifer Calves on Alternative Grass Hay and Barley Rations (165 days).

Item	Grass Hay With 2 lb. Barley		Grass Hay with Large Amount of Barley	
	Heifers	Steers	Heifers	Steers
Average daily gain (lb.)	0.66	0.73	1.00	1.00
Initial weight (lb.)	380	400	380	400
Ending weight (lb.)	489	520	545	565
Average weight (lb.)	435	460	463	483
Intake limit, % as fed	3.05	3.04	2.98	2.98
Intake limit, lb. as fed	13.27	13.99	13.78	14.38
Hay, lb. as fed	11.27	11.99	8.73	10.00
Barley, lb. as fed	2.00	2.00	5.05	4.38
Hay, % of ration as fed	84.93	85.70	63.36	69.55
Barley, % of ration as fed	15.07	14.30	36.64	30.45
Daily requirements for:				
Net energy maint. (Mcal)	4.05	4.23	4.24	4.38
Net energy gain (Mcal)	0.94	1.00	1.54	1.44
Feed for NEm (lb. as fed)	8.25	8.65	7.80	8.29
Feed for NEg (lb. as fed)	5.02	5.34	5.98	6.09
Feed required (lb. as fed)	13.27	13.99	13.78	14.38
Requirements for season:				
Hay consumed (lb.)	1860	1978	1441	1650
Barley consumed (lb.)	330	330	833	723
Hay wasted (lb.)[a/]	186	198	144	165
Barley wasted (lb.)[a/]	16	16	42	36
Total feed (lb.)[b/]	2392	2522	2460	2574
Total feed daily (lb.)[b/]	14.50	15.28	14.91	15.60
Ration contents				
Percent TDN (dry matter basis)	55.54	55.35	60.61	59.15
Percent Protein (dry matter basis)	9.95	9.93	10.49	10.34

a/ 10% of hay consumed and 5% of barley consumed.

b/ Includes waste.

Table 7. Feed Requirements and Performance of Steer and Heifer Calves on Alfalfa or Alfalfa-Grass Hay and Different Levels of Barley (165 days).

Item	Alfalfa-Grass Hay and Barley				Alfalfa-Barley	
	Heifers	Steers	Heifers	Steers	Heifers	Steers
Average daily gain (lb.)	1.00	1.00	1.20	1.25	1.50	1.50
Initial weight (lb.)	380	400	380	400	380	400
Ending weight (lb.)	545	565	578	606	628	648
Average weight (lb.)	463	483	479	503	504	524
Intake limit, % as fed	3.00	3.00	3.03	3.02	3.10	3.06
Intake limit, lb. as fed	13.88	14.48	14.51	15.19	15.62	16.03
Hay, lb. as fed	10.42	11.98	9.36	10.69	11.37	13.68
Barley, lb. as fed	3.46	2.50	5.15	4.50	4.25	2.35
Hay, % of ration as fed	75.07	82.73	64.51	70.38	72.79	85.34
Barley, % of ration as fed	24.93	17.27	35.49	29.62	27.21	14.66
Daily requirements for:						
Net energy maint. (Mcal)	4.24	4.38	4.36	4.52	4.53	4.66
Net energy gain (Mcal)	1.54	1.44	1.94	1.88	2.58	2.36
Feed for NEm (lb. as fed)	7.84	8.34	7.72	8.19	7.84	8.38
Feed for NEg (lb. as fed)	6.04	6.14	6.79	7.00	7.78	7.65
Feed required (lb. as fed)	13.88	14.48	14.51	15.19	15.62	16.03
Requirements for season:						
Hay consumed (lb.)	1719	1976	1545	1764	1876	2257
Barley consumed (lb.)	570	412	850	743	701	388
Hay wasted (lb.)[a/]	172	198	155	176	188	226
Barley wasted (lb.)[a/]	28	21	42	37	35	19
Total feed (lb.)[b/]	2489	2607	2592	2720	2800	2890
Total feed daily (lb.)[b/]	15.09	15.80	15.71	16.48	16.97	17.52
Ration contents						
Percent TDN (dry matter basis)	61.22	59.78	63.22	62.15	64.94	63.11
Percent Protein (dry matter basis)	13.75	13.91	13.52	13.65	17.14	18.00

[a/] 10% of hay consumed and 5% of barley consumed.
[b/] Includes waste.

Lawrence and Pearce (1964) conducted one of the most complete studies of compensatory growth of wintering yearling beef cattle on different planes of nutrition. Shorthorn and Sussex cross steers were individually fed and live-weight gain, food consumption and body size changes were measured during the winter and subsequent summer grazing period. Results were as follows:

Average Daily Gains		
Winter 168 days (lb.)	Summer 153 days (lb.)	Total Gains (lb.)
0.00	2.64	404
0.75	2.16	456
1.50	1.25	443

Skeletal growth indicated by girth, depth, width, length and height continued at a reduced rate for animals at zero gain when compared with the medium and particularly the high gain treatment group. The depth, width and girth of the low treatment animals showed the most growth during the summer period, but the changes were not enough to fully compensate for the differences in winter feeding, and differences between the different treatment groups were still apparent at the end of the summer grazing period.

Very few of the feeding trials involving compensatory gains were conducted using heifers. In Montana, Wood (1957) showed that heifer calves wintered on a high plane of nutrition had the highest gains during the winter and the lowest gains during the summer compared to heifers wintered on a low plane of nutrition.

Table 8. Average Monthly Gains for Yearling Heifers Grazing at Varying Intensities 1940-1949, Central Plains Experiment Range (Nunn, Colo., about 25 miles southeast of Cheyenne, Wyo.).

Item	Unit	Heifers-Intensity of Grazing		
		Heavy (60% use)	Moderate (40% use)	Light (20% use)
Month				
May	lb.	65.5	69.2	69.3
June	lb.	56.2	60.5	64.0
July	lb.	52.3	58.3	58.1
August	lb.	40.9	49.4	51.3
September	lb.	19.8	31.8	34.4
October	lb.	-14.2	.9	7.7
Season	lb.	220.5	270.1	284.8
Average Numbers				
Animals	no.	90.7	91.7	61.9
Acres	Acres	851.9	1455.7	1488.4
Acres/Animal	Acres	9.4	15.9	24.0

Source: Klipple, G.E. and David F. Costello, "Vegetation and Cattle Responses to Different Intensities of Grazing on Short Grass Ranges on the Central Great Plains." Technical Bulletin No. 1216, U.S. Department of Agriculture (Washington: 1960), p. 65, 66.

In northeastern Nevada, Bohman (1955) conducted an experiment in which native mountain meadow hay harvested at two stages of maturity was fed to 137 calves for the winter periods from 1945-1953. Animals fed the higher quality early cut hay had greater gains than those fed approximately the same amount of late cut hay. During the subsequent summer grazing period, the animals fed the late cut hay gained more but still weighed less than those fed the higher quality forage. The main difference in the hay was the protein content. Lack of sufficient protein is critical for young, rapidly growing animals and lactating cows.

A three-year study conducted by Elliot (1967) in Wyoming found that summer gains and also feedlot gains were inversely related to previous winter gains. Approximately 105 Hereford steer calves were wintered each year to gain at three different levels (0.50, 1.0, 1.50 lb. per day). In the spring, half of each group was finished in a feedlot and the other half summered on a short grass range. Inversely related gains were found while on summer pasture with the low winter gain group gaining the most weight while on grass as shown below:

Average Daily Gain (lb.)	
Winter	Summer
0.46	1.48
0.85	1.34
1.46	1.06

Compensatory growth responses are highly variable due to the previous winter treatment and the quality and quantity of the summer forage available. In general, during re-alimentation, animals wintered at low rates of gain will recover about 50% of the difference in gain acquired during the winter period when compared to higher gaining groups. For example, assume two groups of animals wintered on different planes of nutrition weighing 450 lb. and 550 lb. in the spring. At the 50% level of compensatory gains, the spring weight difference of 100 lb. would be reduced to 50 lb. following summer. The lighter calves in the spring have compensated for 50% of the spring weight difference.

In this study, compensatory gains were estimated at 40%, 50% and 60% to reflect the variance in the quality of summer range in Wyoming and the differences in stocking rates. Analyses indicated that differences in percentage compensatory gains were not as critical as expected. Consequently, only the results at 50% compensatory gain are reported here. Ross (1983) reported details on the 40% and 60% rates. Winter and summer gains of steers and heifers on different rations are summarized in Table 9.

CATTLE AND FEED PRICES

In Wyoming the peak marketing months are October and November for calves and September and October for yearling steers and heifers (Table 10). The small quantity of yearling heifers sold in relation to steers is due to retention of heifers for replacement, and inflation of steer sales by re-sale of purchased animals from out-of-state.

The interstate movements shown in Table 10 do not include inter-farm sales and movements. These may be quite significant, particularly in the spring when many of the cattle sold remain in Wyoming for summer grazing.

The three production-marketing alternatives used in this analysis coincide with the months of peak movements:

1. selling November calves;

2. selling April short yearlings which are November calves wintered through April for a period of 165 days on different feed rations and various rates of gain; and,

3. selling long yearlings in October after having been summered on grass.

Table 9. Winter Gains and Subsequent Summer Gains for Steers and Heifers With Initial Calf Weight of 400 lb. for Steers and 380 lb. for Heifers.

Ration	ADG Winter (lb.)	Spring Weight (lb.)	Summer[a] Gains (lb.)	ADG[a] Summer (lb.)	Fall Weights (lb.)
Steers					
Grass hay	0.34	456	261	1.71	717
Alfalfa-grass hay	0.64	506	236	1.54	742
Grass hay and 2 lb. barley	0.73	520	229	1.50	749
Grass hay and barley[b/c]	1.0	565	206	1.35	771
Mixed hay and barley[b/c]	1.0	565	206	1.35	771
Alfalfa-silage[b]	1.0	565	206	1.35	771
Alfalfa hay	1.24	605	186	1.22	791
Mixed hay and barley[b/c]	1.25	606	186	1.22	792
Alfalfa-silage[b]	1.38	628	175	1.14	803
Alfalfa and barley	1.50	648	165	1.08	813
Heifers					
Grass hay	0.28	426	239	1.56	665
Mixed hay	0.57	474	215	1.41	689
Grass hay and 2 lb. barley	0.66	489	208	1.36	697
Grass hay and Barley	1.0	545	180	1.18	725
Mixed hay and barley[b/c]	1.0	545	180	1.18	725
Alfalfa-Silage[c]	1.0	545	180	1.18	725
Alfalfa hay	1.10	562	171	1.12	733
Mixed hay and barley[b/c]	1.20	578	163	1.07	741
Alfalfa-Silage[b]	1.22	581	162	1.06	743
Alfalfa and Barley	1.50	628	138	0.90	766

[a] Summer gains for 153 days (approximately May 1 to Oct. 1) at the 50% level of compensatory gains.
[b] Weight gains at either a medium or the maximum feed intake level.
[c] Mixed hay refers to the alfalfa-grass hay combination.

Table 10. Average Monthly Interstate Movement of Wyoming Cattle by Classes for Years, selected months 1975-1980 (head).

Item	Mar.	Apr.	May	Sept.	Oct.	Nov.
Calves	5,388	5,458	5,776	6,386	57,968	75,718
Yearling Steers	16,219	23,500	21,249	105,312	131,968	45,676
Yearling Heifers	14,182	18,128	15,634	50,238	60,623	33,249

Source: Wyoming Crop and Livestock Reporting Service, Cheyenne, Wyoming.

Cattle Prices

Billings cattle prices were used in this analysis because of proximity to Wyoming and because of the availability of data from 1962 through 1981 for the months required (Kearl, 1981a, 1980). Cattle from northern Wyoming and other cattle marketed at Billings are typical of the quality and type of cattle produced throughout Wyoming. Prices at Billings tend to be about 1% lower in the spring and 2% lower in fall than at Torrington, Wyoming and Greeley, Colorado areas which are two other major market outlets for Wyoming cattle (Kearl, 1981c).

Average monthly prices for choice grade of 400 lb. steers and 380 lb. heifer November calves, April short yearlings and October long yearlings for both steers and heifers were used. The April and October prices were varied to represent prices for specific weights of heavier animals depending on the different winter feed rations and subsequent summer gains.

Costs and Prices Paid

Feed Prices

Feed ingredient prices used were November prices received by Wyoming farmers and ranchers for 1962 through 1980 (Table 11).

The all hay price was used for grass hay. The price of corn silage was based at one-third of the price of alfalfa hay, which reflects the difference in dry matter content. Price of hay in Wyoming has moved upward over the years. There were only two years, 1966 and 1980, when hay prices were abnormally high and out of line with the general trend.

Feed barley prices remained very stable from 1962 through 1971 but increased dramatically in 1973 and 1974 to a high of $6.35 per cwt, due primarily to grain sales to Russia in 1973, and world grain crop short-falls in 1972 and 1974. Prices of all feeds increased rapidly through the 1971-81 period.

Interest

The "Production Credit Association's Average Cost of Loans" for the U.S., was used to represent the annual rate of interest for the years 1962-1974 (Agricultural Statistics, 1972, p. 587; 1977, p. 488). Interest costs charged by the Production Credit Association in Wyoming were used for the years 1975-81 (Vaske, 1982).

Because ownership may be maintained from November of one year through October of the following year, for instance 1962-63 or 1980-81, the interest rate used for each year's analysis was that of the second year in the production period. Interest costs were calculated on the beginning value of the animals for each of the production-marketing phases, and for winter feed costs, summer feed costs and the non-feed costs for both the winter and summer periods.

Cost Index

A cost index representing prices paid by United States farmers for production items, interest, taxes and wage rates was used to adjust estimates of the non-feed costs.

Non-Feed Costs

A study of custom feedlots in Colorado reported a variety of methods used to calculate customers costs. Yardage costs varied from $0.06 to $0.22 per animal-day and feed was priced at cost plus a markup which ranged from $2 to $16 per ton for handling and processing (Madsen et al., p. 18, 1979). The feedlots that charged high yardage costs normally charged a low markup on feed, and vice-versa. The feedlot

Table 11. Input Prices for Feed, Interest, Production Index, and Grazing Costs per AUM, 1962-1981.

Year	November Prices: All Hay $/Ton	November Prices: Alfalfa $/Ton	November Prices: Barley $/cwt[a/]	Interest Rates (%)[b/]	Cost Index 1967=100	Summer Grazing Costs/AUM	Non-Feed Costs $/Ton
1962	17.50	17.50	1.88	[d/]	[d/]	[d/]	
1963	18.50	18.50	1.85	6.30	90	2.22	5.42
1964	20.00	19.50	2.00	6.47	90	2.22	5.42
1965	21.00	21.00	2.02	6.58	94	2.32	5.66
1966	29.00	29.00	2.23	6.87	99	2.44	5.96
1967	18.50	18.50	2.04	7.29	100	2.46	6.02
1968	20.50	20.50	1.88	7.34	102	2.51	6.14
1969	24.00	24.00	2.04	7.79	107	2.64	6.44
1970	24.50	24.00	1.79	8.98	112	2.76	6.74
1971	25.20	25.00	2.08	7.28	117	2.88	7.04
1972	30.20	30.00	2.48	7.02	125	3.08	7.52
1973	43.50	44.00	4.08	8.09	149	3.67	8.97
1974	52.00	52.00	6.35	9.43	169	4.16	10.17
1975	51.00	50.00	5.04	8.60	186	4.58	11.20
1976	55.50	56.00	4.63	7.68	198	4.88	11.92
1977	42.50	43.50	3.00	7.42	208	5.12	12.52
1978	46.50	46.00	3.31	8.65	226	5.57	13.61
1979	56.50	56.00	4.06	10.36	261	6.43	15.71
1980	73.50	69.50	5.31	13.39	293	7.22	17.64
1981	[d/]	[d/]	[d/]	16.11	315	7.76	18.96

[a/] $/feed barley cwt., converted from $/bu @ 48 lb. per bu.
[b/] National P.C.A. rates 1962-74; Wyo. P.C.A. rates 1975-1981.
[c/] Annual average of prices paid by farmers, United States, includes production cost items, interest, taxes, and wages.
[d/] Interest rates, cost index and summer grazing costs are lagged one year to correlate with the expenses that occur over the winter and summer periods. Feeding programs ended in the fall of 1981.

Sources: Wyoming Price Statistics 1908-1970, Bulletin 71-1, Statistical Reporting Service, U.S.D.A. and Division of Markets, Wyoming Dept. of Agriculture.
Wyoming Agricultural Statistics, 1981, p. 103, and 1976, pp. 92-93, Wyoming Crop and Livestock Reporting Service, Cheyenne, Wyoming.
Agricultural Statistics, 1972, p. 587, U.S.D.A.
Agricultural Statistics, 1977, p. 488, U.S.D.A.
Dave Vaske, Wyoming Production Credit Association, Branch Office Manager, Laramie, Wyoming,
Prices Paid and Received by Wyoming Farmers and Ranchers AE-80-19-R, Division of Agricultural Economics, University of Wyoming, Table 18, Sept. 1981.

with the simplest method in 1979 charged the cost of feed plus $16 per ton for handling and processing of all feeds and charged no yardage costs.

A study by Gee (1969, p. 6) reported that cost of feed plus a $7 per ton markup for handling and processing was the most common charge by custom feedlots in Colorado in 1968.

Comparisons of fall purchased stocker systems and spring purchased stocker systems (Kearl, 1969, p. 34) were used to estimate non-feed wintering costs at 1963-65 levels at $5.35 per head. The average rate of gain over the winter period was about 45 lb. for the fall purchased stocker calves which consumed slightly under one ton of feed.

Costs from these three studies, indexed either forward or backward were comparable, as shown below:

		Gee	
Year	Kearl	1969	1979
1963-65	5.35[a/]	6.26	5.60
1968	5.98	7.00[a/]	6.25
1979	15.29	17.91	16.00[a/]

[a/] Cost directly from the study. Other costs were calculated by "indexing" using the production index in Table 11.

Non-feed cost per ton fed was set at $5.50 for hay and barley at the 1963-65 average index of 91.33 (1967=100) and adjusted annually. Because of the high moisture content of corn silage, the feeding cost per ton of silage fed was one-third of that of hay and barley or $1.83 per ton of silage fed at 1963-65 levels.

Non-feed costs presumably include costs for all labor, management, variable costs for facilities and equipment, interest at a fair rate of return on all feedlot facilities and equipment, and other fixed costs such as depreciation, taxes, repairs and insurance on the feedlot and equipment. Non-feed costs as calculated would be greater than the variable costs which a Wyoming rancher might incur for feeding these types of rations to wintering calves.

It was assumed that most veterinary expenses occur during the post-weaning period and during the winter. This expense was included as part of non-feed costs charged per ton of feed fed.

Summer Costs

Two different approaches were considered for estimating non-forage costs for summer. These costs include items such as labor, fuel, repairs for vehicles and improvements, and salt. Non-forage costs from a 1963-65 study were estimated at $2.27 per animal-unit-month (AUM) for summer stocker steers (Kearl, 1969, p. 34), and expand to $7.28 per AUM in 1980. Conversely, Jacobs et al. (1982, p. 40), using a slightly different and more detailed procedure for adjustments and a different reference (Kearl, 1980), show summer non-forage costs of $6.96 per AUM at 1980 prices. This adjusts to $2.17 per AUM at the 1963-65 average. For this study, a summer non-forage cost of $2.25 per AUM was used for the base period, 1963-65, and adjusted annually to reflect changes in the production index. This resulted in a cost of $7.22 per AUM in 1980.

A lease cost or opportunity cost for forage per se was not included. Instead, a return to land was calculated.

Animal-Unit-Months and AUM Requirements

An AUM is defined here as the amount of feed required to maintain a 1,000 lb. cow for one month. Basal metabolic requirements for ruminant

animals is related to the body weight by the formula:

$$AU = \frac{Wt.^{.75}}{1{,}000^{.75}}$$

Wt. is the average monthly weight of the animal during the grazing period and the denominator represents the weight of the mature cow (Lewis et al., 1956). In this study, AUM's are calculated by taking the average of the spring turnout weight and estimated fall weight and using the formula to calculate the required AUM's. That, in turn, was used to calculate return per AUM to allow valid comparisons among programs producing different weights of animals having different pasture requirements.

RESULTS

Ten calf-wintering programs for steers and ten for heifers were evaluated using a simple form of simulation. Prices of cattle, feed and interest rates were allowed to vary as they had actually varied over the years 1962-1981 in Wyoming. Non-feed costs during the winter and summer non-forage costs were also allowed to vary as the production index had varied over the years. Winter weight gains, spring weights, summer weight gains, and fall yearling weights varied with the different winter feeding regimes, but were not varied from year to year.

The total feed and AUM requirements of steers and heifers for the winter and grazing periods are summarized in Table 12. The feeding programs were evaluated through the winter, summer, and the total period.

Alfalfa Hay and Corn Silage

Rations composed of one-third alfalfa and two-thirds corn silage on a dry matter basis provided the largest total return for the winter-summer period. Steers had an average return of $20.73 for the total period, and heifers $11.51 (Table 13). The same rations also produced the largest positive return over all costs for the winter period, $7.77 for steers and $3.08 for heifers. These winter period returns seem small. However, charges at market rates of return or cost compensate for feed and use of capital, labor, management, facilities, and equipment. The return over total costs for the winter period is a "pure profit".

Winter Period

The beginning values for the winter period are based on November prices per cwt. for 400 lb. steers and 380 lb. heifers, but allow for a 3% shrink if the calves were sold with a 3% shrink, or transported to a market. Thus, the beginning value represents an opportunity cost to a rancher if he foregoes a sale by retaining ownership of the calves.

The spring price per cwt., and value are based on April prices at the end of the 165 day winter feeding period and allow for a 2% winter death loss and a 3% shrink. The spring value represents market value if the animals are sold in the spring, or the opportunity cost of keeping the calves for pasturing through the summer.

Gross margin is the ending value minus the beginning fall value.

The total costs of the feed fed during the winter period vary among the feeding regimes. They were computed based on the quantities of the feeds fed, which were constant through all years, and varying feed prices.

Interest costs on the value of calves and cost of feed was calculated for the total winter period of 5.5 months, on the assumption all these costs were incurred at the start of the winter feeding period.

Table 12. Total Winter Feed Required for Steers on Different Feeding Regimes and AUM's Required for the Total Summer Grazing Period.[a/]

Feeding Regime	Winter A.D.G. (lb.)	Hay[b/] (lb.)	Corn Silage[b/] (lb.)	Barley[b/] (lb.)	Total AUM's Summer Period
Steers					
Grass hay	0.34	2176			3.35
Alfalfa-grass hay	0.64	2384			3.51
Grass hay and 2.0 lb. barley	0.73	2176		346	3.55
Grass hay and barley[d/]	1.00	1815		759	3.69
Mixed hay and barley[d/]	1.00	2174		433	3.69
Alfalfa-corn silage	1.00	753	4456		3.69
Alfalfa hay	1.24	2730			3.82
Mixed hay and barley[d/]	1.25	1940		780	3.82
Alfalfa-corn silage	1.38	933	5510		3.89
Alfalfa-barley	1.50	2483		407	3.95
Heifers					
Grass hay	0.28	2046			3.16
Alfalfa-grass hay	0.57	2252			3.33
Grass hay and 2.0 lb. barley	0.66	2046		346	3.38
Grass hay and barley[d/]	1.00	1585		875	3.56
Mixed hay and barley[d/]	1.00	1892		598	3.56
Alfalfa-corn silage	1.00	760	4492		3.56
Alfalfa hay	1.10	2562			3.61
Mixed hay and barley[d/]	1.20	850		892	3.66
Alfalfa-corn silage	1.22	871	5147		3.67
Alfalfa-barley	1.50	2064		736	3.81

[a/] 165 day winter feeding period with initial weight of 400 lb., and 5 month grazing period.

[b/] The kind of hay, whether grass, alfalfa or a mixture is indicated by the side-heading.

[c/] Includes waste @ 10% for roughages and 5% for barley on an "as fed" basis.

[d/] Mixed hay refers to the alfalfa-grass hay combination.

Table 13. Steers and Heifers on Alfalfa Hay-Corn Silage Rations - Summary of Winter, Summer, and Total Period Results for 1962-63 - 1980-81 Average.[a/]

Item	Steers		Heifers	
	Alfalfa-Corn Silage Med Gain	Alfalfa-Corn Silage Max Gain	Alfalfa-Corn Silage Med Gain	Alfalfa-Corn Silage Max Gain
Winter A.D.G.	1.00	1.38	1.00	1.22
Spring weight	565	628	545	581
Summer A.D.G.	1.35	1.14	1.18	1.06
Fall weight	771	803	725	743
Returns over:				
Winter Period	(dol.)	(dol.)	(dol.)	(dol.)
Beginning price per cwt.	43.43	43.43	37.64	37.64
Beginning fall value b/	168.49	168.49	138.74	138.74
Ending spring price (cwt.)	43.00	41.51	38.27	37.62
Ending spring value c/	230.80	247.62	198.16	207.66
Gross margin	62.31	79.13	59.42	68.92
Feed cost	39.14	48.43	39.48	45.23
Interest on cattle and feed	8.91	9.29	7.63	7.88
Return over cattle, feed & int.	14.26	21.41	12.31	15.81
Non-feed costs	11.12	13.64	11.11	12.73
Return over all winter costs (1)	3.14	7.77	1.20	3.08
Summer Period				
Ending price (cwt.) d/	38.26	37.86	34.39	34.21
Ending yearling value	277.26	285.81	234.33	238.93
Gross margin	46.46	38.19	36.17	31.27
Non-forage grazing cost	14.57	15.34	14.02	14.47
Interest on cattle & pasture	9.26	9.90	7.99	8.37
Return to land (2)	22.63	12.95	14.16	8.43
Return to land per AUM	6.13	3.33	3.98	2.30
Total Period				
Return over cattle, feed & int.	51.75	50.00	40.77	38.99
Total return (1) + (2)	25.77	20.72	15.36	11.51

a/ At the 50% compensatory gain level and initial wt. of 400 lb.

b/ Beginning value allows for a 3.0% shrink.

c/ Spring value allows for a 2.0% winter death loss and a 3.0% shrink.

d/ Fall ending value allows for 2.0% winter death loss, 1.0% summer death loss and 3.0% shrink.

The return over cattle, feed and interest costs represents the return to an operator for his labor, equipment, facilities use, and other variable costs.

The basis for calculating non-feed costs has been described. They include costs for labor and management, and both variable and fixed costs for all the feedlot equipment and facilities for feed handling, processing and feeding. Medicine and veterinary services, etc. were also included. The production index was used to adjust the non-feed costs.

Interest charges on the non-feed costs were calculated for half of the winter period because not all these expenses would occur at the beginning.

The return over all winter costs is net return, or profit, after all costs associated with wintering the calves have been deducted.

Summer Period

Summer period sales prices were prices for yearlings in October. These prices vary because of the differences in weight produced by various winter and subsequent summer gains. A 2% winter death loss, 1% summer death loss, and a 3% shrink were used in calculating the ending value so the total gross sale value is reduced by 6%.

Gross margin for the summer period is the difference between the fall and spring values.

The summer non-forage cost has been explained. There was no charge for pasture rent, but instead, a return to land was calculated.

Interest on the cattle was calculated on the spring value and charged for the five months on pasture. Interest on the non-forage costs was calculated on the season non-forage (grazing) costs per head for half of the five summer months, because the costs are distributed through the period.

Return to land for the summer period was calculated by taking the gross margin less the non-forage costs and interest expense on the cattle and pasture.

Total Period

The return over cattle, feed and all interest is the ending October yearling value, less the cattle, feed, and all interest cost of the winter period, and interest costs on cattle for the summer period. Non-feed costs for winter and summer were not deducted. Those non-feed costs can vary widely among different operations, and only variable costs are really relevant for decision-making in the short run. Individuals can estimate their own non-feed costs for comparison with this study.

The total return over all costs for the total period considers costs mentioned and all non-feed costs associated with the winter and summer periods. It does not include a charge or lease for the summer forage which is a return to fixed capital and land.

Feeding for Medium or Maximum Rates of Gain

The alfalfa-corn silage rations were calculated at the maximum daily intake level to produce gains of 1.38 lb. for steers, and 1.22 lb. for heifers. These rations were also calculated at feeding levels to 1.0 lb. average daily gains for either steers or heifers (Table 13).

There is relatively little difference between medium or maximum daily gains in the return over cattle, feed and interest for the total period. Differences in the total return can be attributed to higher feed and non-feed costs because more feed is required and handled during the winter

period for animals on the higher rate of gain. The animals on maximum rates of gain have higher returns for the winter period. The animals on the medium rate of gain have greater returns over the summer period due to their lighter weight and thinner condition at turnout. This results in larger compensatory weight gains.

Cold stress should not be a serious problem or concern at 1.0 lb. average daily gains, if windbreaks or other shelter is available.

Alfalfa and Grass Hay

Alfalfa Hay

Steers and heifers fed alfalfa hay rations had the third and second best returns ($18.97 and $9.97) for the total period (Tables 14 and 15). Alfalfa hay is superior to grass hay or alfalfa-grass hay rations for producing winter gains. Returns over all costs averaged $2.75 for steers, and -$1.39 for heifers over the winter period.

Grass Hay

Steer and heifer calves wintered on grass hay had the lowest winter weight gains and lowest returns (largest losses) for the winter period of any of the rations analyzed. Conversely, they had the highest summer weight gains, and the greatest return to land for the summer period. The low winter gains compared with alfalfa hay are a result of the lower nutritional quality of grass hay. If adequate protein and minerals are available from hay, skeletal growth will continue over the winter months, producing animals with a potential for a substantial amount of compensatory growth over the summer grazing period.

Alfalfa-Grass Hay

These rations were a combination of 50% grass hay and 50% alfalfa hay, resulting in nutrient content of the rations and winter weight gains above those from grass hay, but still lower than from alfalfa hay.

The 19-year average returns using alfalfa-grass hay are very comparable to alfalfa hay for steers, but somewhat less than for alfalfa hay over the total period for heifers. The returns through the winter period are better on the alfalfa ration than on the alfalfa-grass hay for both steers and heifers. Conversely, summer weight gains of animals wintered on alfalfa-grass hay are good.

Hay and Barley

Alfalfa Hay and Barley

Rations consisting of alfalfa hay and barley were used to obtain winter gains of 1.5 lb. per day, the largest winter weight gain of any of the rations analyzed. There were positive returns over total costs of $4.46 per head for steers, and $0.08 for heifers for the winter months (Tables 14 and 15). Returns to land over the summer period were the lowest of any feeding program analyzed, due to the inverse relationship between winter and summer gains.

Grass Hay and Barley

A protein supplement or a grain concentrate such as barley is often added to grass hay to increase winter weight gains and to help offset the effects of cold stress. The barley used in this analysis contained 12.13% protein on a 100% DM basis, higher than the grass hay. Thus, barley helps satisfy requirements for protein, also, and a protein supplement was not required to balance the ration.

Table 14. Steers on Grass Hay, Alfalfa Hay, Alfalfa-Grass Hay, and Alfalfa-Barley Rations - Summary of Winter, Summer, and Total Period Results for 1962-63 - 1980-81 Average.[a/]

Item	Grass Hay	Alfalfa Grass Hay	Alfalfa Hay	Alfalfa and Barley
	(lb.)	(lb.)	(lb.)	(lb.)
Winter A.D.G.	0.34	0.64	1.24	1.50
Spring weight	456	506	605	648
Summer A.D.G.	1.71	1.54	1.22	1.08
Fall weight	717	742	791	813
Returns over:				
Winter Period	(dol.)	(dol.)	(dol.)	(dol.)
Beginning price per cwt.	43.43	43.43	43.43	43.43
Beginning fall value[b/]	168.49	168.49	168.49	168.49
Ending spring price (cwt.)	46.38	44.77	42.05	41.03
Ending spring value[c/]	200.92	215.22	241.69	252.59
Gross margin	32.43	46.73	73.20	84.10
Feed cost	38.36	38.01	47.74	55.83
Interest on cattle and feed	8.88	8.87	9.27	9.60
Return over cattle, feed & int.	-14.81	-0.15	16.19	18.67
Non-feed costs	10.71	10.66	13.44	14.21
Return over all winter costs (1)	-25.52	-10.80	2.75	4.46
Summer Period				
Ending price (cwt.)	38.98	38.63	38.01	37.74
Ending yearling value[d/]	262.72	269.41	282.63	288.43
Gross margin	61.80	54.19	40.94	35.84
Non-forage grazing cost	13.22	13.84	15.04	15.57
Interest on cattle & pasture	8.09	8.65	9.68	10.09
Return to land (2)	40.49	31.70	16.22	10.18
Return to land per AUM	12.08	9.03	4.25	2.58
Total Period				
Return over cattle, feed & int.	39.16	45.67	47.76	44.74
Total return (1) + (2)	14.97	20.90	18.97	14.64

a/ At the 50% compensatory gain level and initial wt. of 400 lb.
b/ Beginning value allows for a 3.0% shrink.
c/ Spring value allows for a 2.0% winter death loss and 3.0% shrink.
d/ Fall ending value allows for 2.0% winter death loss, 1.0% summer death loss and 3.0% shrink.

Table 15. Heifers on Grass Hay, Alfalfa Hay, Alfalfa-Grass Hay, and Alfalfa-Barley Rations - Summary of Winter, Summer, and Total Period Results for 1962-63 - 1980-81 Average.[a/]

Item	Grass Hay	Alfalfa-Grass Hay	Alfalfa Hay	Alfalfa and Barley
	(lb.)	(lb.)	(lb.)	(lb.)
Winter A.D.G.	0.28	0.57	1.10	1.50
Spring weight	426	474	562	628
Summer A.D.G.	1.56	1.41	1.12	0.90
Fall weight	665	689	733	766
Returns over:				
Winter Period	(dol.)	(dol.)	(dol.)	(dol.)
Beginning price per cwt.	37.64	37.64	37.64	37.64
Beginning fall value[b/]	138.74	138.74	138.74	138.74
Ending spring price (cwt.)	40.89	39.90	37.95	36.81
Ending spring value[c/]	165.47	179.65	202.62	219.60
Gross margin	26.73	40.91	63.88	80.86
Feed cost	36.07	39.56	44.80	58.59
Interest on cattle and feed	7.50	7.63	7.86	8.42
Return over cattle, feed & int.	-16.84	-6.28	11.22	13.85
Non-feed costs	10.06	11.10	12.61	13.78
Return over all winter costs (1)	-26.90	-17.38	-1.39	0.07
Summer Period				
Ending price (cwt.)	34.97	34.73	34.31	33.99
Ending yearling value[d/]	218.58	224.96	236.38	244.72
Gross margin	53.11	45.31	33.76	25.12
Non-forage grazing cost	12.51	13.13	14.23	15.04
Interest on cattle & pasture	6.70	7.26	8.17	8.84
Return to land (2)	33.90	24.92	11.36	1.24
Return to land per AUM	10.68	7.49	3.15	0.32
Total Period				
Return over cattle, feed & int.	29.83	32.02	37.09	30.42
Total return (1) + (2)	7.00	7.54	9.97	1.31

[a/] At the 50% compensatory gain level and initial wt. of 380 lb.
[b/] Beginning value allows for a 3.0% shrink.
[c/] Spring value allows for a 2.0% winter death loss and 3.0% shrink.
[d/] Fall ending value allows for 2.0% winter death loss, 1.0% summer death loss and 3.0% shrink.

Rations were calculated on the assumption that calves could eat 2.0 lb. of barley in addition to their maximum intake of grass hay to attain daily gains of 0.73 and 0.66 lb. for steers and heifers. Rations were also calculated to meet the nutritional requirements for a 1.0 lb. average daily gain.

Results of the total period are very similar for the two rations for both steers and heifers, whether fed for 1.0 lb. average daily gain, or for the lower rates of gain (Tables 16 and 17). The higher rate of gain resulted in a smaller loss through the winter, but the advantage was offset by higher summer returns from lower rates of gain.

Use of more barley to obtain a higher rate of gain may be desirable for replacement breeding heifers to help them reach their first estrus cycle earlier in the summer, breed earlier, perhaps have better conception rates, and produce a larger calf crop.

Alfalfa-Grass Hay and Barley

Barley was also added to the alfalfa-grass hay rations to produce gains of 1.0 lb. per day. A second set of rations was based on barley comprising about one-third and hay two-thirds of the ration. Feeding a higher proportion of barley to growing calves may cause digestive problems.

Results for the rations calculated using the lesser amount of barley and producing 1.0 lb. gain per day were superior to the rations for the heavier gain for both steers and heifers. Neither rate of gain produced a positive return over all costs for the winter period (Tables 16 and 17). Results of the total period show a return of -$1.31 for heifers wintered at 1.2 lb. per day gain as compared to $1.72 for heifers wintered at 1.0 lb. per day.

Results for steers over the total period show a higher total return for steers wintered at 1.0 lb. per day, $11.30 versus $8.69 for steers gaining 1.25 lb. per day. The average return to land per AUM for the summer period is $6.13 for steers at 1.0 lb. per day, compared to $4.24 for steers wintered to gain 1.25 lb. per day.

In general, higher total winter-summer period returns are available from feeding only roughages for steers. Adding barley to a ration increases the cost. The added winter weight gain does not offset the reduction in summer weight gains due to the inverse relationship between winter and summer gains. Thus, a rancher can increase net return by feeding only roughages and possibly adding an energy concentrate during extremely cold weather to help offset the effects of cold stress and heat loss.

Concentrates for Replacement Heifers

Replacement heifers are often chosen from among the larger heifer calves and may be heavier than the average 380 lb. heifers chosen for this analysis. It is important that skeletal growth continues over the winter months but without fattening the heifers.

Replacement heifers should weigh 600-650 lb. or more at breeding season. That can be achieved with gains of 200-250 lb. over the winter period and the first month on summer pasture. Thus, gains of 1.0 to 1.25 lb. or more per day over the winter months are desirable to facilitate breeding at 13 to 15 months of age. When heifers are not fed to gain well after weaning, they will take longer to reach puberty, resulting in a lower percentage of heifers cycling at the start of the breeding season.

Table 16. Summary of Winter, Summer, and Total Period Results for Steers On Grass Hay and Barley, and Alfalfa-Grass Hay and Barley Rations 1962-63 - 1980-81 Average.[a/]

Item	Grass Hay and 2 lb. Barley	Grass Hay and Barley	Alfalfa-Grass Hay and Barley	Alfalfa Grass Hay and Barley
	(lb.)	(lb.)	(lb.)	(lb.)
Winter A.D.G.	0.73	1.00	1.00	1.25
Spring weight	520	565	565	606
Summer A.D.G.	1.50	1.35	1.35	1.22
Fall weight	749	771	771	792
Returns over:				
Winter Period	(dol.)	(dol.)	(dol.)	(dol.)
Beginning price per cwt.	43.43	43.43	43.43	43.43
Beginning fall value[b/]	168.49	168.49	168.49	168.49
Ending spring price (cwt.)	44.32	43.00	43.00	42.03
Ending spring value[c/]	218.94	230.80	230.80	241.95
Gross margin	50.45	62.31	62.31	73.46
Feed cost	48.93	55.19	51.40	57.90
Interest on cattle and feed	9.32	9.57	9.42	9.68
Return over cattle, feed & int.	-7.80	-2.45	1.49	5.88
Non-feed costs	12.41	12.67	12.83	13.38
Return over all winter costs (1)	-20.21	-15.12	-11.34	-7.50
Summer Period				
Ending price (cwt.)	38.53	38.26	38.26	38.00
Ending yearling value[d/]	271.25	277.26	277.26	282.90
Gross margin	52.31	46.46	46.46	40.95
Non-forage grazing cost	14.02	14.56	14.56	15.07
Interest on cattle & pasture	8.75	9.26	9.26	9.69
Return to land (2)	29.54	22.64	22.64	16.19
Return to land per AUM	8.30	6.13	6.13	4.24
Total Period				
Return over cattle, feed & int.	35.99	35.04	38.98	37.44
Total return (1) + (2)	9.33	7.52	11.30	8.69

[a/] At the 50% compensatory gain level and initial wt. of 400 lb.
[b/] Beginning value allows for a 3.0% shrink.
[c/] Spring value allows for a 2.0% winter death loss and 3.0% shrink.
[d/] Fall ending value allows for 2.0% winter death loss, 1.0% summer death loss and 3.0% shrink.

Table 17. Summary of Winter, Summer, and Total Period Results for Heifers fed Grass Hay and Barley, and Alfalfa-Grass Hay and Barley Rations, 1962-63 - 1980-81 Average.[a/]

Item	Grass Hay & 2 lb. Barley	Grass Hay & Barley	Alfalfa-Grass Hay & Barley	Alfalfa-Grass Hay & Barley
	(lb.)	(lb.)	(lb.)	(lb.)
Winter A.D.G.	0.66	1.00	1.00	1.20
Spring weight	489	545	545	578
Summer A.D.G.	1.36	1.18	1.18	1.07
Fall weight	697	725	725	741
Returns over:				
Winter Period	(dol.)	(dol.)	(dol.)	(dol.)
Beginning price per cwt.	37.64	37.64	37.64	37.64
Beginning fall value[b/]	138.74	138.74	138.74	138.74
Ending spring price (cwt.)	39.55	38.27	38.27	37.67
Ending spring value[c/]	183.74	198.16	198.16	206.87
Gross Margin	45.00	59.42	59.42	68.13
Feed cost	46.64	54.69	51.48	57.11
Interest on cattle and feed	7.93	8.25	8.13	8.35
Return over cattle, feed & int.	-9.57	-3.52	-0.19	2.67
Non-feed costs	11.78	12.11	12.25	12.76
Return over all winter costs (1)	-21.35	-15.63	-12.44	-10.09
Summer Period				
Ending price (cwt.)	34.66	34.39	34.39	34.23
Ending yearling value[d/]	227.07	234.33	234.33	238.42
Gross margin	43.33	36.17	36.17	31.55
Non-forage grazing cost	13.33	14.02	14.02	14.43
Interest on cattle & pasture	7.42	7.99	7.99	8.35
Return to land (2)	22.58	14.16	14.16	8.77
Return to land per AUM	6.68	3.98	3.98	2.40
Total Period				
Return over cattle, feed, & int.	26.59	24.93	28.27	26.16
Total return (1) + (2)	1.23	-1.47	1.72	-1.32

[a/] At the 50% compensatory gain level and initial wt. of 380 lb.
[b/] Beginning value allows for a 3.0% shrink.
[c/] Spring value allows for a 2.0% winter death loss and 3.0% shrink.
[d/] Fall ending value allows for 2.0% winter death loss, 1.0% summer death loss and 3.0% shrink.

Many ranchers can grow only grass hay or an alfalfa-grass hay mixture and these feeds fail to produce the required gain by replacement heifers. Consequently, these ranchers need to feed a concentrate such as barley to attain the 1.0 to 1.25 lb. per day gain. The results of this analysis showed low or negative returns for heifers on all the grass hay or the alfalfa-grass hay rations with additional barley. Ranchers may prefer to select a limited number of replacement heifers and feed them extra grain to produce desired gains. Non-replacement heifers may be fed only hay. Their winter gain would be reduced to take full advantage of the compensatory gains available over the summer grazing period to produce higher net returns.

VARIATIONS THROUGH TIME

Comparisons among average returns are important, but consideration of variations in returns from year-to-year are also important. As explained previously, prices for calves, yearlings and feed, as well as interest rates and the production cost index, were all allowed to vary as they had varied through the years.

Prices

Prices have moved upward over the long run but show great variations within the long run and shorter periods of stable prices or periods when there are no upward trends and other periods of rapidly rising or falling prices. Cattle price data are available from Kansas City from 1920 up to the present, and are used here for example and discussion. These observations were tested by regression for the time periods 1926-41, 1935-51, 1948-69, and 1965-79. Details and results are reported elsewhere (Ross, 1983).

There were no significant long term trends either upward or downward through 1926-41 or 1948-69 although the price level was higher in the latter period. The price levels differed, but trends were similar. There were also two periods, 1935-1951 and 1965-1979 in which prices moved up rapidly. During the last period, 1965-1979, there were two rapid upward movements that reached peaks in 1973 and 1979 followed by precipitous declines to lower prices. These short-term price movements of such large dimensions magnify profits or losses and are significant in making management decisions. The analyses which follows was based on the 1962-81 time period, generally upward trending but with significant variations.

Prices at Billings, Montana were used in this analysis because of proximity to Wyoming and because of the availability of data from 1962 through 1981 for the months required. Figure 1 shows the October prices for 750 lb. steers at Billings, Montana from 1962-1982. Prices were at relatively low levels through most of the 1960's after having reached a peak in the spring of 1959. Prices trended upward from 1965 until 1973 when there was a sharp reversal. Uptrends resumed from 1974 through 1979 and then a reversal occurred in 1980 and 1981.

Feed Prices

November prices received by Wyoming farmers and ranchers for 1962 through 1980 were shown in Table 11. Hay prices moved upward over the years. They were higher than the general trend in 1966 and 1980 only. Feed barley prices remained stable from 1962 through 1971, increased through the 1971-81 period, and touched highs in 1973 and 1974. Interest rates also trended upward steadily, with reversals in some years. The production cost index increased steadily throughout.

Returns

The year-to-year variations of prices, costs and returns for the alfalfa hay ration are shown in Tables 18 and 19 for steers and heifers. Total returns were positive for the winter-summer period in 14 out of 19 years for steers, and 13 out of 19 years for heifers. Returns for winter, summer and season long were generally positive from 1962-63 through 1972-73. Prices were relatively low through the time period, but were trending upward. Price margins were negative from November to April in eight years and from November or April to the following October in ten years. However, the negative margins were generally in the 0.0% to -10% range and still allowed positive returns over costs most years.

Prices were more volatile for 1973-74 through 1980-81. Large negative returns occurred in 1973-74, 1979-80 and 1980-81 production years. In each case the large negative returns occurred after prices had moved up to high levels in 1973 and 1979, and had then fallen. For instance, in 1973-74 prices for steers declined about $17 per cwt. or 28% between November and April. The total price decline from November to the following October amounted to 50%. Declines were about as severe in absolute terms, but not in percentage terms, in 1979-80 and 1980-81 resulting in severe losses those years also.

Results on grass hay, alfalfa-grass hay, and alfalfa-corn silage are summarized in Tables 20, 21 and 22 and Appendix Tables 5, 6, 7, 8, 9 and 10. More complete details are available on other feeding regimes (Ross, 1983).

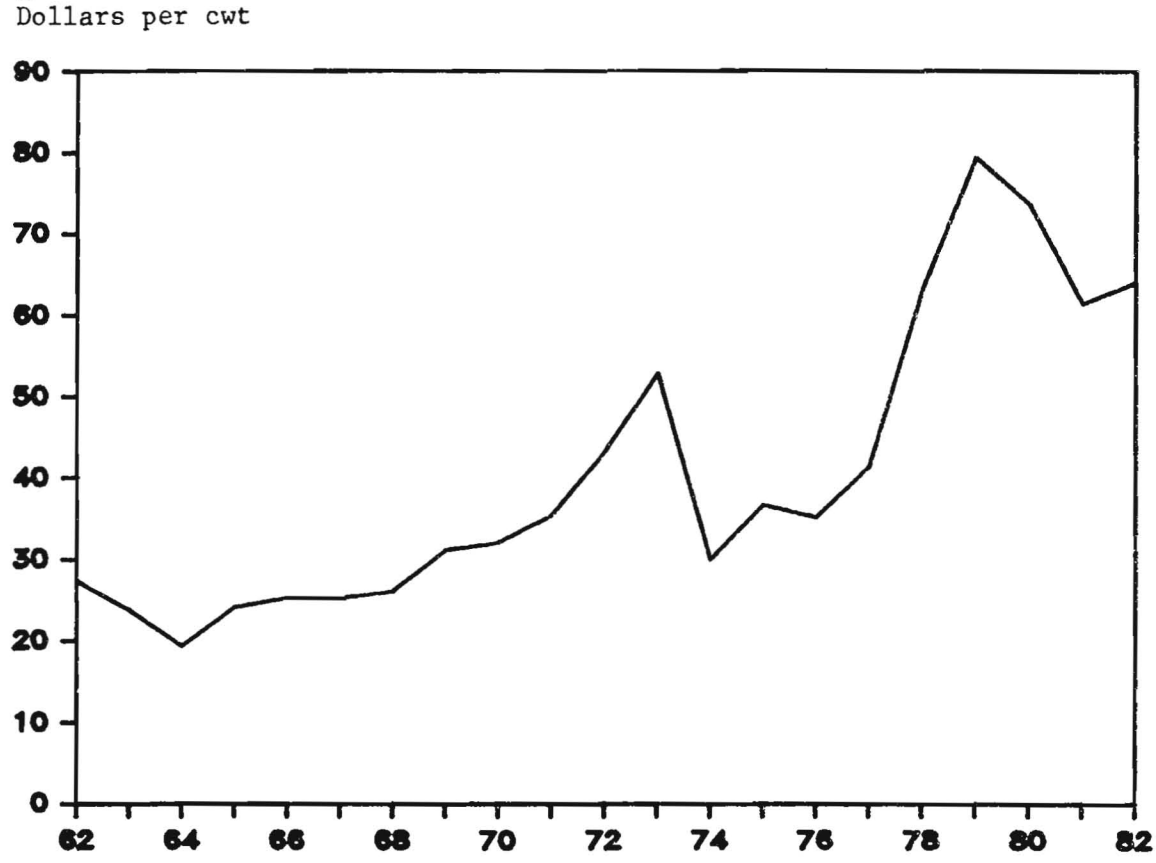

Figure 1. October Prices for 750 lb. Steers at Billings, Montana, 1962-1982.

Table 18. Steers on Alfalfa Hay at 1.24 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	30.33	26.03	23.89	4.05	-3.45	22.77	7.16	1.88	19.79	3.71
1963-64	26.75	21.50	25.25	-9.21	-16.71	18.86	4.72	1.24	4.10	-11.99
1964-65	21.60	23.50	26.62	21.36	13.52	23.26	25.18	6.60	55.51	38.70
1965-66	25.41	27.75	28.67	28.31	20.05	24.46	8.34	2.18	46.10	28.39
1966-67	27.88	25.89	39.59	-3.81	-12.16	24.38	18.42	4.82	24.16	6.25
1967-68	28.35	27.96	25.25	20.99	12.46	24.91	9.80	2.57	40.53	22.27
1968-69	30.51	30.97	27.98	26.50	17.55	29.36	24.24	6.35	60.98	41.80
1969-70	35.85	35.06	32.76	22.72	13.33	30.16	4.48	1.17	37.93	17.81
1970-71	36.47	35.41	32.76	23.54	13.77	33.15	25.60	6.71	60.32	39.37
1971-72	42.24	38.98	34.13	19.78	9.34	39.73	52.86	13.84	84.57	62.20
1972-73	52.66	52.51	40.95	47.58	35.11	48.93	37.56	9.84	99.39	72.67
1973-74	60.60	43.73	60.06	-56.45	-70.64	30.03	-54.13	-14.18	-94.37	-124.76
1974-75	26.62	32.09	70.98	3.39	-12.19	37.26	68.22	17.87	89.43	56.03
1975-76	36.30	46.26	68.25	49.54	32.98	33.38	-45.14	-11.82	23.32	-12.16
1976-77	39.03	41.78	76.44	4.61	-12.77	39.29	24.71	6.47	49.19	11.94
1977-78	45.13	55.77	59.38	76.88	57.94	59.57	89.24	23.37	187.75	147.17
1978-79	78.77	91.30	62.79	139.09	117.13	73.23	-27.95	-7.32	136.22	89.19
1979-80	97.02	71.20	76.44	-71.10	-95.91	69.70	57.86	15.15	15.09	-38.05
1980-81	83.60	71.26	94.87	-40.19	-67.03	59.80	-23.08	-6.05	-32.65	-90.11
Mean										
1972-81	56.20	54.49	64.43	17.31	-0.60	49.09	18.02	4.72	55.79	17.42
1962-81	43.43	42.05	47.74	16.19	2.75	38.01	16.22	4.25	47.76	18.97
Std. Dev.	21.69	18.94	22.20	46.46	47.25	16.52	36.92	9.67	60.23	61.06

[a/] Return over cattle, feed and interest.

Table 19. Heifers on Alfalfa Hay at 1.10 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	28.36	24.52	22.42	.37	-6.67	21.80	7.72	2.14	16.19	1.04
1963-64	24.92	19.92	23.70	-12.56	-19.60	16.37	-4.55	-1.26	-9.00	-24.15
1964-65	18.56	20.64	24.98	13.99	6.63	20.27	17.98	4.98	40.44	24.61
1965-66	21.95	24.45	26.90	19.35	11.60	21.55	5.28	1.46	33.56	16.88
1966-67	24.41	22.57	37.15	-10.80	-18.64	21.47	14.72	4.08	12.95	-3.92
1967-68	24.68	24.80	23.70	13.91	5.91	22.35	8.32	2.31	31.44	14.23
1968-69	25.94	27.79	26.26	22.21	13.81	25.56	13.25	3.67	45.12	27.05
1969-70	31.30	31.13	30.74	14.19	5.37	27.17	4.63	1.28	28.96	10.00
1970-71	32.40	32.58	30.74	18.80	9.63	30.43	19.90	5.51	49.26	29.53
1971-72	37.75	35.80	32.03	14.53	4.74	36.65	44.50	12.33	70.31	49.24
1972-73	44.96	46.55	38.43	36.89	25.19	44.57	36.72	10.17	87.08	61.90
1973-74	52.65	41.03	56.36	-42.04	-55.35	25.61	-66.53	-18.43	-93.25	-121.88
1974-75	22.05	26.04	66.61	-14.58	-29.21	30.35	48.28	13.38	50.54	19.07
1975-76	27.35	38.75	64.05	36.30	20.76	29.00	-31.59	-8.75	22.60	-10.83
1976-77	32.65	36.25	71.74	-4.98	-21.30	36.25	31.47	8.72	45.26	10.17
1977-78	38.37	49.40	55.72	58.87	41.10	56.90	98.35	27.25	177.68	139.45
1978-79	70.15	87.91	58.93	137.01	116.41	67.96	-45.11	-12.50	115.60	71.29
1979-80	86.19	66.29	71.74	-59.09	-82.37	64.56	44.41	12.31	12.10	-37.96
1980-81	70.52	64.65	89.03	-29.20	-54.38	53.03	-31.88	-8.83	-32.13	-86.26
Mean										
1972-81	48.26	49.27	60.46	13.37	-3.44	44.49	12.86	3.57	45.58	9.42
1962-81	37.64	37.95	44.80	11.22	-1.39	34.31	11.36	3.15	37.09	9.97
Std. Dev.	19.08	18.18	20.83	41.61	41.97	15.69	37.73	10.46	55.71	56.08

[a/] Return over cattle, feed and interest.

Table 20. Steers and Heifers on Grass Hay - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Steers					Heifers				
	Winter Period		Summer Period		Total	Winter Period		Summer Period		Total
Years	Return Over CF&I[a/]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over All Costs	Return Over CF&I[a/]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over All Costs
1962-63	-21.88	-27.86	27.64	8.25	-.22	-21.87	-27.49	25.07	7.90	-2.42
1963-64	-27.76	-33.74	18.50	5.52	-15.25	-27.99	-33.61	8.60	2.71	-25.01
1964-65	-2.41	-8.66	42.51	12.68	33.85	-5.11	-10.98	32.15	10.13	21.17
1965-66	5.77	-.82	24.77	7.39	23.95	-.52	-6.72	20.94	6.60	14.23
1966-67	-24.80	-31.46	35.80	10.68	4.33	-24.81	-31.07	27.13	8.55	-3.95
1967-68	-5.45	-12.24	30.31	9.05	18.07	-7.15	-13.53	24.35	7.67	10.82
1968-69	-.98	-8.11	45.68	13.63	37.57	.80	-5.91	29.36	9.25	23.45
1969-70	-4.40	-11.89	26.76	7.98	14.87	-4.69	-11.73	19.04	6.00	7.31
1970-71	-8.62	-16.41	51.45	15.35	35.04	-9.45	-16.77	40.83	12.86	24.05
1971-72	-6.41	-14.73	72.07	21.51	57.34	-9.20	-17.02	59.70	18.81	42.68
1973-73	13.61	3.67	62.52	18.66	66.19	6.79	-2.56	59.51	18.75	56.95
1973-74	-81.45	-92.76	-32.98	-9.84	-125.73	-64.81	-75.44	-42.49	-13.39	-117.93
1974-75	-24.38	-36.81	86.58	25.84	49.77	-35.59	-47.27	64.18	20.22	16.91
1975-76	7.87	-5.33	-4.04	-1.21	-9.37	3.46	-8.94	3.10	.98	-5.84
1976-77	-22.30	-36.16	51.37	15.33	15.21	-33.27	-46.30	56.68	17.86	10.38
1977-78	36.67	21.57	118.54	35.38	140.11	24.25	10.06	120.51	37.97	130.57
1978-79	86.85	69.35	13.73	4.10	83.08	79.63	63.18	2.72	.86	65.90
1979-80	-105.28	-125.06	78.02	23.28	-47.05	-103.52	-122.12	76.16	24.00	-45.96
1980-81	-95.96	-117.35	20.18	6.02	-97.18	-86.82	-106.94	16.63	5.24	-90.31
Mean										
1972-81	-19.08	-33.36	46.60	13.91	13.24	-21.91	-35.34	41.67	13.13	6.34
1962-81	-14.81	-25.52	40.49	12.08	14.98	-16.84	-26.90	33.90	10.68	7.00
Std. Dev.	44.13	45.61	34.23	10.22	60.26	39.85	41.36	34.49	10.87	54.12

[a/] Return over cattle, feed and interest.

Table 21. Steers and Heifers on Alfalfa-Grass Hay - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Steers					Heifers				
	Winter Period		Summer Period		Total	Winter Period		Summer Period		Total
Years	Return Over CF&I[a/]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over All Costs	Return Over CF&I[a/]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over All Costs
1962-63	-10.97	-16.92	20.43	5.82	3.50	-13.90	-20.09	18.65	5.60	-1.44
1963-64	-19.17	-25.12	13.41	3.82	-11.71	-22.38	-28.58	3.59	1.08	-24.99
1964-65	7.96	1.74	36.46	10.39	38.19	1.65	-4.82	26.96	8.10	22.14
1965-66	16.26	9.70	18.54	5.28	28.25	6.66	-.16	15.01	4.51	14.85
1966-67	-14.27	-20.90	29.51	8.41	8.61	-19.69	-26.59	22.24	6.68	-4.35
1967-68	5.87	-.89	22.97	6.54	22.07	.49	-6.55	18.29	5.49	11.74
1968-69	11.11	4.01	37.85	10.78	41.85	8.75	1.36	23.07	6.93	24.43
1969-70	8.29	.84	18.29	5.21	19.13	2.76	-4.99	12.91	3.88	7.92
1970-71	5.55	-2.20	42.13	12.00	39.93	.85	-7.21	32.92	9.89	25.71
1971-72	4.33	-3.95	65.72	18.72	61.77	-.28	-8.89	53.60	16.10	44.71
1972-73	28.14	18.25	54.37	15.49	72.63	17.57	7.28	51.16	15.37	58.43
1973-74	-69.32	-80.57	-38.86	-11.07	-119.43	-56.41	-68.12	-51.96	-15.61	-120.08
1974-75	-9.42	-21.78	80.05	22.80	58.27	-28.26	-41.13	57.89	17.39	16.76
1975-76	26.90	13.77	-17.96	-5.12	-4.19	15.70	2.04	-10.27	-3.09	-8.24
1976-77	-8.16	-21.95	42.66	12.15	20.71	-23.87	-38.22	47.61	14.30	9.39
1977-78	55.06	40.04	108.20	30.82	148.24	37.06	21.43	111.54	33.50	132.97
1978-79	111.18	93.77	-1.71	-.49	92.06	107.02	88.90	-21.82	-6.55	67.08
1979-80	-85.24	-104.92	67.57	19.25	-37.35	-86.83	-107.31	63.32	19.02	-43.99
1980-81	-66.91	-88.19	2.73	.78	-85.47	-66.37	-88.52	-1.13	-.34	-89.65
Mean										
1972-81	-1.34	-15.55	36.28	10.33	20.72	-8.47	-23.25	29.99	9.01	6.74
1962-81	-0.15	-10.80	31.70	9.03	20.90	-6.28	-17.38	24.92	7.49	7.54
Std. Dev.	44.04	44.98	34.75	9.90	59.97	41.06	42.15	35.72	10.73	54.85

[a/] Return over cattle, feed and interest.

Table 22. Steers and Heifers on Alfalfa and Corn Silage at 1.38 lb. or 1.22 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Steers						Heifers					
	Winter Period		Summer Period		Total Period		Winter Period		Summer Period		Total Period	
Years	Return Over CF&I[a]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over CF&I[a]	Return Over All Costs	Return Over CF&I[a]	Return Over All Costs	Return Over Costs	Return Per AUM	Return Over CF&I[a]	Return Over All Costs
1962-63	8.12	.51	4.38	1.13	21.24	4.89	3.65	-3.46	5.59	1.52	17.48	2.13
1963-64	-6.30	-13.91	3.07	.79	5.52	-10.84	-10.23	-17.35	-6.06	-1.65	-8.04	-23.40
1964-65	25.15	17.20	22.82	5.87	57.10	40.02	16.92	9.49	16.21	4.42	41.74	25.69
1965-66	31.66	23.27	6.51	1.67	47.79	29.78	22.32	14.49	3.47	.95	34.87	17.96
1966-67	-.31	-8.78	16.23	4.17	25.65	7.44	-8.50	-16.41	13.40	3.65	14.08	-3.01
1967-68	25.06	16.41	7.13	1.83	42.11	23.54	17.00	8.92	6.45	1.76	32.80	15.37
1968-69	30.62	21.54	21.57	5.55	62.61	43.11	25.24	16.76	11.51	3.14	46.58	28.27
1969-70	26.58	17.05	1.96	.50	39.47	19.01	16.66	7.76	3.42	.93	30.40	11.18
1970-71	28.32	18.40	22.27	5.72	61.97	40.67	22.86	13.60	17.44	4.75	51.03	31.04
1971-72	25.28	14.69	49.23	12.66	86.66	63.92	19.03	9.14	41.78	11.39	72.28	50.92
1972-73	53.89	41.24	33.25	8.55	101.66	74.49	42.35	30.53	32.93	8.97	88.97	63.46
1973-74	-50.47	-64.87	-58.44	-15.02	-92.40	-123.31	-37.37	-50.81	-70.15	-19.12	-91.94	-120.96
1974-75	8.64	-7.17	65.96	16.96	92.75	58.79	-10.44	-25.20	46.36	12.63	53.04	21.15
1975-76	57.35	40.55	-51.61	-13.27	25.02	-11.06	42.24	26.55	-36.69	-10.00	23.74	-10.14
1976-77	10.87	-6.77	20.12	5.17	51.23	13.35	.08	-16.39	28.45	7.75	47.62	12.05
1977-78	84.00	64.78	85.09	21.88	191.14	149.88	66.09	48.14	94.15	25.66	181.04	142.30
1978-79	147.08	124.81	-33.46	-8.60	139.18	91.35	144.81	124.01	-50.53	-13.77	118.39	73.48
1979-80	-66.46	-91.63	57.34	14.74	19.74	-34.29	-52.78	-76.29	41.41	11.28	15.86	-34.88
1980-81	-32.38	-59.60	-27.34	-7.03	-28.52	-86.94	-19.57	-45.00	-38.88	-10.60	-29.02	-83.88
Mean												
1972-81	23.78	5.60	14.01	3.60	58.65	19.62	19.44	2.47	8.88	2.42	48.00	11.35
1962-81	21.41	7.77	12.95	3.33	50.00	20.73	15.81	3.08	8.43	2.30	38.99	11.51
Std. Dev.	47.04	47.67	37.60	9.67	60.38	61.05	42.10	42.20	38.27	10.43	56.04	56.27

[a] Return over cattle, feed and interest.

The grass hay regime had the largest negative return over all costs for the winter period of any of the rations analyzed. Negative returns were the rule and positive returns the exception. Conversely, animals wintered on grass hay had the greatest return to land for the summer period with losses in only 2 of 19 years. As with the alfalfa hay, large losses were shown in 1973-74, when both steers and heifers had a negative return to land for the summer grazing period as well as winter and total. Significant losses occurred in 1979-80 and 1980-81 also.

The addition of alfalfa hay to grass hay produces results intermediate between the alfalfa and grass hay separately. The returns through the winter are less and negative returns more frequent than for alfalfa. However, summer period returns are better and total period returns and variations very similar to the alfalfa regimes.

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the costs and returns of winter feeding and summer pasturing programs for calves using different feeding regimes common to Wyoming.

The ration for each feeding regime was calculated to find the maximum rate of gain possible for both steers and heifers when only roughage was fed through a 165 day feeding period. Alfalfa, grass hay, a combination, and alfalfa-corn silage were roughages used. Several of the rations included barley at two different levels to produce different rates of gain, but not the maximum gain.

Weight gains through the 153 day grazing period were treated as a function of winter weight gains with an inverse relationship existing between winter and summer gains.

Budgeting and simulation through a 19-year time period, 1962-63 through 1980-81 were used for this analysis.

The cattle prices were from the Billings, Montana auction and were interpolated to represent prices for specific weights produced by different winter feeding regimes and subsequent summer gains.

Feed costs were based on the prices received by Wyoming farmers for November.

Non-feed costs implicitly cover costs for the operators labor and management, variable and fixed costs for other labor, machinery and facility use.

Summer costs were calculated to allow for non-land costs of grazing. Thus, returns to land were left as a residual.

In the simulation analysis, prices of cattle, feed, non-feed costs, and interest were allowed to vary over the years, 1962-1981.

The feeding programs were evaluated through the winter, summer and the total period.

Results of the Feeding Programs

Alfalfa hay alone and alfalfa with corn silage provided the best average returns over all costs for the winter period and the total period for both steers and heifers for 1962-63 through 1980-81 (Table 23). The summer returns to land were low on these feeds because of the inverse relationship between winter and summer gains.

Alfalfa-grass hay produced returns comparable to alfalfa or alfalfa-corn silage for the total period for steers, and results not as good for heifers. Performance on alfalfa-grass hay was inferior for the winter period, but that was mostly offset by higher gains and returns through the summer period.

Table 23. Summary of Returns over Costs for the Winter, Summer, and Total Period for Steers and Heifers on Various Rations and Rates of Gain, 1962-63 Through 1980-81 Average.

Item	Grass Hay	Alfalfa-Grass Hay	Grass Hay and 2 lb. Barley	Grass Hay & Barley	Alfalfa-Grass Hay & Barley	Alfalfa Hay	Alfalfa-Grass Hay & Barley	Alfalfa-Corn Silage	Alfalfa Hay & Barley
Steers	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Winter ADG	0.34	0.64	0.73	1.0	1.0	1.24	1.25	1.38	1.50
Summer ADG	1.71	1.54	1.50	1.35	1.35	1.22	1.22	1.14	1.08
Winter - return over all costs	(dol.) -25.52	(dol.) -10.80	(dol.) -20.21	(dol.) -15.12	(dol.) -11.34	(dol.) 2.75	(dol.) -7.50	(dol.) 7.77	(dol.) 4.46
Summer - return to land									
Total	40.49	31.70	29.54	22.64	22.64	16.22	16.19	12.95	10.18
Per AUM	12.08	9.03	8.30	6.13	6.13	4.25	4.24	3.33	2.58
Winter-Summer									
Return over CF&I[a/]	39.16	45.67	35.99	35.04	38.98	47.76	37.44	50.00	44.74
Total return	14.98	20.90	9.33	7.52	11.30	18.97	8.69	20.73	14.64
Heifers	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Winter ADG	0.28	0.57	0.66	1.0	1.0	1.10	1.20	1.22	1.50
Summer ADG	1.56	1.41	1.36	1.18	1.18	1.12	1.07	1.06	0.90
Winter - return over all costs	(dol.) -26.90	(dol.) -17.38	(dol.) -21.35	(dol.) -15.63	(dol.) -12.44	(dol.) -1.39	(dol.) -10.09	(dol.) 3.08	(dol.) 0.07
Summer - return to land									
Total	33.90	24.92	22.58	14.16	14.16	11.36	8.79	8.43	1.24
Per AUM	10.68	7.49	6.68	3.98	3.98	3.15	2.40	2.30	0.32
Winter-Summer									
Return over CF&I[a/]	29.83	32.05	26.59	24.93	28.27	37.09	26.16	38.99	30.42
Total return	7.00	7.54	1.23	-1.47	1.72	9.97	-1.32	11.51	1.31

[a/] Return over cattle, feed, and interest.

The results of the grass hay ration showed the lowest winter gains and largest winter loss for both steers and heifers but the largest gains and highest return for the summer period.

Barley was added as a concentrate to the hay rations to act as an energy source and to improve weight gains. In general, the use of barley in addition to grass or alfalfa-grass hay reduces the loss through the winter period, but the advantage is lost through the summer period. Ranchers may find it best to accept the gains and returns available from use of roughages and not use concentrates for steer calves and heifer calves that are to be pastured and sold the next fall.

Replacement heifers should weigh 600-650 lb. or more at breeding time. That can be achieved with gains of 150 to 200 lb. over the winter period and additional 50 to 60 lb. on pasture prior to breeding. Ranchers may be well advised to feed concentrates if necessary to achieve that performance and have a high proportion of yearling heifers cycling to be bred early.

The barley-alfalfa hay regime produced the heaviest rates of gain over the winter period but also the lowest gains on grass forage over the summer period. Return over costs for the winter period were positive for both steers and heifers but summer returns to land were the lowest of all the rations. There were small positive total returns for the winter-summer period.

The different feeding programs were also compared for the 1972-73 through 1980-81 period (Table 24).

Conclusions

A general set of conclusions can be drawn from this analysis.

Ranchers planning to winter calves for sale in the spring should consider feeding for higher winter gains and disregard summer gains. Gains above 1.5 lb. per day would probably increase returns above those shown in this analysis.

Operators planning to winter calves with the intention of putting them on pasture for summer grazing need to consider the effects of compensatory gains. Feeding for high rates of winter gain will decrease summer gains. Animals wintered at low rates of winter gain with continued skeletal growth will have high rates of gain over the summer grazing period.

It may be necessary to add a concentrate such as barley to a ration such as grass hay or alfalfa-grass hay, to achieve higher rates of gain for replacement heifers.

Rations and animal performance were estimated without use of growth stimulants or feed additives such as Ralgro or Rumensin. Their use was not considered for two primary reasons: (1) they, and similar products, have not been widely used with wintering calves; and, (2) analysis without use of those products represents a conservative approach.

Average total returns per head for the entire time period ranged from $7.52 to $20.90 for steers and -$1.31 to $11.52 for heifers on the various rations. The use of implants or additives could increase the profit margins, as well as the safety margin.

The analysis has been based on calf input prices (opportunity costs) and sale prices based on monthly averages. This does not recognize, or allow for the factor of management in selecting sale dates. That could increase any program profits.

Table 24. Summary of Returns over Costs for the Winter, Summer, and Total Period for Steers and Heifers on Various Rations and Rates of Gain, 1972-73 Through 1980-81 Average.

Item	Grass Hay	Alfalfa-Grass Hay	Grass Hay and 2 lb. Barley	Grass Hay & Barley	Alfalfa-Grass Hay & Barley	Alfalfa Hay	Alfalfa-Grass Hay & Barley	Alfalfa-Corn Silage	Alfalfa Hay & Barley
Steers	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Winter ADG	0.34	0.64	0.73	1.00	1.00	1.24	1.25	1.38	1.50
Summer ADG	1.71	1.54	1.50	1.35	1.35	1.22	1.22	1.14	1.08
Winter - return over all costs	(dol.) -33.36	(dol.) -15.55	(dol.) -28.61	(dol.) -23.13	(dol.) -18.30	(dol.) -.60	(dol.) -13.82	(dol.) 5.60	(dol.) .98
Summer - return to land									
Total	46.60	36.28	33.78	25.99	25.99	18.02	17.99	14.01	10.64
Per AUM	13.91	10.33	9.50	7.03	7.03	4.72	4.71	3.60	2.69
Winter-Summer									
Return over CF&I[a/]	45.48	53.75	40.78	39.55	44.60	55.59	42.52	58.65	51.76
Total return	13.24	13.24	5.17	2.86	7.69	17.42	4.17	19.61	11.62
Heifers	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
Winter ADG	0.28	0.57	0.66	1.00	1.00	1.10	1.20	1.22	1.50
Summer ADG	1.56	1.41	1.36	1.18	1.18	1.12	1.07	1.06	0.90
Winter - return over all costs	-35.34	23.25	-28.67	-21.74	-17.65	-3.44	-14.53	2.47	-1.16
Summer - return to land									
Total	41.67	29.99	27.04	16.56	16.56	12.86	9.37	8.88	-.95
Per AUM	13.13	9.01	8.01	4.65	4.65	3.57	2.56	2.42	-.25
Winter-Summer									
Return over CF&I[a/]	36.78	39.37	32.19	30.03	34.30	45.58	31.47	48.00	36.71
Total return	6.33	6.54	-1.63	-5.18	-1.09	9.42	-5.16	11.35	-2.11

[a/] Return over cattle, feed and interest.

Appendix Table 1. Coefficients for Estimating Nutritional Requirements for Steers,

$$Y = b_0 + b_1W + b_2G + b_3W^2 = b_4G^2 + b_5WG$$ [a/]

Dependent Variable	Intercept b_0	Weight b_1	Gain b_2	Weight^2 b_3	Gain^2 b_4	Wt. x G b_5	R^2	F** Value
Min. DM cons.	-1.29373	2.54066 (10.23)**	2.81244 (5.47)**	-0.09922 (5.41)**	-1.16843 (7.32)**	-.30816 (6.54)**	.9881	375
Pct rough mid-point	0.88372	0.05649 (2.67)**	-0.27111 (6.18)**	-0.00472 (3.02)**	-0.04181 (3.07)**	0.01095 (2.72)**	.9591	183
Total protein	-0.07932	0.20192 (12.92)**	0.48889 (15.12)**	-0.00729 (6.31)**	-0.07691 (7.67)**	0.00525 (1.77)*	.9906	827
Digestible protein	-0.04112	0.11263 (13.87)**	0.35960 (21.40)**	-0.00394 (6.57)**	-0.03972 (7.62)**	-0.00323 (2.10)*	.9934	1168
Net energy for maint.	0.81415	0.79690 (91.91)**		-0.01208 (20.17)**			.9999	121,600
Net energy for gain	-0.18609	0.08280 (12.41)**	0.15129 (14.06)**	-0.00714 (15.93)**	0.10703 (43.49)**	0.23197 (248.41)**	.9998	232,212
Metabolized energy	-0.36046	1.99796 (16.46)**	1.87239 (7.45)**	-0.06810 (7.59)**	-0.47096 (6.04)**	0.53097 (23.06)*	.9978	3592
Total digest. nut.	-0.23290	1.23898 (15.76)**	1.15873 (7.12)**	-0.04353 (7.49)**	-0.30508 (6.04)**	0.32647 (21.90)**	.9975	3163
Calcium	0.96750	1.26187 (8.97)**	10.65406 (36.59)**	-0.01326 (1.28)	0.64607 (7.15)**	-0.85696 (32.11)**	.9960	1941
Phosphorus	0.06938	1.74255 (11.51)**	7.31577 (23.36)**	-0.05326 (4.76)**	0.00989 (0.10)	0.37906 (13.20)**	.9925	1034
Vitamin A	-0.72541	2.28066 (11.25)**	3.26089 (7.77)**	-0.07969 (5.32)**	-1.04120 (8.00)**	0.21637 (5.63)**	.9840	512

a/ Data from: Nutrient Requirements of Beef Cattle, 5th ed., Table 1; and Lofgreen and Garrett, Journal of Animal Science, Vol. 27, page 801, Table 5.

* Denotes significance at the 0.95 probability level. Numbers in parentheses are the t-ratios.

** Denotes significance at the 0.99 probability level All F values are significant at the 0.99 probability level.

Appendix Table 2. Coefficients for Estimating Nutritional Requirements for Heifers,

$$Y = b_0 + b_1W + b_2G + b_3W^2 = b_4G^2 + b_5WG$$ [a/]

Dependent Variable	Intercept b_0	Weight b_1	Gain b_2	Weight^2 b_3	Gain^2 b_4	Wt. x G b_5	R^2	F** Value
Min. DM Cons.	-2.53788	2.95910 (7.20)**	4.62465 (5.51)**	-0.11920 (3.83)**	-1.62805 (6.47)**	0.13504 (1.60)	.9414	135
Pct rough mid-point	0.75747	0.10144 (4.45)**	-0.10162 (2.18)*	-0.00789 (4.57)**	-0.09865 (7.07)**	-0.00374 (0.80)	.9678	253
Total protein	-0.13647	0.22082 (8.30)**	0.63333 (11.67)**	-0.00774 (3.84)**	-0.11212 (6.88)**	-0.01207 (2.22)*	.9631	219
Digestible protein	-0.06198	0.12124 (8.79)**	0.43050 (15.29)**	-0.00422 (4.04)**	-0.05330 (6.31)**	-0.01454 (5.15)**	.9726	298
Net energy for maint.	0.81415	0.79690 (91.91)**		-0.01208 (20.17)**			.9999	121,600
Net energy for gain	-0.10733	0.07870 (7.47)**	-0.05173 (3.05)**	-0.00801 (11.31)**	0.19754 (50.83)**	0.27629 (187.36)**	.9996	131,387
Metabolized energy	-0.80577	2.18396 (10.84)**	2.58562 (6.29)**	-0.07763 (5.09)**	-0.62677 (5.08)**	0.51935 (12.59)**	.9918	1,018
Total digest. nut.	-0.39436	1.30471 (10.06)**	1.47683 (5.58)**	-0.04540 (4.62)**	-0.35116 (4.42)**	0.32002 (12.05)**	.9909	913
Calcium	1.4490	0.77787 (2.18)*	12.20470 (16.75)**	0.05167 (1.91)*	0.42464 (1.94)*	-1.16607 (15.95)**	.9741	315
Phosphorus	0.36960	1.40325 (4.81)**	8.63762 (14.51)**	-0.01043 (0.47)	-0.27239 (1.51)	-0.58811 (9.84)**	.9649	231
Vitamin A	-2.74436	3.04112 (9.12)**	4.63616 (6.81)**	-1.28360 (5.08)**	-1.57612 (7.72)**	0.14865 (2.18)*	.9611	208

[a/] Data from: Nutrient Requirements of Beef Cattle 5th ed., Table 2; and Lofgreen and Garrett, Journal of Animal Science, Vol. 27, page 801, Table 6.

* Denotes significance at the 0.95 probability level. Numbers in parentheses are the t-ratios.

** Denotes significance at the 0.99 probability level. All F values are significant at the 0.99 probability level.

Appendix Table 3. Nutrient Requirements and Nutrients Supplied from Various Rations for Growing Steer Calves Starting at 400 Pounds and Fed for 165 Days at Different Rates of Gain.[a/]

Ration	Daily Gain	Requirements[b/]					Supplied from Ration[b/]				
		Protein	TDN	Ca.	Phos.	Vitamin A	Protein	TDN	Ca.	Phos.	Vitamin A
	(lb.)	(lb.)	(lb.)	(gm)	(gm)	(1000IU)	(lb.)	(lb.)	(gm)	(gm)	(1000IU)
Grass Hay	0.34	0.80	5.11	8.58	8.35	8.88	1.03	5.61	26.40	8.08	204.99
Alfalfa-Grass Hay	0.66	0.96	6.05	11.01	10.32	10.26	1.69	6.68	64.61	10.92	210.90
Grass Hay and Two lb. Barley	0.73	1.00	6.33	11.74	10.89	10.64	1.25	6.97	26.95	11.53	204.99
Alfalfa Hay	0.80	1.03	6.54	12.30	11.34	10.92	2.04	6.55	91.23	11.80	179.28
Grass Hay and Barley	1.00	1.12	7.16	13.91	12.60	11.69	1.34	7.65	23.21	14.30	171.00
Alfalfa-Grass Hay and Barley	1.00	1.12	7.16	13.91	12.60	11.69	1.81	7.79	59.64	14.28	213.84
Alfalfa-Corn Silage	1.00	1.12	7.16	13.91	12.60	11.69	1.75	8.09	56.72	15.77	108.28
Alfalfa Hay	1.24	1.22	7.89	15.84	14.07	12.51	2.57	8.26	115.06	14.88	226.12
Alfalfa-Grass Hay and Barley	1.25	1.23	7.92	15.92	14.13	12.54	1.86	8.49	53.84	16.65	190.82
Alfalfa-Corn Silage	1.38	1.28	8.32	16.96	14.91	12.94	2.17	10.01	70.15	19.51	133.91
Alfalfa Hay and Barley	1.50	1.32	8.68	17.92	15.61	13.28	2.60	9.10	105.17	17.59	228.46

[a/] Average and ending weight can be calculated from information given.
[b/] Dry matter basis.

Appendix Table 4. Nutrient Requirements and Nutrients Supplied from Various Rations for Growing Heifer Calves Starting at 380 Pounds and Fed for 165 Days at Different Rates of Gain[a/]

Ration	Daily Gain	Requirements[b/]					Supplied from Ration[b/]				
		Protein	TDN	Ca.	Phos.	Vitamin A	Protein	TDN	Ca.	Phos.	Vitamin A
	(lb.)	(lb.)	(lb.)	(gm)	(gm)	(1000IU)	(lb.)	(lb.)	(gm)	(gm)	(1000IU)
Grass Hay	0.28	0.78	4.87	7.56	7.59	8.77	0.97	5.27	24.82	7.60	192.74
Alfalfa-Grass Hay	0.57	0.96	5.86	9.97	9.58	10.39	1.60	6.31	61.09	10.32	199.40
Grass Hay and Two lb. Barley	0.66	1.01	6.16	10.70	10.17	10.84	1.19	6.63	25.37	11.05	214.13
Alfalfa Hay	0.75	1.06	6.46	11.42	10.74	11.27	1.97	6.32	88.11	11.39	173.15
Grass Hay and Barley	1.00	1.18	7.27	13.39	12.28	12.32	1.30	7.51	20.60	14.60	165.87
Alfalfa-Grass Hay and Barley	1.00	1.18	7.27	13.39	12.28	12.32	1.72	7.64	52.23	14.63	167.40
Alfalfa Hay and Silage	1.00	1.18	7.27	13.39	12.28	12.32	1.77	8.16	57.19	15.90	109.17
Alfalfa Hay	1.10	1.23	7.60	14.16	12.87	12.69	2.41	7.75	107.96	13.96	212.15
Alfalfa-Grass Hay and Barley	1.20	1.27	7.92	14.92	13.44	13.03	1.76	8.25	47.47	16.67	150.37
Alfalfa and Corn Silage	1.22	1.28	7.98	15.07	13.56	13.09	2.03	9.35	65.53	18.22	125.09
Alfalfa Hay and Barley	1.50	1.39	8.87	17.13	15.07	13.85	2.41	9.12	88.03	18.58	170.89

a/ Average and ending weight can be calculated from information given.
b/ Dry matter basis.

Appendix Table 5. Steers on Grass Hay at 0.34 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	30.33	27.40	19.04	-21.88	-27.86	23.29	27.64	8.25	13.29	-.22
1963-64	26.75	23.03	20.13	-27.76	-33.74	19.06	18.50	5.52	-1.74	-15.25
1964-65	21.60	24.54	21.76	-2.41	-8.66	23.68	42.51	12.68	47.96	33.85
1965-66	25.41	30.23	22.85	5.77	-.82	24.89	24.77	7.39	38.82	23.95
1966-67	27.88	27.59	31.55	-24.80	-31.46	24.83	35.80	10.68	19.37	4.33
1967-68	28.35	29.78	20.13	-5.45	-12.24	25.49	30.31	9.05	33.41	18.07
1968-69	30.51	33.39	22.30	-.98	-8.11	30.27	45.68	13.63	53.68	37.57
1969-70	35.85	38.66	26.11	-4.40	-11.89	31.15	26.76	7.98	31.77	14.87
1970-71	36.47	38.10	26.66	-8.62	-16.41	34.32	51.45	15.35	52.64	35.04
1971-72	42.24	44.08	27.42	-6.41	-14.73	41.41	72.07	21.51	76.13	57.34
1972-73	52.66	59.90	32.86	13.61	3.67	50.93	62.52	18.66	88.64	66.19
1973-74	60.60	49.18	47.33	-81.45	-92.76	30.07	-32.98	-9.84	-100.20	-125.73
1974-75	26.62	32.71	56.58	-24.38	-36.81	36.94	86.58	25.84	77.82	49.77
1975-76	36.30	48.71	55.49	7.87	-5.33	34.17	-4.04	-1.21	20.43	-9.37
1976-77	39.03	45.38	60.38	-22.30	-36.16	40.28	51.37	15.33	46.50	15.21
1977-78	45.13	61.56	46.24	36.67	21.57	61.40	118.54	35.38	174.20	140.11
1978-79	78.77	106.13	50.59	86.85	69.35	76.46	13.73	4.10	122.59	83.08
1979-80	97.02	82.90	61.47	-105.28	-125.06	71.52	78.02	23.28	-2.41	-47.05
1980-81	83.60	77.98	79.97	-95.96	-117.35	60.47	20.18	6.02	-48.91	-97.18
Mean										
1972-81	56.20	60.85	51.83	-19.08	-33.36	50.37	46.60	13.91	45.48	13.24
1962-81	43.43	46.38	38.36	-14.81	-25.52	38.98	40.49	12.08	39.16	14.97
Std. Dev.	21.69	22.47	18.20	44.13	45.61	17.16	34.23	10.22	59.21	60.26

[a/] Return over cattle, feed and interest.

Appendix Table 6. Heifers on Grass Hay at 0.28 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	28.36	25.71	17.90	-21.87	-27.49	22.23	25.07	7.90	10.33	-2.42
1963-64	24.92	21.26	18.93	-27.99	-33.61	16.65	8.60	2.71	-12.25	-25.01
1964-65	18.56	21.35	20.46	-5.11	-10.98	20.54	32.15	10.13	34.50	21.17
1965-66	21.95	25.96	21.48	-.52	-6.72	21.89	20.94	6.60	28.27	14.23
1966-67	24.41	24.40	29.67	-24.81	-31.07	21.89	27.13	8.55	10.25	-3.95
1967-68	24.68	26.29	18.93	-7.15	-13.53	22.73	24.35	7.67	25.30	10.82
1968-69	25.94	30.02	20.97	.80	-5.91	26.13	29.36	9.25	38.66	23.45
1969-70	31.30	34.82	24.55	-4.69	-11.73	27.86	19.04	6.00	23.27	7.31
1970-71	32.40	34.55	25.06	-9.45	-16.77	31.06	40.83	12.86	40.67	24.05
1971-72	37.75	39.77	25.78	-9.20	-17.02	37.64	59.70	18.81	60.42	42.68
1972-73	44.96	52.04	30.89	6.79	-2.56	46.24	59.51	18.75	78.14	56.95
1973-74	52.65	45.45	44.50	-64.81	-75.44	25.94	-42.49	-13.39	-93.83	-117.93
1974-75	22.05	25.72	53.20	-35.59	-47.27	29.88	64.18	20.22	43.39	16.91
1975-76	27.35	39.97	52.17	3.46	-8.94	29.72	3.10	.98	22.30	-5.84
1976-77	32.65	37.01	56.78	-33.27	-46.30	36.41	56.68	17.86	39.93	10.38
1977-78	38.37	53.47	43.48	24.25	10.06	58.02	120.51	37.97	162.75	130.57
1978-79	70.15	98.87	47.57	79.63	63.18	70.54	2.72	.86	103.20	65.90
1979-80	86.19	72.82	57.80	-103.52	-122.12	65.72	76.16	24.00	-3.81	-45.96
1980-81	70.52	67.38	75.19	-86.82	-106.94	53.28	16.63	5.24	-44.74	-90.31
Mean										
1972-81	48.26	53.25	48.74	-21.91	-35.34	45.34	41.67	13.13	36.78	6.33
1962-81	37.64	40.89	36.07	-16.84	-26.90	34.97	33.90	10.68	29.83	7.00
Std. Dev.	19.08	20.46	17.11	39.85	41.36	16.14	34.49	10.87	53.47	54.12

[a/] Return over cattle, feed and interest.

Appendix Table 7. Steers on Alfalfa-Grass Hay at 0.64 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	30.33	26.94	18.94	-10.97	-16.92	23.12	20.43	5.82	17.34	3.50
1963-64	26.75	22.52	20.03	-19.17	-25.12	18.99	13.41	3.82	2.13	-11.71
1964-65	21.60	24.19	21.38	7.96	1.74	23.54	36.46	10.39	52.65	38.19
1965-66	25.41	29.40	22.73	16.26	9.70	24.75	18.54	5.28	43.48	28.25
1966-67	27.88	27.02	31.39	-14.27	-20.90	24.68	29.51	8.41	24.01	8.61
1967-68	28.35	29.17	20.03	5.87	-.89	25.29	22.97	6.54	37.79	22.07
1968-69	30.51	32.58	22.19	11.11	4.01	29.96	37.85	10.78	58.36	41.85
1969-70	35.85	37.45	25.98	8.29	.84	30.82	18.29	5.21	36.44	19.13
1970-71	36.47	37.20	26.25	5.55	-2.20	33.93	42.13	12.00	57.95	39.93
1971-72	42.24	41.90	27.17	4.33	-3.95	40.72	65.72	18.72	81.02	61.77
1972-73	52.66	56.94	32.58	28.14	18.25	50.24	54.37	15.49	95.62	72.63
1973-74	60.60	46.85	47.36	-69.32	-80.57	30.12	-38.86	-11.07	-93.28	-119.43
1974-75	26.62	32.53	56.29	-9.42	-21.78	37.05	80.05	22.80	87.01	58.27
1975-76	36.30	47.68	54.67	26.90	13.77	33.83	-17.96	-5.12	26.34	-4.19
1976-77	39.03	43.83	60.35	-8.16	-21.95	39.88	42.66	12.15	52.76	20.71
1977-78	45.13	59.37	46.55	55.06	40.04	60.76	108.20	30.82	183.15	148.24
1978-79	78.77	100.59	50.07	111.18	93.77	75.38	-1.71	-.49	132.53	92.06
1979-80	97.02	78.75	60.89	-85.24	-104.92	70.73	67.57	19.25	8.37	-37.35
1980-81	83.60	75.75	77.40	-66.91	-88.19	60.14	2.73	.78	-36.03	-85.47
Mean										
1972-81	56.20	58.42	51.33	-1.34	-15.55	49.89	36.28	10.33	53.75	20.73
1962-81	43.43	44.77	38.01	-0.15	-10.80	38.63	31.70	9.03	45.67	20.90
Std. Dev.	21.69	21.15	17.85	44.04	44.98	16.91	34.75	9.90	59.34	59.97

[a/] Return over cattle, feed and interest.

Appendix Table 8. Heifers on Alfalfa-Grass Hay at 0.57 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	28.36	25.29	19.71	-13.90	-20.09	22.08	18.65	5.60	12.23	-1.44
1963-64	24.92	20.78	20.84	-22.38	-28.58	16.55	3.59	1.08	-11.31	-24.99
1964-65	18.56	21.10	22.25	1.65	-4.82	20.44	26.96	8.10	36.43	22.14
1965-66	21.95	25.42	23.66	6.66	-.16	21.77	15.01	4.51	29.91	14.85
1966-67	24.41	23.76	32.67	-19.69	-26.59	21.74	22.24	6.68	10.87	-4.35
1967-68	24.68	25.77	20.84	.49	-6.55	22.60	18.29	5.49	27.27	11.74
1968-69	25.94	29.24	23.09	8.75	1.36	25.93	23.07	6.93	40.74	24.43
1969-70	31.30	33.52	27.04	2.76	-4.99	27.62	12.91	3.88	25.03	7.92
1970-71	32.40	33.85	27.32	.85	-7.21	30.84	32.92	9.89	43.52	25.71
1971-72	37.75	38.30	28.28	-.28	-8.89	37.29	53.60	16.10	63.73	44.71
1972-73	44.96	49.86	33.91	17.57	7.28	45.65	51.16	15.37	81.15	58.43
1973-74	52.65	43.82	49.28	-56.41	-68.12	25.82	-51.96	-15.61	-94.24	-120.08
1974-75	22.05	25.98	58.58	-28.26	-41.13	30.05	57.89	17.39	45.15	16.76
1975-76	27.35	39.73	56.89	15.70	2.04	29.47	-10.27	-3.09	21.93	-8.24
1976-77	32.65	36.74	62.80	-23.87	-38.22	36.36	47.61	14.30	41.06	9.39
1977-78	38.37	52.05	48.44	37.06	21.43	57.63	111.54	33.50	167.47	132.97
1978-79	70.15	95.99	52.10	107.02	88.90	69.63	-21.82	-6.55	107.07	67.08
1979-80	86.19	70.46	63.37	-86.83	-107.31	65.31	63.32	19.02	1.19	-43.99
1980-81	70.52	66.38	80.54	-66.37	-88.52	53.20	-1.13	-.34	-40.80	-89.65
Mean										
1972-81	48.26	51.93	53.42	-8.47	-23.25	45.04	29.99	9.01	39.37	6.74
1962-81	37.64	39.90	39.56	-6.28	-17.38	34.73	24.92	7.49	32.02	7.55
Std. Dev.	19.08	19.78	18.58	41.06	42.15	15.98	35.72	10.73	54.25	54.85

[a/] Return over cattle, feed and interest.

Appendix Table 9. Steers on Alfalfa and Corn Silage at 1.38 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	30.33	25.82	24.23	8.12	.51	22.68	4.38	1.13	21.24	4.89
1963-64	26.75	21.27	25.62	-6.30	-13.91	18.83	3.07	.79	5.52	-10.84
1964-65	21.60	23.34	27.00	25.15	17.20	23.19	22.82	5.87	57.10	40.02
1965-66	25.41	27.37	29.08	31.66	23.27	24.39	6.51	1.67	47.79	29.78
1966-67	27.88	25.63	40.16	-.31	-8.78	24.31	16.23	4.17	25.65	7.44
1967-68	28.35	27.69	25.62	25.06	16.41	24.81	7.13	1.83	42.11	23.54
1968-69	30.51	30.60	28.39	30.62	21.54	29.21	21.57	5.55	62.61	43.11
1969-70	35.85	34.51	33.23	26.58	17.05	30.01	1.96	.50	39.47	19.01
1970-71	36.47	35.00	33.23	28.32	18.40	32.96	22.27	5.72	61.97	40.67
1971-72	42.24	38.56	34.62	25.28	14.69	39.50	49.23	12.66	86.66	63.92
1972-73	52.66	51.75	41.54	53.89	41.24	48.61	33.25	8.55	101.66	74.49
1973-74	60.60	43.28	60.93	-50.47	-64.87	30.00	-58.44	-15.02	-92.40	-123.31
1974-75	26.62	31.97	72.01	8.64	-7.17	37.32	65.96	16.96	92.75	58.79
1975-76	36.30	46.04	69.24	57.35	40.55	33.27	-51.61	-13.27	25.02	-11.06
1976-77	39.03	41.49	77.55	10.87	-6.77	39.15	20.12	5.17	51.23	13.35
1977-78	45.13	55.07	60.24	84.00	64.78	59.29	85.09	21.88	191.14	149.88
1978-79	78.77	89.45	63.70	147.08	124.81	72.71	-33.46	-8.60	139.18	91.35
1979-80	97.02	69.56	77.55	-66.46	-91.63	69.47	57.34	14.74	19.74	-34.29
1980-81	83.60	70.21	96.24	-32.38	-59.60	59.73	-27.34	-7.03	-28.52	-86.94
Mean										
1972-81	56.20	53.74	65.36	23.78	5.60	48.91	14.01	3.60	58.65	19.61
1962-81	43.43	41.51	48.43	21.41	7.77	37.86	12.95	3.33	50.00	20.72
Std. Dev.	21.69	18.50	22.52	47.04	47.67	16.43	37.60	9.67	60.38	61.05

[a/] Return over Cattle, Feed and Interest

Appendix Table 10. Heifers on Alfalfa Hay and Corn Silage at 1.22 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1962-63 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
1962-63	28.36	24.36	22.63	3.65	-3.46	21.73	5.59	1.52	17.48	2.13
1963-64	24.92	19.73	23.93	-10.23	-17.35	16.33	-6.06	-1.65	-8.04	-23.40
1964-65	18.56	20.54	25.22	16.92	9.49	20.23	16.21	4.42	41.74	25.69
1965-66	21.95	24.23	27.16	22.32	14.49	21.50	3.47	.95	34.87	17.96
1966-67	24.41	22.31	37.50	-8.50	-16.41	21.40	13.40	3.65	14.08	-3.01
1967-68	24.68	24.59	23.93	17.00	8.92	22.29	6.45	1.76	32.80	15.37
1968-69	25.94	27.48	26.51	25.24	16.76	25.48	11.51	3.14	46.58	28.27
1969-70	31.30	30.62	31.04	16.66	7.76	27.07	3.42	.93	30.40	11.18
1970-71	32.40	32.30	31.04	22.86	13.60	30.34	17.44	4.75	51.03	31.04
1971-72	37.75	35.50	32.33	19.03	9.14	36.50	41.78	11.39	72.28	50.92
1972-73	44.96	46.08	38.80	42.35	30.53	44.32	32.93	8.97	88.97	63.46
1973-74	52.65	40.64	56.90	-37.37	-50.81	25.56	-70.15	-19.12	-91.94	-120.96
1974-75	22.05	26.06	67.25	-10.44	-25.20	30.42	46.36	12.63	53.04	21.15
1975-76	27.35	38.68	64.66	42.24	26.55	28.89	-36.69	-10.00	23.74	-10.14
1976-77	32.65	36.11	72.42	.08	-16.39	36.23	28.45	7.75	47.62	12.05
1977-78	38.37	49.19	56.26	66.09	48.14	56.74	94.15	25.66	181.04	142.30
1978-79	70.15	86.56	59.49	144.81	124.01	67.58	-50.53	-13.77	118.39	73.48
1979-80	86.19	65.39	72.42	-52.78	-76.29	64.39	41.41	11.28	15.86	-34.88
1980-81	70.52	64.45	89.88	-19.57	-45.00	53.00	-38.88	-10.60	-29.02	-83.88
Mean										
1972-81	48.26	48.87	61.04	19.44	2.47	44.36	8.88	2.42	48.00	11.35
1962-81	37.64	37.62	45.23	15.81	3.08	34.21	8.43	2.30	38.99	11.51
Std. Dev.	19.08	17.94	21.03	42.10	42.20	15.62	38.27	10.43	56.04	56.27

[a/] Return over cattle, feed and interest.

Appendix Table 11. Steers and Heifers on Grass Hay and Two lb. of Barley at 0.73 lb. or .66 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1971-72 - 1980-81 (Dollars.)

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a]	Total Returns
Steers										
1971-72	42.24	41.30	34.61	-.79	-10.43	40.53	64.27	18.08	74.59	53.84
1972-73	52.66	56.11	41.44	22.45	10.93	50.05	52.55	14.78	88.27	63.48
1973-74	60.60	46.20	61.44	-81.00	-94.10	30.14	-40.09	-11.28	-105.99	-134.19
1974-75	26.62	32.48	78.55	-28.46	-42.86	37.08	78.27	22.02	66.38	35.41
1975-76	36.30	47.39	72.93	12.92	-2.37	33.73	-21.70	-6.10	8.84	-24.07
1976-77	39.03	43.40	76.40	-21.07	-37.13	39.77	40.46	11.38	37.89	3.33
1977-78	45.13	58.75	56.62	49.46	31.96	60.58	105.64	29.72	175.24	137.60
1978-79	78.77	99.03	62.04	104.36	84.07	75.07	-5.14	-1.44	122.57	78.94
1979-80	97.02	77.59	75.52	-96.02	-118.94	70.50	65.32	18.38	-4.32	-53.62
1980-81	83.60	75.12	98.34	-82.39	-107.19	60.04	-1.78	-.50	-55.66	-108.96
Mean 1972-81	56.20	57.74	65.79	-12.05	-28.61	49.75	33.78	9.50	40.78	5.17
Heifers										
1971-72	37.75	37.84	32.98	-1.79	-10.93	37.17	52.05	15.41	60.82	41.12
1972-73	44.96	49.26	39.48	16.14	5.21	45.45	48.63	14.39	77.38	53.84
1973-74	52.65	43.32	58.62	-62.23	-74.66	25.78	-54.55	-16.14	-102.43	-129.20
1974-75	22.05	25.99	75.17	-41.75	-55.41	30.10	56.40	16.69	30.40	.99
1975-76	27.35	39.54	69.61	7.35	-7.16	29.38	-13.82	-4.09	10.27	-20.98
1976-77	32.65	36.66	72.80	-29.33	-44.56	36.34	44.94	13.30	33.19	.37
1977-78	38.37	51.55	53.86	36.54	19.94	57.49	109.44	32.39	165.13	129.38
1978-79	70.15	94.57	59.02	106.84	87.60	69.32	-26.26	-7.77	102.77	61.34
1979-80	86.19	69.75	71.85	-89.09	-110.84	65.18	59.86	17.72	-4.16	-50.97
1980-81	70.52	66.06	93.56	-72.34	-95.85	53.17	-6.25	-1.85	-51.50	-102.11
Mean 1972-81	48.26	51.45	62.70	-12.97	-28.67	44.94	27.04	8.01	32.19	-1.63

[a] Return over cattle, feed and interest.

Appendix Table 12. Steers and Heifers on Grass Hay and Barley at 1.0 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1971-72 - 1980-81 (Dollars).

Years	Winter Period					Summer Period			Total Period	
	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
Steers										
1971-72	42.24	39.72	38.66	4.22	-5.62	40.11	59.71	16.16	75.47	54.08
1972-73	52.66	53.84	46.23	29.28	17.52	49.46	45.94	12.43	89.01	63.46
1973-74	60.60	44.51	70.44	-79.70	-93.08	30.08	-45.94	-12.43	-109.96	-139.02
1974-75	26.62	32.29	95.39	-33.06	-47.76	37.17	72.64	19.66	56.81	24.88
1975-76	36.30	46.63	84.54	17.10	1.49	33.54	-33.50	-9.07	1.91	-32.01
1976-77	39.03	42.28	85.51	-17.93	-34.32	39.51	33.18	8.98	34.48	-1.14
1977-78	45.13	56.98	61.34	60.17	42.32	60.05	97.38	26.36	178.49	139.70
1978-79	78.77	94.51	67.32	116.87	96.17	74.11	-16.33	-4.42	124.81	79.84
1979-80	97.02	74.04	82.09	-88.90	-112.29	70.07	60.88	16.48	-.61	-51.41
1980-81	83.60	73.09	107.00	-70.46	-95.76	59.91	-14.10	-3.82	-54.93	-109.86
Mean 1972-81	56.20	55.79	73.85	-6.24	-23.13	49.40	25.99	7.03	39.55	2.86
Heifers										
1971-72	37.75	36.14	38.17	4.17	-5.23	36.77	46.84	13.17	62.13	41.61
1972-73	44.96	47.04	45.63	24.45	13.21	44.77	40.05	11.26	77.77	53.26
1973-74	52.65	41.45	70.17	-60.91	-73.70	25.65	-63.32	-17.80	-109.13	-137.02
1974-75	22.05	26.03	96.77	-50.20	-64.24	30.30	50.30	14.14	16.70	-13.94
1975-76	27.35	38.86	84.52	9.42	-5.50	29.09	-27.05	-7.61	-.00	-32.55
1976-77	32.65	36.37	84.50	-23.43	-39.09	36.27	34.57	9.72	29.64	-4.53
1977-78	38.37	49.70	59.93	48.05	30.99	57.03	101.95	28.66	170.16	132.93
1978-79	70.15	89.25	65.81	122.49	102.71	68.26	-40.18	-11.30	105.67	62.52
1979-80	86.19	67.09	80.30	-74.73	-97.09	64.70	47.80	13.44	-.54	-49.29
1980-81	70.52	64.89	104.71	-55.25	-79.43	53.06	-25.40	-7.14	-52.12	-104.83
Mean 1972-81	48.26	49.68	73.05	-5.59	-21.74	44.59	16.56	4.65	30.03	-5.18

[a/] Return over cattle, feed and interest.

Appendix Table 13. Steers and Heifers on Alfalfa-Grass Hay and Barley at 1.0 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1971-72 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
Steers										
1971-72	42.24	39.72	36.29	6.66	-3.31	40.11	59.71	16.16	77.91	56.40
1972-73	52.66	53.84	43.46	32.16	20.25	49.46	45.94	12.43	91.88	66.19
1973-74	60.60	44.51	65.22	-74.26	-87.81	30.08	-45.94	-12.43	-104.52	-133.75
1974-75	26.62	32.29	84.02	-21.25	-36.14	37.17	72.64	19.66	68.62	36.50
1975-76	36.30	46.63	76.72	25.20	9.38	33.54	-33.50	-9.07	10.00	-24.12
1976-77	39.03	42.28	80.65	-12.91	-29.51	39.51	33.18	8.98	39.50	3.67
1977-78	45.13	56.98	59.73	61.84	43.76	60.05	97.38	26.36	180.17	141.14
1978-79	78.77	94.51	64.61	119.71	98.75	74.11	-16.33	-4.42	127.66	82.42
1979-80	97.02	74.04	78.72	-85.33	-109.02	70.07	60.88	16.48	2.96	-48.14
1980-81	83.60	73.09	100.71	-63.71	-89.34	59.91	-14.10	-3.82	-48.18	-103.44
Mean 1972-81	56.20	55.79	69.01	-1.19	-18.30	49.40	25.99	7.03	44.60	7.69
Heifers										
1971-72	37.75	36.14	36.17	6.24	-3.28	36.77	46.84	13.17	64.19	43.56
1972-73	44.96	47.04	43.29	26.88	15.51	44.77	40.05	11.26	80.20	55.55
1973-74	52.65	41.45	65.76	-56.32	-69.25	25.65	-63.32	-17.80	-104.54	-132.57
1974-75	22.05	26.03	87.14	-40.19	-54.40	30.30	50.30	14.14	26.70	-4.09
1975-76	27.35	38.86	77.89	16.28	1.19	29.09	-27.05	-7.61	6.86	-25.87
1976-77	32.65	36.37	80.40	-19.20	-35.04	36.27	34.57	9.72	33.88	-.48
1977-78	38.37	49.70	58.60	49.44	32.17	57.03	101.95	28.66	171.54	134.12
1978-79	70.15	89.25	63.52	124.89	104.87	68.26	-40.18	-11.30	108.07	64.69
1979-80	86.19	67.09	77.46	-71.72	-94.34	64.70	47.80	13.44	2.47	-46.54
1980-81	70.52	64.89	99.36	-49.50	-73.97	53.06	-25.40	-7.14	-46.37	-99.37
Mean 1972-81	48.26	49.68	68.96	-1.32	-17.65	44.59	16.56	4.65	34.30	-1.09

[a/] eturn over cattle, feed and interest.

Appendix Table 14. Steers and Heifers on Alfalfa-Grass Hay and Barley at 1.25 lb. or 1.2 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results for 1971-72 - 1980-81 (Dollars).

	Winter Period					Summer Period			Total Period	
Years	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a/]	Return Over All Costs	Oct. Ylrg. Price	Return to Land	Return Per AUM	Return Over CF&I[a/]	Total Returns
Steers										
1971-72	42.24	38.97	40.57	13.39	2.99	39.71	52.81	13.82	78.14	55.80
1972-73	52.66	52.48	48.54	40.02	27.60	48.90	37.49	9.81	91.78	65.08
1973-74	60.60	43.71	74.26	-70.95	-85.09	30.03	-54.20	-14.18	-108.92	-139.29
1974-75	26.62	32.08	99.97	-26.45	-41.98	37.27	68.30	17.87	59.68	26.33
1975-76	36.30	46.25	88.30	29.18	12.68	33.37	-45.31	-11.85	2.82	-32.62
1976-77	39.03	41.76	90.19	-9.27	-26.60	39.28	24.64	6.45	35.25	-1.96
1977-78	45.13	55.74	65.11	71.27	52.40	59.55	89.23	23.34	182.17	141.63
1978-79	78.77	91.22	70.68	131.24	109.36	73.19	-28.04	-7.33	128.31	81.32
1979-80	97.02	71.12	86.23	-81.21	-105.93	69.68	58.06	15.19	5.21	-47.88
1980-81	83.60	71.22	110.77	-56.84	-83.58	59.79	-23.04	-6.03	-49.22	-106.62
Mean 1972-81	56.20	54.46	77.46	4.04	-13.82	49.08	17.99	4.71	42.52	4.17
Heifers										
1971-72	37.75	35.55	39.89	10.48	.57	36.53	42.11	11.51	64.02	42.68
1972-73	44.96	46.16	47.71	32.20	20.36	44.37	33.42	9.13	79.28	53.78
1973-74	52.65	40.70	73.58	-55.57	-69.04	25.57	-69.67	-19.04	-109.71	-138.72
1974-75	22.05	26.06	100.84	-46.09	-60.89	30.41	46.52	12.71	17.50	-14.37
1975-76	27.35	38.69	87.88	17.18	1.45	28.92	-35.96	-9.83	-.65	-34.51
1976-77	32.65	36.13	88.69	-17.64	-34.15	36.23	28.79	7.87	30.19	-5.36
1977-78	38.37	49.22	63.31	57.54	39.56	56.77	94.64	25.86	172.92	134.20
1978-79	70.15	86.77	68.84	133.73	112.89	67.65	-49.86	-13.62	107.91	63.03
1979-80	86.19	65.53	84.03	-66.18	-89.74	64.42	41.66	11.39	2.64	-48.07
1980-81	70.52	64.48	108.14	-40.82	-66.30	53.00	-37.97	-10.38	-49.44	-104.27
Mean 1972-81	48.26	48.93	76.29	2.48	-14.53	44.39	9.37	2.56	31.47	-5.16

[a/] Return over cattle, feed and interest.

Appendix Table 15. Steers and Heifers on Alfalfa and Barley at 1.5 lb. Average Daily Gain - Year-to-Year Variations in Winter, Summer, and Total Period Results in 1971-72 - 1980-81 (Dollars).

Years	Winter Period					Summer Period			Total Period	
	Nov. Calf Price	April Spring Price	Winter Feed Cost	Return Over CF&I[a]	Return Over All Costs	Oct. Yirg. Price	Return to Land	Return Per AUM	Return Over CF&I[a]	Total Returns
Steers										
1971-72	42.24	38.20	39.48	25.33	14.29	39.32	46.10	11.67	83.77	60.38
1972-73	52.66	51.09	47.31	53.65	40.45	48.34	29.62	7.50	98.02	70.07
1973-74	60.60	42.89	71.19	-55.35	-70.37	29.97	-62.13	-15.73	-100.72	-132.50
1974-75	26.62	31.87	90.34	-4.96	-21.45	37.36	63.89	16.17	77.36	42.44
1975-76	36.30	45.86	82.54	51.19	33.67	33.19	-57.27	-14.50	13.50	-23.60
1976-77	39.03	41.24	88.32	6.06	-12.33	39.04	16.09	4.07	42.71	3.75
1977-78	45.13	54.46	66.19	84.54	64.49	59.05	81.54	20.64	188.47	146.03
1978-79	78.77	87.85	70.55	147.03	123.80	72.27	-37.80	-9.57	135.19	86.00
1979-80	97.02	68.14	86.01	-70.95	-97.21	69.28	57.25	14.49	15.60	-39.97
1980-81	83.60	69.29	107.84	-37.13	-65.53	59.67	-30.86	-7.81	-36.30	-96.39
Mean 1972-81	56.20	53.09	74.98	19.94	0.98	48.75	10.64	2.69	51.76	11.62
Heifers										
1971-72	37.75	34.77	41.11	21.43	10.72	36.17	35.02	9.18	68.36	45.74
1972-73	44.96	44.94	49.21	45.29	32.50	43.76	23.70	6.21	83.22	56.20
1973-74	52.65	39.67	75.44	-44.35	-58.90	25.45	-78.86	-20.68	-107.02	-137.76
1974-75	22.05	26.11	100.40	-32.96	-48.95	30.58	41.06	10.77	25.89	-7.89
1975-76	27.35	38.49	88.69	33.52	16.54	28.65	-49.58	-13.00	2.84	-33.04
1976-77	32.65	35.76	91.87	-5.97	-23.80	36.17	20.65	5.41	34.52	-3.16
1977-78	38.37	48.68	66.97	73.86	54.44	56.36	83.28	21.83	178.76	137.71
1978-79	70.15	83.21	71.83	150.55	128.03	66.70	-62.62	-16.42	112.97	65.40
1979-80	86.19	63.18	87.67	-52.94	-78.38	64.00	34.51	9.05	9.88	-43.87
1980-81	70.52	63.94	110.81	-16.27	-43.80	52.91	-56.67	-14.86	-42.35	-100.47
Mean 1972-81	48.26	47.88	78.40	17.22	-1.16	44.08	-0.95	-0.25	36.71	-2.11

[a] Return over cattle, feed and interest.

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