THE ECONOMIC IMPLICATIONS OF FEEDING VARIOUS RATION ENERGY CONCENTRATION DIETS TO FEEDLOT CATTLE

by

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B.S., Kansas State University, 1975

A MASTER'S THESIS

submitted in partial fulfillment of the

requirement for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1978

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ACKNOWLEDGMENTS

The author wishes to acknowledge with special gratification Dr. Donald Erickson, Professor of Agricultural Economics, for his invaluable guidance, indulgence, and time spent in the development of this thesis. I also extend a thanks to Dr. John H. McCoy, Professor of Agricultural Economics, and Dr. Frank Orazem, Professor of Agricultural Economics, for their suggestions and assistance in this project.

A special thanks of appreciation goes to Mr. Kim Rochat, Research Assistant, for his expertise in constructing a computer model that enabled me to complete this research project.

Lastly, I would like to express a word of thanks to Allan Chestnut, a graduate student in Animal Science and Industry, for his thoughts and the privilege to use the raw research data from his thesis project in my analysis.

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Chapter 1

Introduction

Economic efficiency is a primary goal in allocating resources in agricultural production. Efforts in striving for improved economic efficiency in beef production has altered feed resource utilization in cattle feeding in the past half century.

Fifty years ago, grass was the principal feed resource for producing slaughter beef animals. As the nation's grain supply became more plentiful with the developments of hybrid seed varieties and chemical fertilizers, some farmers began the practice of marketing their grain through cattle. They would purchase light weight calves from cow-calf operators and fatten them on grain. Shortly hereafter, beginning in the 1950's the production of grain-fed cattle for slaughter began to become more and more specialized with the rapid growth of the feedlot industry. During the period from 1962 to 1976 the number of fed cattle marketed primarily from feedlots, increased 66 percent from 14.560 million head to 24.180 million head.[1]

One definite incentive which spurred this growth of feedlot capacity was the low cost feed resource grain, provided from the high grain productive years of the 1960's.[2] Also, since the 1950's indications show that the level of demand for grain-fed beef by the American consumer was supportive to the increase in production that was realized. For instance, from 1950 to 1976 the per capita yearly beef consumption on carcass weight

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[1]See Appendix A for further detail.

[2]<u>Ibid</u>.

basis had increased from 63.4 pounds to 128.9 pounds.[3] Grain-fed beef accounted for approximately 66 percent of the retail beef consumed (1971-1976).[4]

Questions have recently been raised about the continual practice of feeding large quantities of feed grains in the traditional feedlot rations, and even whether cattle should be grown in feedlots at all. Answers to these questions involve physical and economic efficiency considerations, consumer preferences, and ethical and political considerations as well.[5] There are some humantarian organizations that declare the conversion of feed-grain protein into beef protein is inefficient, and therefore, wasteful in a world of widespread hunger and malnutrition. The Senate Select Committee on Nutrition and Human Needs issued a report in January 1977, "the American diet, which includes a steady fare of fatty, grain-fed beef, contributes to obesity and illness."[6] Certainly, the political and ethical

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[3]Source of data -- American Meat Institute, Meatfacts: A Statistical Summary about America's Largest Food Industry, 76 Edition, Washington D.C., (1976).

U.S., Department of Agriculture, Economic Research Service, Livestock and Meat Statistics, LMS - 213, Washington D.C., (February 1977), p. 27.

[4]Supportive information came from the source -- U.S., Department of Agriculture, Economic Research Service, Livestock and Meat Situation, Table 1 - Beef supplies and prices, LMS - 213, Washington D.C., (February 1977), p. 7.

[5]Ray F. Brokken, T.M. Hammonds, A.A. Dinius, and John Valpsy,"Framework for Economic Analysis of Grain versus Harvested Roughage for Feedlot Cattle", American Journal of Agricultural Economics, 58 NO. 1, (May 1976), p. 245. (hereafter cited as Ray Brokken et. al., "Grain vs. Harvested Roughage for Feedlot Cattle.").

[6]Morgan, Dean, "Corn Industry Raises Doubts about Feedlots", Topeka Daily Capital, Topeka, Kansas, 4 February 1977, p. 11.

considerations should be based on knowledge of the physiological and economic efficiencies and the trade-offs involved, and not on misinformation about them.[7] The physiological and economic considerations can be made objectively and quantitatively; and then evaluated to provide a better understanding for all directly concerned special interest groups: producers, processors, and consumers of beef.

The forage-grain balance question could be analyzed in various ways for considering the physiological and economic considerations involved. This study focuses on analyzing the economic considerations, in terms of profit maximization to the producer, with further implications to the processor and consumer of beef.

[7] Ray Brokken et. al., "Grain vs. Harvested Roughage for Feedlot Cattle", p. 245.

Chapter II

Review of Literature

Feed Resource Utilization by Cattle and other Farm Animals

Generally, beef production is divided into three phases: the cow-calf phase, backgrounding (growing) phase, and the finishing phase. The common practice has been to utilize forage and limit concentrates supplements for the cow-calf and backgrounding phases. Then during the finishing phase increasing amounts of concentrates are fed up to the usual maximum level of 85 percent of the ration. For this reason cattle in feedlots consume the largest proportion of feed grains fed to all cattle. This proportion in recent years has been approximately equivalent to the share of feed grains fed to hogs and poultry. Looking back, from 1974 to 1976, approximately 438.3 million tons of feed concentrates were fed to livestock from a total three years production of 756.5 million tons. Cattle on feed consumed roughly 24.7 percent of 756.5 million tons of feed concentrates consumed by livestock, as compared to dairy cattle of 16.9 percent, and hogs of 25.1 percent and poultry at 24.0 percent. In terms of the total supply of feed concentrates, cattle on feed consumed 16 percent of the 756.5 million tons that was available from 1974 to 1976 (see figure 2.1).[1]

Studies have shown that the ability of beef cattle to convert feed protein into edible protein for human consumption is about 6 percent,

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[1]See Appendix B entitled, "Feed Resource Utilization by Cattle and Other Farm Animals," for supportive information.

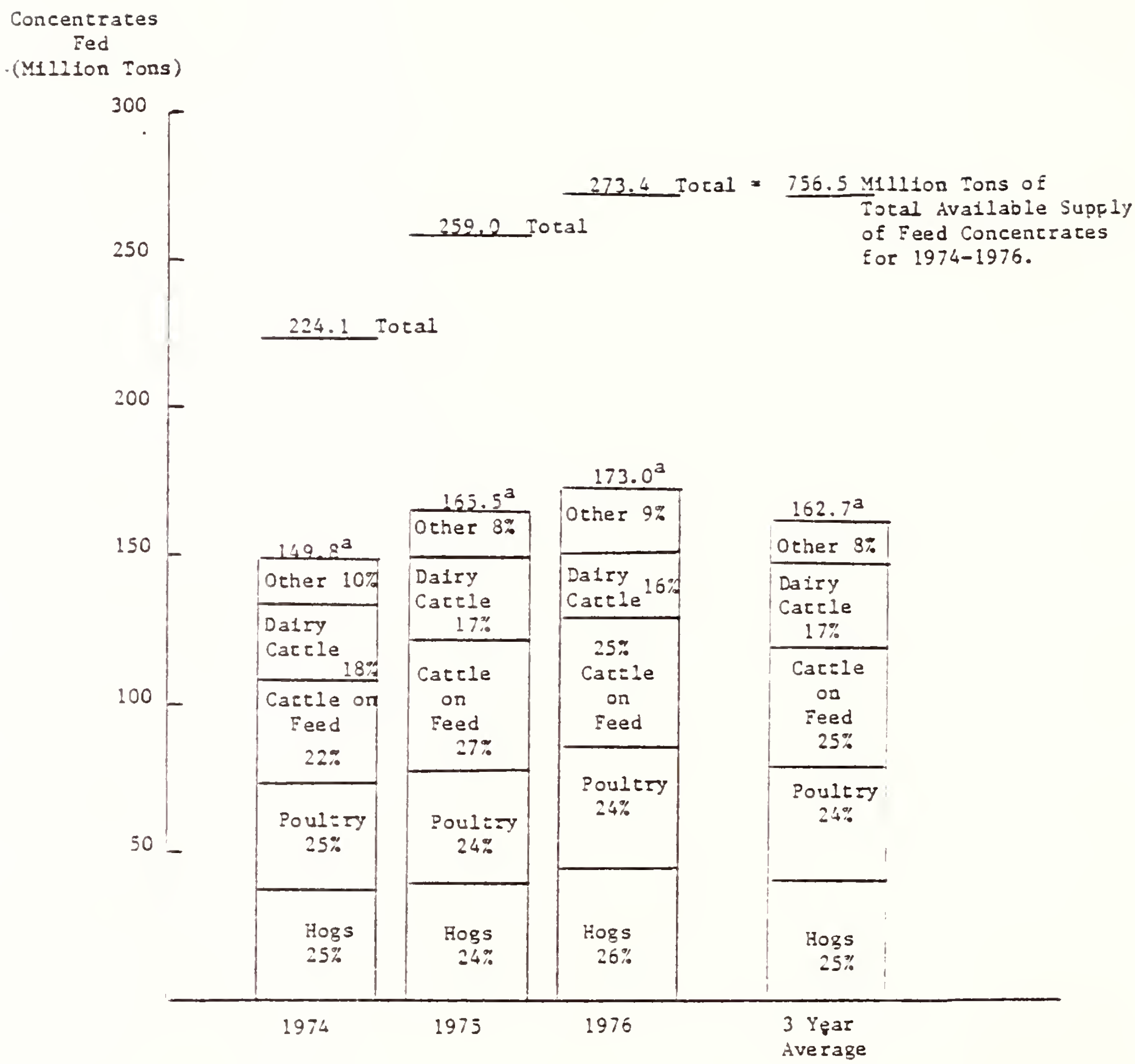

Figure 2.1. Feed Concentrate Supply and Consumption by Livestock Class for 1974 - 1976.[2]

[a] Millions of Tons of Concentrates Fed to Livestock of All Classes

[2] Supportive information for Figure 1 came from the source — U.S. Department of Agriculture, Economic Research Service, Feed Situation, FdS - 264, Washington D.C., (February 1977), p. 4.

which is the lowest in comparison to the other primary classes of farm animals, as shown in Table 2.1. Poultry convert feed protein at a rate of about 22 percent and swine at a rate of about 16 percent.

Table 2.1: Comparative efficiency of various farm animals in producing protein for human consumption[3]

Animal Class	Source		
	Byerly (percent)	Welcke (percent)	Preston (percent)
Dairy Cattle (milk)	30	22	28
Hen (eggs)	20	23	23
Broiler	25	17	26
Swine	(19)	12	17
Beef Cattle	(5)	4	8

The comparative efficiency of various farm animals in converting feed protein is directly related to their voluntary consumption of energy relative to their maintenance requirements, as shown in Figure 2.2. Probably the major reason for poor efficiency in growing ruminants such as beef cattle is their inadequate intake of (feed) energy relative to their (body) maintenance requirements.[4]

Beef cattle are considered poor convertors of feed protein into protein for human consumption. However, it has been the production of beef cattle fed approximately 7 percent to 8 percent more feed grains as fed for the production of substitutional meat products, pork and poultry, that

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[3]Dr. R.L. Preston, "What is Needed to Break Through the Efficiency Barrier in Beef Cattle?", Feedstuffs, 40 No. 13, Washington D.C., (March 30, 1968), p. 26. (hereafter cited as Preston, "Efficiency in Beef Cattle.")

[4]Ibid.

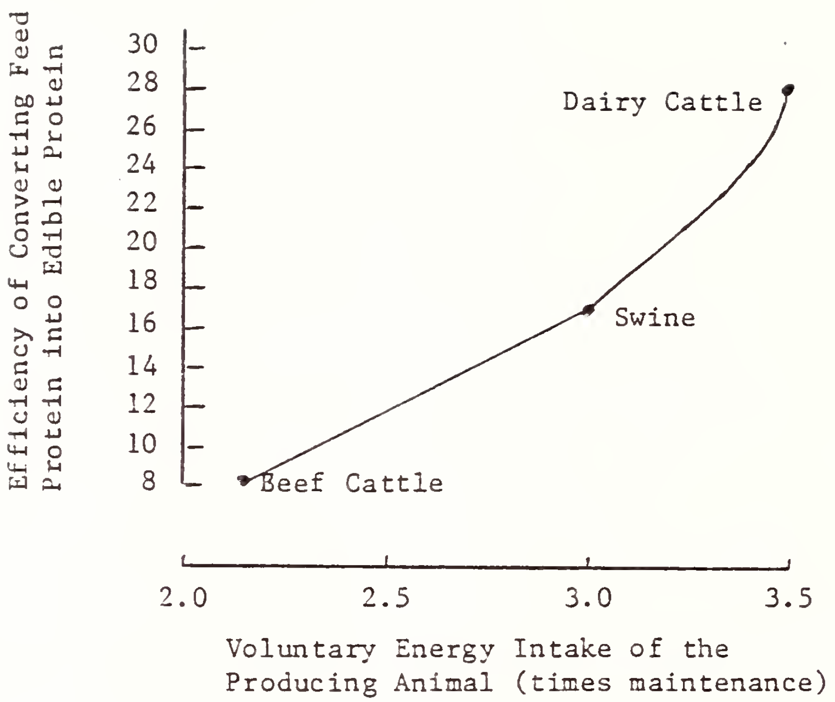

Figure 2.2. Comparative Efficiencies of Various Classes of Farm Animals Plotted Against Their Voluntary Energy Intakes.[5]

[5] *Ibid.*

makes up the largest share of the consumer's meat diet. The per capita consumption of retail beef has been 1.8 times greater than that of retail pork or poultry meat (see Table 2.2).

Table 2.2: Comparisons between beef, pork, and poultry of per capita annual consumption, percent of feed grain supply consumed in the production of each, and their protein conversion efficiencies.

Type of Meat Production	Per Capita Annual Consumption on Retail Wt. Bases[6]		Percent of Feed Grain Supply Consumed in the Production of Meat Products[7]	Feed Protein to Human Protein Conversion Eff.[8]
	(kg.)	(pounds)	(percent)	(percent)
Beef	43.27	95.4	32[a]	6
Pork	24.53	54.1	25	16
Poultry	23.81	52.5	24	22

[a]Includes Cattle on Feed and other Cattle excluding Dairy Cattle.

Since cattle are ruminants they can utilize the feed resource roughage, which cannot be efficiently used in the production of pork or poultry as a primary feed source. Therefore, roughage has been one reason beef production, as measured by retail per capita consumption, has been approximately 19 Kg. (42 lbs.) greater than that of pork or poultry.

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[6]U.S. Department of Agriculture, Economic Research Service, Livestock and Meat Situation, Table 12 - Per capita meat consumption by quarters, LMS - 213, Washington D.C., (February 1977), p. 27.

[7]Supportive information came from the source -- U.S. Department of Agriculture, Economic Research Service, Feed Situation, FdS - 264; Washington D.C., (February 1977), p. 4.

[8]Preston, "Efficiency in Beef Cattle," p. 26.

Currently pasture and harvested forages account for approximately 80 percent of all feed resources fed to beef cattle in the U.S. The remaining 20 percent of feed resources fed to cattle are concentrates, primarily corn and sorghum grain. Cattle on feed consume roughly 77 percent of the total amount of feed concentrates fed to all cattle. This breakdown in proportions of feeds consumed by cattle is reflected in the following Figures 2.3 and 2.4 with more detailed results given in appendix B.

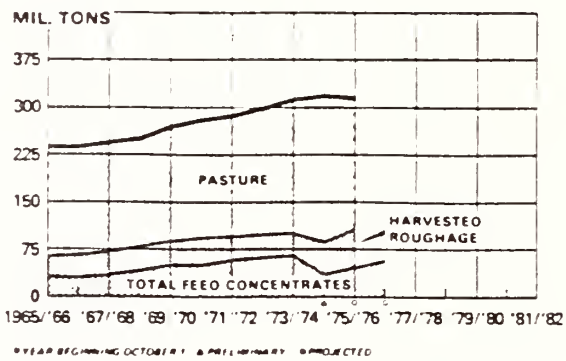

Figure 2.3. Total Feed Consumption by All Beef Cattle, 1965-76.[9]

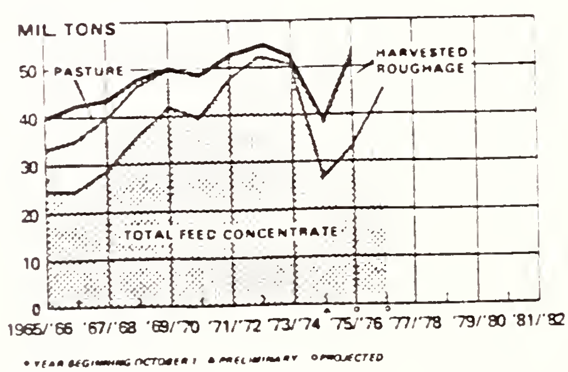

Figure 2.4. Total Feed Consumption by Cattle on Feed, 1965-76.[10]

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[9] U.S. Department of Agriculture, Economic Research Service, Feed Situation, FdS - 262, Washington D.C., (September 1976), p. 16.

[10] Ibid., p. 17.

Total concentrates fed to all beef cattle, as shown in Figure 2.3, decreased dramatically from the 1973/74 level of 66,099,000 tons to 37,442,000 tons. During this same period harvested roughage fed increased by 9,522,000 tons and is estimated to have increased another 11,932,000 tons from 1974/75 to 1975/76. The major changes in feed grain and roughage utilization by cattle took place in the feedlot sector, as Figure 2.4 shows. From 1973/74 to 1975/76 harvested roughage utilization by cattle on feed increased by approximately 19,020,000 tons. This adjustment of feeding more roughage to feedlot cattle came about as the price of corn increased from a price level of $1.60 per bushel early in 1973 to price levels of $2.75 per bushel and higher as realized from 1974 to 1976 as shown in Figure 2.5. These changes require the feedlot sector to analyze the forage-grain balance as it affects the final meat quality and costs of producing the product.

Ration Forage - Grain Balance
Terms of Ration Energy Concentration

The term ration energy concentration refers to the energy density of a feedstuff generally expressed as mega-calories per kilogram (Mcal/Kg) of dry matter feed.[11] "Ration energy concentration" is analogous term for the phrase ration forage - grain balance, since roughages generally contain less available feed energy (Mcal) per kilogram of dry matter than concentrates.[12]

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[11] Calories are used to express the energy value of feedstuffs. One calorie is the amount of heat required to raise the temperature of 1 gram of water 1^{o} centigrade. 1Kcal = 1000 calories. 1Mcal or therm = 1 million calories.

[12] Roughages are feeds that in the dry state contain on the average more than 18 percent of crude fiber.*

Protein Supplements are feeds that contain 20 percent or more of protein.*

Energy Feeds are those that contain less than 20 percent of protein and less than 18 percent crude fiber.*

*National Academy of Sciences, Nutrient Requirements of Beef Cattle, Fifth Revised Edition, Washington D.C., (1976), p. 18.

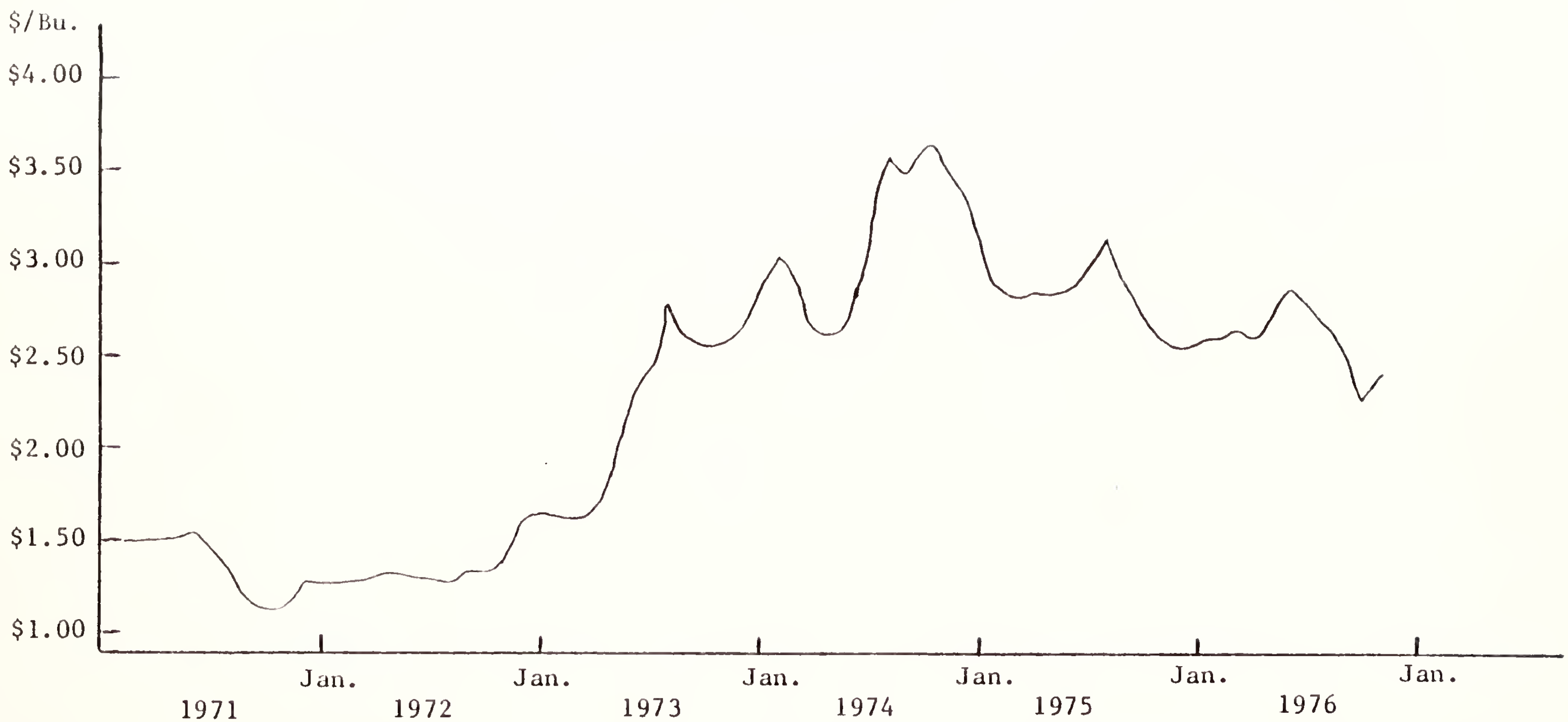

Figure 2.5. Price of Kansas City, No. 2 Yellow Corn: Monthly Average Price in Cents per Bushel, 1971 - 1976.[13]

[13] U.S. Department of Agriculture, Agricultural Marketing Service, Grain Division, Market News Branch, Grain Market News, Washington D.C., (October 1955 to November 1976).

The energy values of feedstuffs can be broken down according to how the energy is utilized by the animal, as shown in Figure 2.6.

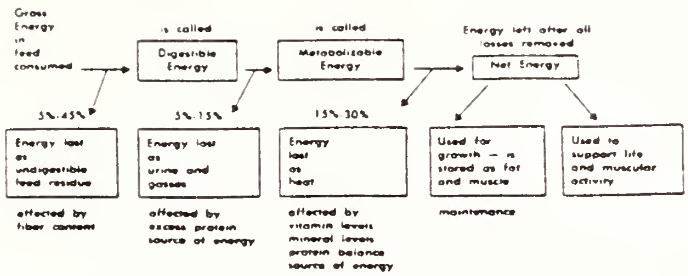

Figure 2.6. Feed Energy Utilization by Beef Cattle.[14]

Gross Energy (GE) represents the total combustible energy in a feedstuff.[15] GE does not vary greatly over a wide range of feeds, except for those high in fat. Therefore, GE does little to describe the useful energy in feeds for beef cattle.

Digestible Energy (DE) is the proportion of GE in a feed that is not excreted in the feces.[16] The major factor affecting variability in DE values of feedstuffs is fiber content.

Metabolizable Energy (ME) represents that portions of the GE that is not lost in the feces, urine, and gas.[17] Feedstuffs are often compared on this basis.

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[14] Danny G. Fox, "Use of Energy Values in Ration Formulation," Great Plains Beef Cattle Feeding Handbook, USDA, Cooperative Extension Service, Washington D.C., GPE-1000 (October 1972), 1000.2. (hereafter cited as Danny Fox, "Uses of Energy Values in Ration Formulation.")

[15] Ibid, p. 1000.3

[16] Ibid, p. 1000.3

[17] Ibid, p. 1000.3

Net Energy (NE) is the energy remaining after digestive losses, gas losses, urinary losses, and work of digestion are deducted.[18] A feedstuff has two net energy values. The net energy value of a feed for maintenance (NEm) represents the energy (Mcal/Kg) available for supporting the animal's maintenance functions (beating of the heart and functioning of the other organs and muscular activity). The net energy value of a feed for growth (NEg) represents the energy in a feed (Mcal/Kg) that is available for supporting growth of body tissues and is actually deposited as protein and fat tissue gain in beef cattle. NEm and NEg values are not necessarily the same since a feedstuff's net energy utilized for body maintenance is utilized at a different rate than if the same net energy is used to produce weight gain.

There is considerable amount of variation between feedstuffs in NEm and NEg values. Generally, roughages are lower in both NEm and NEg than concentrates for two basic reasons. The first is, because roughages contain a higher fiber content so less of the feed energy is digestible and more is lost as feces. The second reason is that during the digestion process of transforming the energy in the feed into a form usable by the animal a higher proportion of the metabolizable energy (ME) is lost as heat from roughages than from grains. As a general rule of thumb, about 60 percent of the total combustible energy in grains and about 80 percent of the total combustible energy in roughage is lost as feces, urine, gases, and heat.[19]

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[18] Donald Gill, "Net Energy Requirements of Feedlot Cattle, "Great Plains Beef Cattle Feeding Handbook, USDA, Cooperative Extension Service, Washington D.C., GPE-1001, (December 1972), 1001.1.

[19] Danny Fox, "Uses of Energy Values in Ration Formulation", p. 1000.2.

Roughages and concentrates of all types vary in the amount of net energy they contain per Mcal of metabolizable energy (ME), as well as, the value of NE for maintenance (NEm) and for gain (NEg). Concentrates relative to roughages have a higher ration energy concentration value on the basis of ME as well as in terms of NE values. Thus, the ration energy concentration is directly related to the proportion of concentrate fed in that ration. A traditional finish ration for feedlot cattle containing upwards of 60 percent concentrate has a much higher ration energy concentration value than a growing ration largely composed of roughage with only a small amount of concentrate.

Growth Efficiency as Affected by Ration Energy Concentration

The ration energy concentration fed has a direct effect on growth efficiency in terms of rate of gain and feed conversion (kilograms of feed necessary to obtain one kilogram of live weight gain), as shown in Figure 2.7.

There are two basic relationships shown in Figure 2.7. First, as the ration energy concentration increases by feeding a greater proportion of grain, less feed is required to achieve a given gain. In terms of cost, as the energy concentration increases feed conversion decreases, resulting in less cost associated with feed handling. Secondly, rate of gain trends to increase as the ration energy concentration increases, till the animal reaches a maximum level of energy intake. Fixed and nonfeed variable costs applied to the cost per pound of live weight gain will decrease as the ration energy concentration increases.

The reasons a lower ration energy concentration causes a slower rate of gain and a higher feed conversion ratio are: (1) forages generally

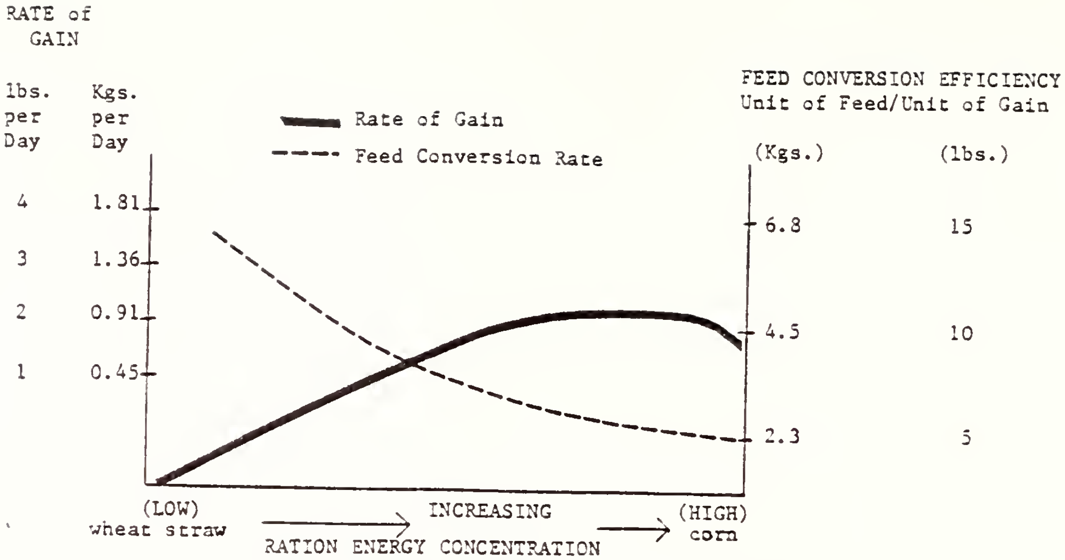

Figure 2.7. Theoretical Effect of Ration Energy Concentration on Rate of Gain and Feed Conversion Efficiency.[20]

contain less net energy for maintenance and gain per unit of feed than grains; (2) forages usually take longer to digest due to their higher level of crude fiber and bulk. The consequence of feeding a lower ration energy concentration is simply cattle cannot consume enough energy to reach their maximum possible rate of gain due to limited stomach capacity, so their growth efficiency is lessened.

Montgomery and Baumgardt has proposed a relationship between feed intake regulation and the ration energy concentration fed, as described in Figure 2.8.

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[20] Donald R. Gill, "Formulating Rations for Finishing Cattle," Great Plains Beef Cattle Feeding Handbook, USDA, Cooperative Extension Service, Washington D.C., GPE-16, (October 1972) 1600.4 - 1600.5.

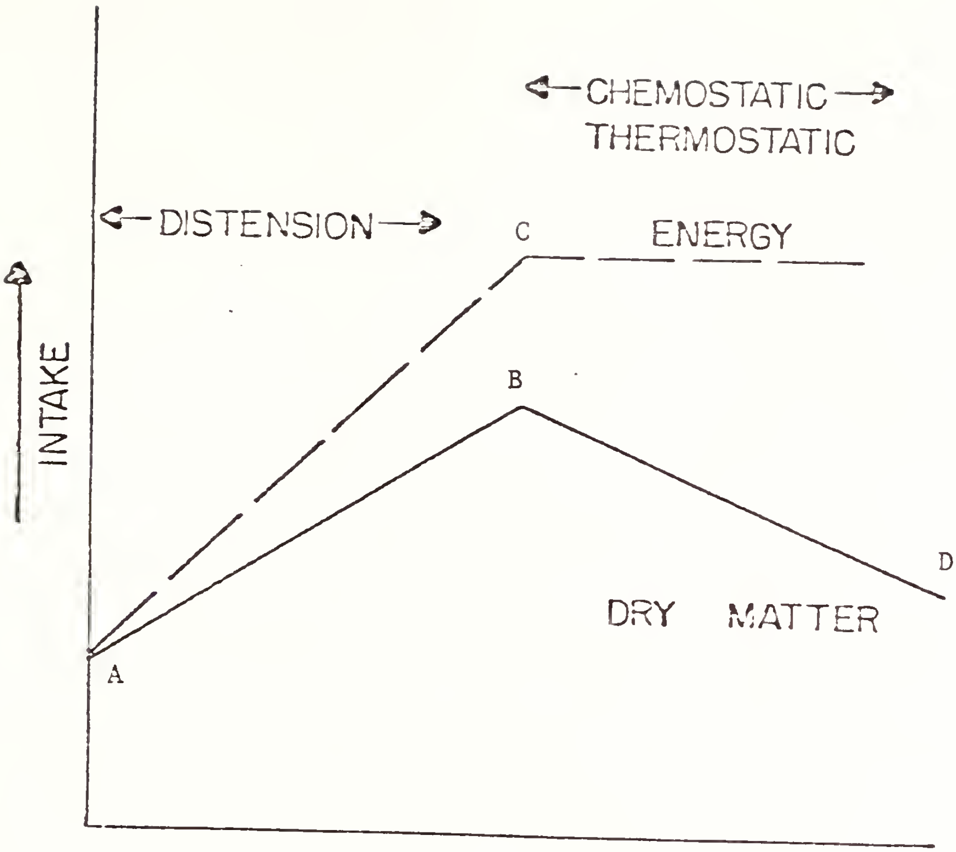

Figure 2. 8. Proposed relations in regulation of feed intake in ruminants (Montgomery and Baumgardt).[21]

At low levels of ration energy concentration feed intake is limited by stomach capacity, referred to as distension (points A to B in Figure 2.8). When a feedlot animal consumes a certain level of energy concentration (point C), the ruman fill limitation on feed intake ceases to regulate feed intake, and further increases in the ration energy concentration fed results in a decrease of voluntary dry matter intake (points B to D). Thus, to the left of the dry matter feed intake peak, ruman fill limits intake. To the right of the peak it is hypothesized that chemostatic and/or

[21] Ray Brokken et.al., "Grain vs. Harvested Roughage for Feedlot Cattle", p. 246.

thermostatic mechanisms regulate voluntary dry matter feed intake, whereas the animal consumes for its needs in terms of its inherent genetic capability for growth.

Some recent study (Brokken) has suggested slight adjustments to the Montgomery and Baumgardt proposed relationships.

> It is known that net energy (NE) as a proportion of digestible energy (DE) increases as the DE concentration increases. Then, if DE intake were to remain constant as ration energy concentration increases, NE intake must be increasing. This implies an increasing rate of gain as ration energy concentration increases, which is indeed the case. Further, if daily dry matter intake, Y, is a linear function of energy concentration, X; i.e., if Y = f(X), then energy intake, XY = Xf(X), is nonlinear and vice versa. Figure 2.8 is inconsistent in this respect. These relationships have been reexamined... (Brokken and Dinius 1974, 1976; Dinus et. al.). Their work provides a framework which accomodates differences between individual animals for estimating the effect on voluntary daily feed intake and daily gain of changing dietary energy concentration.[22]

Recent Research Completed on the Grain-Forage Balance Question

Since the period of high grain prices from 1973 to 1975, a good share of research effort has been put forth in analyzing the economic efficiency in feeding feedlot cattle.

Brokken has recently done an extensive amount of study in this area, arriving at the general conclusion that - "within the feedlot, high concentrate rations remain economical on a profit per head basis or under the criteria of maximizing feedlot profits per unit of time, even with relative high grain prices."[23] Also, Brokken concluded that grain-roughage substitution curves (isoquants) to be decreasing at an increasing rate

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[22]Ibid, p. 247.

[23]Ray Brokken, Economics of Grain-Roughage Substitution in the Beef Sector, Paper for Southern Regional Forage Fed Beef Research Workshop, New Orleans, LA. (October 20-22, 1975), 30. (hereafter cited as Brokken, Economics of Grain-Roughage Substitution.)

(i.e., concave to the origin) over the upper range of the energy concentration diet is the limiting factor of feed intake.[24] This suggests that when grain prices increase relative to lower energy feedstuff sufficiently to cause a shift (in the forage-grain balance of a feedlot ration), the shift in the optimum proportions of grain and roughage in the diet will be a large one.[25]

Wilson completed an analysis of implications of short-run rising average productivity in cattle feeding and came up with a similar conclusion as Brokken of - "When two rations of different energy concentrations were compared, the higher energy ration was preferred on grounds of physical and economic efficiency over a relevant range of corn and cattle prices.[26] Contrary to these results, Young made a study from which he reported that the cost of gain for steers fed a high forage ration were 8 to 10 percent lower than for the corn finished steers using grain and forages prices of that time.[27] However, the performance results from a feeding trial done by Dikeman, Bolsen and Riley indicated substantially more production efficiency in feeding higher energy rations.[28] Their results showed, during

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[24]Ray Brokken, Effects of Ration Nutrient Concentration on Voluntary Feed Intake and Animal Performance: An Analytic Framework, Paper for First International Symposium on Feed Composition, Animal Nutrient Requirements, and Computerization of Diets. Logan, Utah, (July 11-16, 1976), p. 20.

[25]Ibid, p. 20.

[26]Ewen M. Wilson, "Implications of Short-Run Rising Average Productivity in Cattle Feeding," American Journal of Agricultural Economics, 58 No. 2 (May 1976), p. 309.

[27]A.W. Young, "Questions on Forage Fed Beef", unpublished report, (University of Wisconsin).

[28]Mike Dikeman, Keith Bolsen, and Jack Riley, "Energy Levels for Growing and Finishing Steers," 63rd Annual Cattlemen's Day Report, Kansas State University, Manhattan, Kansas, (March 5, 1976), pp. 66-69.

the growing phase, steers fed a moderate ration gained 23 percent faster and 6 percent more efficient than steers fed the low energy ration. In the finishing phase, feeding the high energy concentration ration resulted in a 14 percent faster and 9 percent more efficient gain than the moderate ration.

Contrasting opinions can be found over the issue of what forage-grain balance feedlot ration would be most efficient to feed if consumers would purchase more lower quality beef. Preston reported results of a Lofgreen study, "if the consumer is willing to accept a product with less fat, more protein and less marbling, this product can be produced at the same weight as our present slaughter animals by feeding different (ration) energy levels."[29] However, Preston indicated that he could find little evidence to support Lofgreen's conclusion.[30] Brokken, keeping in mind that he found high energy rations most economical, also mentioned that, "It is safe to say that over most of the decades of the 1950's and 1960's the Choice animal had a lower cost per pound than it would have had if marketed at a lower grade."[31] Somewhat opposite to Brokken's view, Purcell and Nelson found that live marginal cost of a pound of lean (muscle) gain was lower than the same marginal cost for a pound of live weight gain, which suggested earlier replacement of feedlot cattle and possibilities for reducing production costs of beef.[32]

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[29] R.L. Preston, "Effects of Nutrition on the Body Composition of Cattle and Sheep", Paper for the Georgia Nutrition Conference, Ohio State University, (February 18, 1971), p. 32.

[30] Ibid, p. 32.

[31] Brokken, Economics of Grain-Roughage Substitution, p. 19.

[32] Kenneth E. Nelson and Wayne D. Purcell, "A Comparison of Liveweight, Carcass and Lean Meat Criteria for the Feedlot Replacement Decision," Southern Journal of Agricultural Economics, 5 No. 2 (December, 1973), pp. 99-100.

Chapter III

Factors of the Past and Future to Consider in the Forage-Grain Balance Question

Economic Incentives in Feeding the Traditional High Concentrate Rations to Feedlot Cattle

Feed cost generally account for 60 to 80 percent of the cost of live weight gain for feedlot cattle. Since grains and forages are the two primary feed ingredients that can be substituted in a feedlot ration, their balance or rate of substitution should depend on their relative prices. However, in the past, substitution between forage and grain in formulation of optimum balanced finish ration for feedlot cattle has not been very sensitive to small shifts in forage to grain price ratio.[1] Feedlot finish rations have typically contained only what is regarded as a physiological minimum level of roughage for three reasons.

First, the cost per unit of live weight gain per unit of net energy (or metabolizable energy) fed has been traditionally cheaper for high energy concentration rations. Table 3.1 illustrates the cost advantage of a high energy ration over a low energy ration in a hypothetical example, using feed cost of $0.0913/Kg ($2.32/bu.) corn, $22.05/metric ton ($20.00/ton) corn silage, and $0.1764/Kg ($8.00/cwt.) protein supplement costs,

[1]In a discussion by Brokken he mentioned: "A casual mental construction of technical substitution between roughage and grain in the finishing phase of beef production may suggest an optimum balance that is very sensitive to small shifts in ratios of ingredient prices. However, this has not been the case."

Ray Brokken, "Framework for Economic Analysis of Grain versus Harvested Roughage for Feedlot Cattle," American Journal of Agricultural Economics, Vol 58 No. 2 (May 1976), p. 245.

Table 3.1 Hypothetical example comparing ration cost of Gain and Ration cost for feed energy between a low energy and a high energy ration for a 350 Kg. steer.

Ration	% of Ration D.M. Basis	Feed Ingredients Energy Values[d] (Mcal/Kg) NEm	NEg	Ration Energy Values (Mcal/Kg) NEm	NEg	Feed Ingredient Cost[a] ($/Kg)	Cost in Ration ($/Kg)	Daily DMC[b] (Kg)	Daily Feed Cost ($)	Expected ADG[c,d] (Kg)	Ration Cost for Gain ($/Kg)	Ration Cost for Gain per Unit Energy ($/Kg/NEg)
Low Energy Ration	100%	—	—	1.741	1.118	—	0.0954	7.875	0.75	0.80	0.94	0.84
Corn	20%	2.28	1.48	.456	.296	0.1027	0.0205	—	—	—	—	—
Corn Silage	70%	1.56	0.99	1.092	0.693	0.0790	0.0553	—	—	—	—	—
Supplement	10%	1.93	1.29	0.193	0.129	0.1960	0.0196	—	—	—	—	—
High Energy Ration	100%	—	—	2.173	1.412	—	0.1073	7.875	0.85	1.05	0.81	0.57
Corn	80%	2.28	1.48	1.824	1.184	0.1027	0.0719	—	—	—	—	—
Corn Silage	10%	1.56	0.99	0.156	0.099	0.0790	0.0158	—	—	—	—	—
Supplement	10%	1.93	1.29	0.193	0.129	0.1960	0.0196	—	—	—	—	—
Differences in Rations				+.432	+.294		-.0119		-.10	+.25	+.13	+.27
+ Favorable to High Energy Ration												
- Unfavorable to High Energy Ration												

a/ Assumes \$.0913/Kg (\$2.32/bu.) Corn, \$22.05/metric ton (\$20.00/ton) corn silage, and \$.1764/Kg (\$8.00/cwt.) Protein Supplement Cost.

b/ DMC is Daily Dry Matter Feed Consumption.

c/ ADG is Average Daily Gain.

d/ All energy values and the average daily gain estimate taken from : National Academy of Science, Nutrient Requirements of Beef Cattle, 5th Revised Edition, Washington D.C., (1976).

the cost savings of feeding the high energy ration was $0.27 per Kg. of weight gain per unit of net energy for gain (NEg) fed.

Secondly, less total net feed energy is required to produce a given amount of live weight gain when cattle are fed a high ration energy concentration diet. A slower rate of gain results from feeding a lower ration energy concentration diet, which means a longer feeding period is needed in order to obtain a similar slaughter weight. This results in more days of net energy needs for the animal's body maintenance. Furthermore, since approximately one-third to one-half of the feed consumed is required for body maintenance, feed cost is largely dependent upon the amount of feed consumed for maintenance. Table 3.2 illustrates the advantage of feeding a high concentrate ration, in which 368 fewer units of net energy for maintenance (NEm) was needed due to a 68-day shorter feeding period for the higher energy ration.

Table 3.2. Total net energy requirements for body maintenance (NEm) by NRC Standards to feed a steer from 350 Kgs. (722 lbs.) to 500 Kgs. (1,102 llbs.) under two alternative forage-grain balance diets.[2]

Ration Energy Concentration Difference	Roughage	Expected Average Daily Gain	Animal Weight Interval of 350 Kgs. to 500 Kgs.	
			Total Units of NEm	Total Number of Days
	(percent)	(Kg/Day)	(Mcal.)	
Lower	45-55	0.9	1199	222
Higher	15	1.3	831	154
Differences in favor of the higher ration energy concentrate diet:			368 NEm	68 days

[2]Energy values and expected average daily gain values based upon the source: National Academy of Science, Nutrient Requirements of Beef Cattle, 5th Revised Edition, Washington D.C., (1976).

This example shows a steer fed the higher energy concentration ration would be on feed 68 fewer days to obtain the same market weight. This would mean a $6.80 per head advantage for the higher concentrate ration if the feedlot cost per head per day was 10¢. Assuming a feedlot operating cost and interest cost of 15¢ per head per day, the cost saving advantage of feeding the higher concentrate ration would have been $10.28 to obtain the same slaughter weight of 500 Kg.

Thirdly, a cattle feeder has had the incentive to shorten the time necessary to obtain a marketable slaughter weight (generally to the Choice quality grade) by feeding a high concentrate ration. The shorter the feeding period, the less total fixed cost associated with time and usage, such as interest cost on the investment and machinery depreciation cost.

Another economic incentive for feedlot producers to produce grain-fed beef has been the positive price spread between live Choice slaughter cattle and the lower quality Good grade cattle, as indicated in Table 3.3.

The returns from the positive price spread between Good and Choice has generally been greater than the returns from live weight added between the two grades.[3] Cattle with the genetic potential to reach the Choice quality grade have a greater probability of doing so as a larger percentage of the carcass is fat up to a certain point. Therefore, to obtain a high percentage of Choice quality cattle, the feedlot producer has found it necessary to feed a high energy concentration ration for a sufficient number of days that will allow the animal to fatten.

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[3]Ray Brokken, et. al., "Framework for Economic Analysis of Grain versus Harvested Roughage for Feedlot Cattle, "American Journal of Agricultural Economics, Vol 58 No. 2 (May 1976), p. 252.

Table 3.3. Yearly average live price spreads between Choice and Good quality slaughter grade steers, Omaha, 1950 - 1976.[4]

Year	Price Spread	Year	Price Spread	Year	Price Spread
	($/cwt)		($/cwt)		($/cwt)
1950	$ --	1960	$1.32	1970	$1.42
1951	2.28	1961	.97	1971	1.52
1952	3.12	1962	1.65	1972	1.41
1953	2.52	1963	.91	1973	1.66
1954	2.57	1964	1.36	1974	2.18
1955	1.79	1965	1.79	1975	5.05
1956	2.25	1966	1.14	1976	3.24
1957	1.52	1967	1.15		
1958	1.43	1968	1.37		
1959	1.31	1969	1.71		

The willingness of the American consumer to purchase Choice quality grade beef has been greater than for any other grade of beef. This has resulted in the largest share of slaughter cattle coming from Choice grade animals, as shown in Table 3.4.

This willingness by consumers to purchase Choice beef in past years has resulted from their consideration of disposable income, taste and price of choice beef in relation to other grades of beef and other meats.

The mentioned economic incentives to feed high concentrate rations to feedlot cattle are largely a result of past price relationships between

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[4]Source of data used to calculate the price spread figures for Table 5 was obtained from: U.S., Department of Agriculture, Economic Research Service and Statistical Research Service, Livestock and Meat Statistics, Statistical Bulletin No.522, Washington D.C.

U.S. Department of Agriculture, Economic Research Service, Statistical Reporting Service, Agricultural Marketing Service, Livestock & Meat Statistics: Supplement for 1976, Statistical Bulletin No. 522, Washington D.C. (June 1977), p. 120.

U.S. Department of Agriculture, Economic Research Service, Livestock and Meat Situation, LMS-208 and 206, Washington D.C. (December 1975 and April 1976), p. 32 and p. 39.

Table 3.4 Percent slaughter steer and heifer sales and total number of head sold out of first hand sales, by quality grades, by years, Omaha, 1970 - 1974.[5]

Year	Total Sales	Prime	Choice	Good	Other
		Percent	Graded		
1970	825,835	7.0	70.0	20.9	2.1
1971	788,395	8.0	67.5	22.0	2.5
1972	717,301	8.6	67.5	21.2	2.9
1973	591,141	9.4	67.4	20.9	2.3
1974	700,294	7.0	64.4	26.0	2.6

forages and grains, and between quality grades of beef. These factors and others may change in the future which could alter feed resource utilization in feedlot rations.

Reasons to Investigate the Economics of Forage-Grain Balance in Feedlot Rations

Recent new developments have brought forth a surge of interest in investigating the question of how to best utilize feed resources (primarily grain and forages) in production of feedlot cattle. Such developments are: (1) more concern for improved energy conservation in agricultural production; (2) recognized adjustments made by cattle feeders in rations fed and length of feeding periods due to increased cost of gain during periods of high grain prices; (3) increase consumption of lower quality cuts and hamburger; and (4) an apparent increased emphasis being placed on lean value of beef. The interest of producers, processors and consumers of

[5]Source of data from: U.S. Department of Agriculture, Economic Research Service and Statistical Research Service, Livestock and Meat Statistics, Statistical Bulletin No. 543, Suppl. for 1974, Washington D.C., p. 72 & 73.

beef are all tied into these recent developments and into what may occur in the future.

Energy Conservation in Beef Production

A common suggestion for energy conservation is to reduce grain feeding to cattle and return to predominantly forage feeding.[6] Such a suggestion is based on the assumption that forage beef production is less energy-intensive than beef production utilizing feed grain resources. A recent study was completed in determining the energy inputs for alternate beef production systems (see appendix C). The results of the study show that crop production of common concentrates used today in feedlot rations, such as irrigated corn and dryland milo, are more energy-intensive crops to produce than irrigated corn silage and dryland forage pasture, as summarized in Table 3.5.

Table 3.5. Mega-calories (Mcal) of cultural energy input per Mcal of net energy gain obtained for various feed resources.[7]

	FEED RESOURCES				
	Irrigated				
	Corn	Corn Silage	Alfalfa Hay	Dryland Milo	Forage Pasture
Mcal of Cultural Energy per Mcal Net Energy for Gain	0.70	0.44	1.48	0.64	0.26

[6] Dr. Gerald M. Ward, "Energy and Resource Requirements for Beef Cattle Production," Feedstuffs, (December 20, 1976), p. 16.

[7] See appendix C, Table 4. Source of data: Ward, "Energy and Resource Requirements for Beef Cattle", Feedstuffs, (December 20, 1976), p. 18.

As can be noted from Table 3.5, irrigated corn, dryland milo and irrigated alfalfa hay requires a good deal more energy to produce for every unit of feed energy received than irrigated corn silage and dryland forage pasture. These results might explain how corn and milo prices could react more dramatically to increasing energy cost than forages. Also, a conclusion stated from the study mentioned that -- energy efficiency can be high for use of corn silage in beef production.[8] Another table of results of this study (see appendix C, Table 6) revealed that the Mega-calories of input per Maga-calories of retail beef obtained was less as the beef production system utilized more of the less energy-intensive forages.

With respect to energy usage, the study shows the importance of giving serious consideration for utilizing more forages in future feedlot production. However, other considerations must be taken into account as well, such as, the quantity and quality of beef which could be produced from the available forage resources. Dr. Ward, concluded that, "it would be difficult or impossible to suggest less energy-intensive methods that will still provide the U.S. with the same quantity of beef."[9]

<u>Adjustments in Rations and Length of Feeding</u>:

The feedlot producer has recently, 1974-1976, experienced times of high cost of gain, primarily due to increased feed grain prices, coupled with depressed cattle prices. These conditions brought about an adjustment in the amount grain fed in rations and the length of time cattle were kept on feed. Generally if feed grains are cheap relative to beef prices, a higher percentage of grain is fed and at younger and younger ages, as in 1972-73. However, when grain was costly relative to the price of cattle,

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[8] Ibid, p. 18.

[9] Ibid, p. 18.

the finishing phase became shorter and in fact, many feedlot cattle were slaughtered with little or no grain feeding, as occurred in 1975-76.[10] Supportive evidence of these occurrences is the quarterly nonfed steer and heifer slaughter in relation to the quarterly beef-steer/corn ratios, as presented in Figure 3.1. The value of slaughter steers relative to corn dropped from the first quarter in 1973 to the low point of $11.00 in the fourth.

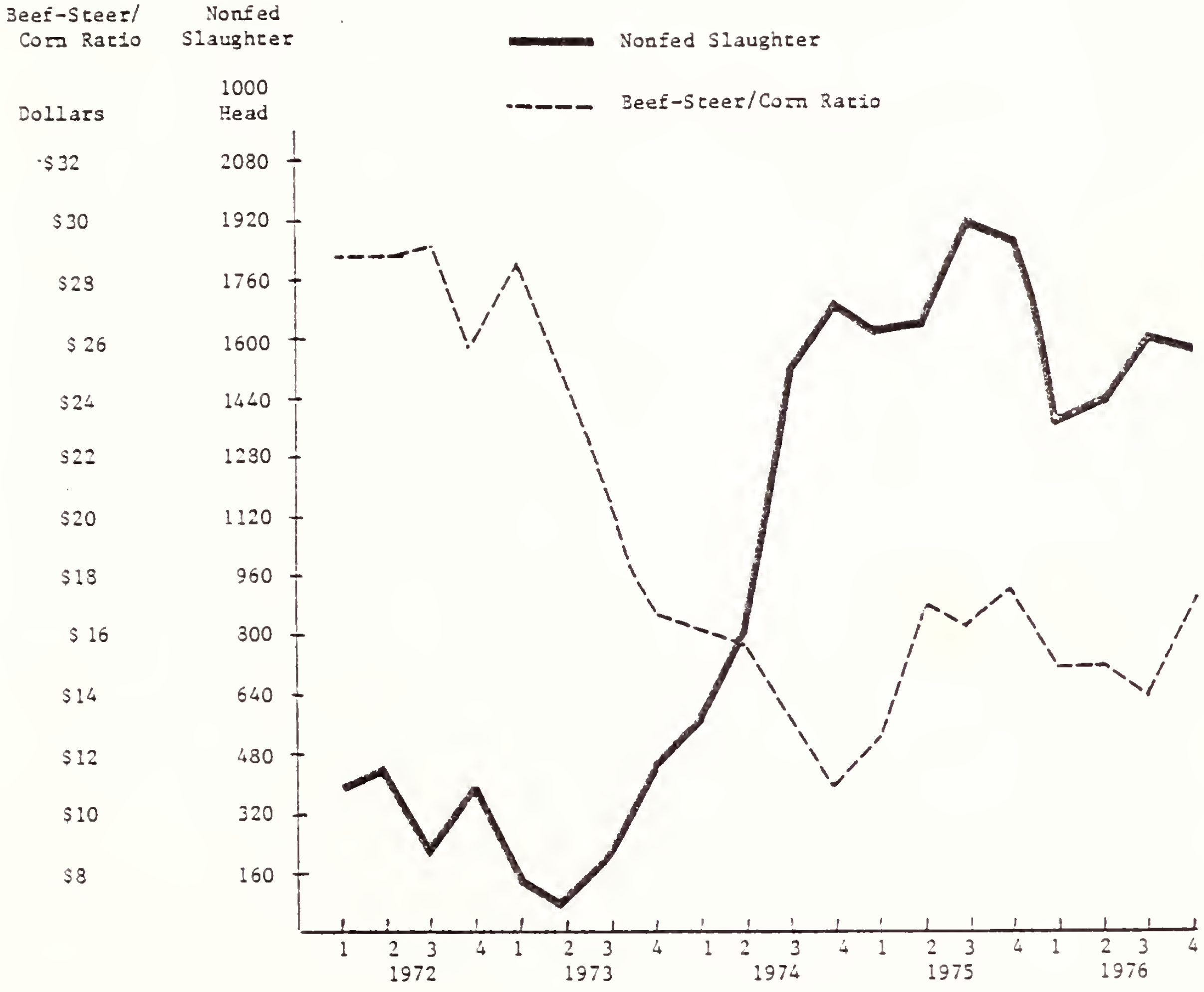

Figure 3.1. The Beef-Steer/Corn Ratio[a] in Comparison to Nonfed Slaughter by Quarter, 1972-1976.[11]

[a]Beef-Steer/Corn Ratio is the Number of Bushels of No. 2 Yellow Corn Equivalent in Value to 100 Pounds of a Choice Slaughter Steer at Omaha.

[10]Ibid, p. 16.

[11]Data Sources: U.S. Department of Agriculture, Livestock and Meat Statistics: Supplement for 1976, Statistical Bulletin No. 522, Washington D.C., (June 1977), p. 132.

Furthermore, since 1974 when the beef-steer/corn ratio became low, there has been a definite adjustment in feedlot rations towards feeding more roughage and less concentrate. Figure 3.2 indicates the vast increase in roughage feed units consumed by cattle on feed in the recent past.

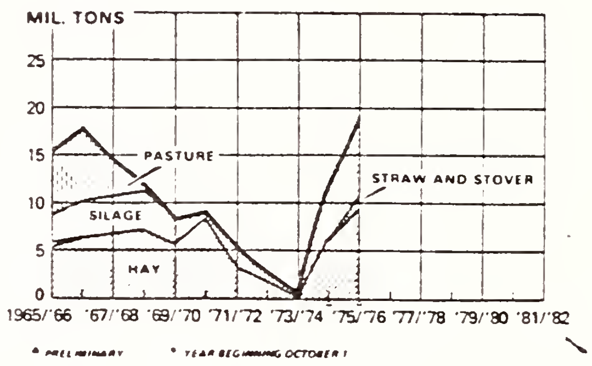

Figure 3.2. Roughage Feed Units Consumed by Cattle on Feed, 1965-76.[12]

It is doubtful nonfed slaughter would have been nearly as high and the steer/corn ratio as low, if the cattle numbers had not been at their peak. It should be recognized that the cattle cycle reached its peak in 1975, as shown in the cattle-people ratio chart in Figure 3.3 on the following page. Nonetheless, such a combination of circumstances as what has recently occurred in live beef production has caused adjustments in feeding practices by feedlot producers. Further adjustments are difficult to predict with the ever-changing relative factors, such as cattle prices feed grain prices and forage prices, which the cattle producer may face

[12]U.S., Department of Agriculture, Economic Research Service, Feed Situation, FdS - 262, Washington D.C., (September 1976), p. 16.

tomorrow. However, recent past adjustments have been made in cattle feeding and similar adjustments are possible in the future.

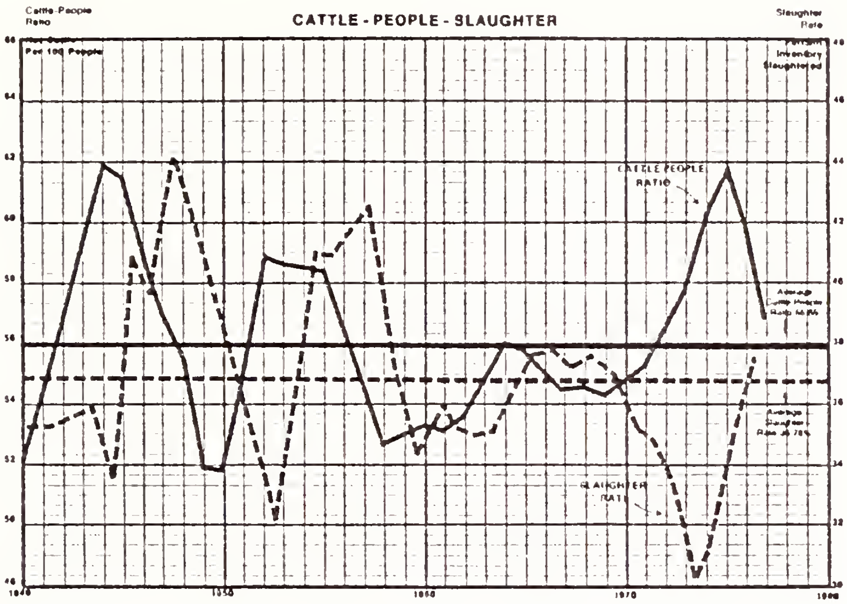

Figure 3.3. Numbers of Total Cattle per 100 People in the U.S., and Percentage of Cattle Inventory Slaughtered Each Year.[13]

Production and Consumption of Lower Quality Beef:

Consumer demand for various quality grades of beef must also be considered a determining factor on the forage-grain balance question. It has been argued that if consumers accepted a lower quality grade of beef this would allow cattle feeders to feed a cheaper ration consiting of more

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[13] John H. McCoy, What's Ahead for Cattle, provide for Information Services, Farm Credit Banks of Wichita, Kansas State University, 1977.

forages.[14] The primary signal for cattle producers to determine at what quality grade to sell their live cattle is the price spread between quality grades. In the short-run price spreads between quality grades is vastly determined by the quality grade slaughter mix. Since beef is a perishable product, the storage stocks of beef are small relative to the live animal level. Hence, it may well be assumed that consumption for beef in a given period will be predominantly determined by slaughter production in that period. If the price spread between Good and Choice quality grade cattle should become narrow enough and/or, if the additional cost to reach the Choice quality grade became great enough, a cattle feeder would be more encouraged to sell his cattle at the lower quality grade. Figure 3.4 shows a hypothetical situation where cattle at a weight within the Good quality grade would be more profitable to market than if these cattle would be fed longer in order to reach the Choice quality grade weight.

In the hypothetical situation illustrated in Figure 3.4, there is a $5.00 profit advantage in selling the animal at 400 Kgs. in the Good quality grade rather than to continue to feed the animal to Choice at 500 Kgs. The profit advantage can be partially explained by the increasing average cost of gain from $0.88 per Kg. ($0.40 per lb.) to $0.97 per Kg. ($0.44 per lb.) realized in feeding the animal from Good to Choice. This additional cost exceeds the additional revenue received from the $0.02 per Kg. ($0.91 per cwt.) premium given for a Choice slaughter animal in this instance.

Cattle producers would be more inclined to feed rations of more forages and less concentrates if the Good grade cattle became more profitable to

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[14]Ray Brokken, Economics of Grain-Roughage Substitution in the Beef Sector, Paper for Southern Regional Forage Fed Beef Research Workshop, New Orleans, La. (October 20-22, 1975), p. 10.

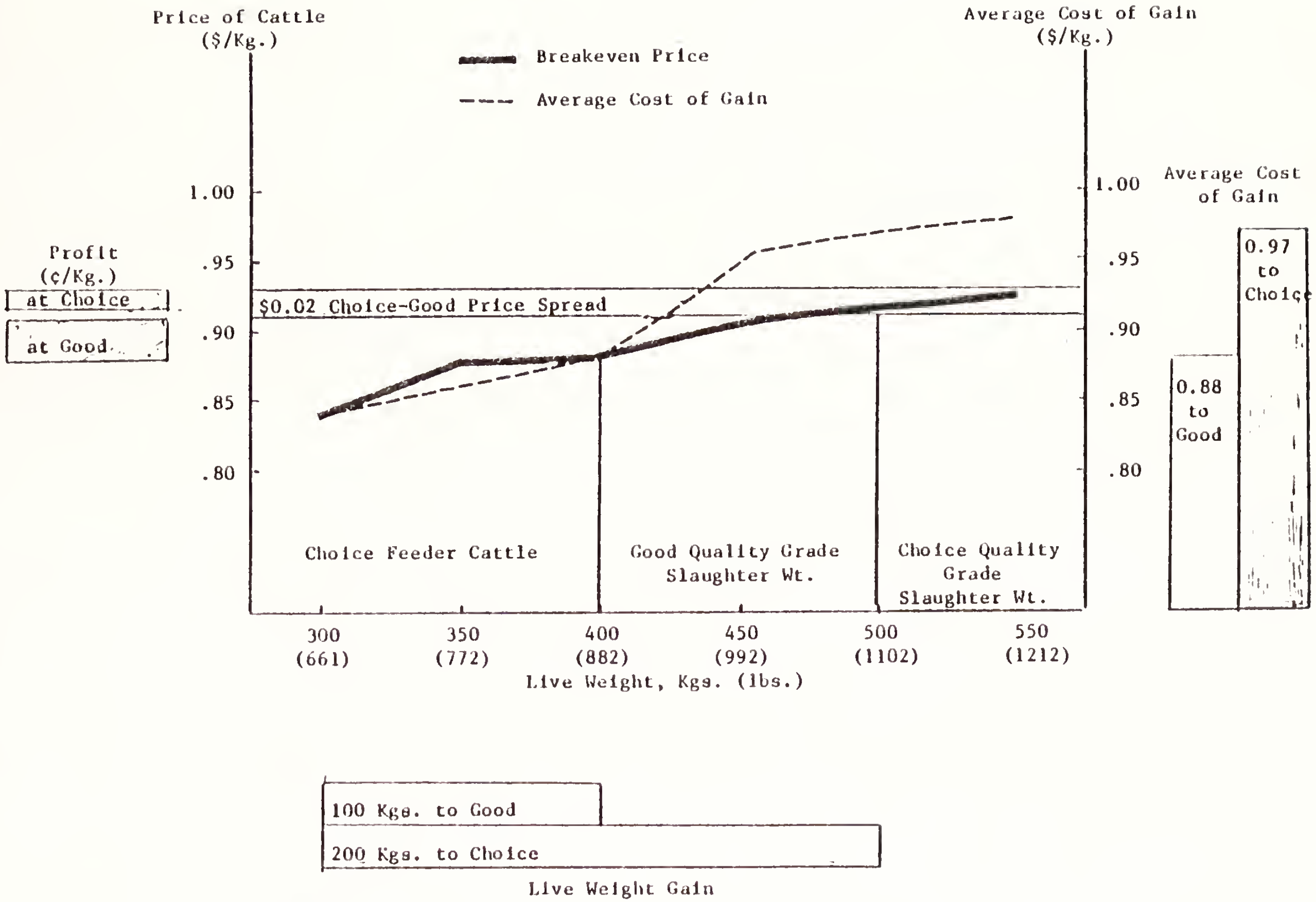

Figure 3.4 Hypothetical situation when slaughter cattle in the Good quality grade would be more profitable to sell versus selling at the Choice quality grade at a heavier slaughter weight.

feed relative to choice grade cattle. Increase demand for lower quality beef in the future could encourage more emphasis on the production of Good grade slaughter animals. In a long-run perspective, a continual shift by consumers towards increase consumption of lower quality beef is foreseen.

> The United States has indeed become a "hamburger society"... Based on data and estimates from industry, as well as government sources, of the total amount of beef that will be consumed in 1976 (about 125 pounds per capita), a minimum of 40 percent of this beef will be ground beef in one form or another... It is estimated that by 1980, between 50-60 percent of the total beef consumed in the U.S. will be ground beef in one form or another, irrespective of the slaughter mix relative to fed vs. non-fed cattle over the next 3-5 years.[15]

Much of the increase in hamburger consumption can be explained by the fact that a minimum of 45 percent of the total beef consumed in the U.S. was eaten away from home in restaurants, institutions, airlines, and numerous types of fast-service food centers.[16] Over half of this beef consumed away from home was ground beef.[17]

The retail food store average price of all ground beef in the U.S. during the first half of 1976 was about 85¢ per pound ($1.87 per Kg.). The average retail price of the other 60 percent of the beef sold at the supermarket level, in the form of steaks, roast, and other beef cuts, was $1.85 per pound ($4.07 per Kg.) or 218 percent higher than the price of ground beef.[18] The trend is clearly towards an everyday low price for ground beef and everyday high prices on the "better" cuts of beef.[19]

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[15] William C. Helming, Market Implications of Ground Beef, Presentation for the Great Plains and Western States Outlook Conference, Colorado State University, (July 22, 1976), p. 2.

[16] Ibid, p. 2

[17] Ibid, p. 2.

[18] Ibid, p. 2.

[19] Ibid, p. 2.

The trend to ground beef will lead to turning cattle in feedlots 3.5 to 4.0 times a year and thus, less feeding of grain per animal.

There are many restaurants and other away-from-home eating establishments in the U.S. today that were serving and selling large quantities of what is commonly referred to in the trade as "reconstituted" or "fabricated" meat, often called "steak". These "steaks" are generally made from a relatively rough cut of beef and/or grades of beef that are otherwise too tough for anything other than hamburger. The growing number of away-from-home establishments serving and selling these "reconstituted steaks" claim that the consumer acceptance is good and is growing and that the major advantages are portion control plus significantly lower costs (25 percent to 35 percent less than a real steak).[20] This is another indication towards increase production of lower quality beef which suggests that more forages and less grain will be utilized in feedlot rations.

Emphasis on Lean Value in Beef:

Lean is the primary product sold from retail beef cuts, and any excess fat trimmed away in the processing of beef carcasses to retail products is a by-product of less value. The packer and processor of beef carcasses have become more aware of the dollar significance of the lean value in a beef carcass since implication of the mandatory Yield Grade policy in 1976. The (dollar) significance of yield grades becomes evident when tests reveal that carcasses of the same quality grade -- Choice for example can vary in value by $75 per carcass or more due to differences in cutability.[21] For example one study revealed that--

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[20] Ibid, p. 3.

[21] U.S., Department of Agriculture, Agricultural Marketing Service, Federal Register, 40FR11535, Washington D.C., (March 12, 1975), p. 2.

> Choice 700-pound (317.5 Kg.), yield grade 2 carcass and a Choice 700-pound (317.5 Kg.), yield grade 4 carcass, there was 9.8 percent difference (70.1 versus 60.3 percent) in retail product. That equals 68.6 pounds difference. At $1.25 per pound ($2.75 per Kg.) of retail product, that's a distinct difference of $85.75 between yield grades 2 and 4. That doesn't include feed wastage in producing the yield grade 4 carcass nor the extra labor in cutting the carcass into retail cuts.[23]

The increased price emphasis on Yield Grades relative to Quality Grades from 1975 to 1976 can be realized from Figure 3.5, showing the price spreads between Quality grades Good and Choice and between Yield Grades 3's and 4 carcasses.

The drop in the dollar value of Choice beef carcasses with the increase in yield grades (indicating a higher proportion of fat) can be seen in Table 3.6, which was done by USDA using beef prices for April of 1977. For this time period, it appears for every increase of a yield grade the carcass retail sales value decreased by approximately $5.63/cwt.

For the most part of 1976, in contrast to 1975, the Yield Grade price spread between 3's and 4's for carcass beef was greater than the price spread between Good and Choice quality grades. This signified an increased emphasis being placed on the lean value relative to the quality grade value of carcassed beef. The importance of lean value in live feedlot cattle ready for slaughter to a prospective packer buyer becomes even more critical to the packer buyer when his plant breaks and trims the carcasses into wholesale and retail cuts at the packing plant. Industry surveys show a trend to less carcass beef and more pre-fabricated primals and sub-primals (box beef method of distribution) being received by retailers. Counting both stores and retail central warehouses the volume of primals and

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[23]Mike Dikeman, R.J. Lipsey, and D.M. Allen, "Reliability of USDA Beef Carcass Yield Grades in Reflecting Differences in Retail Yields", 63rd Annual Cattlemen's Day Report, Kansas State University, Manhattan, Kansas, (March 5, 1976), p. 76-78.

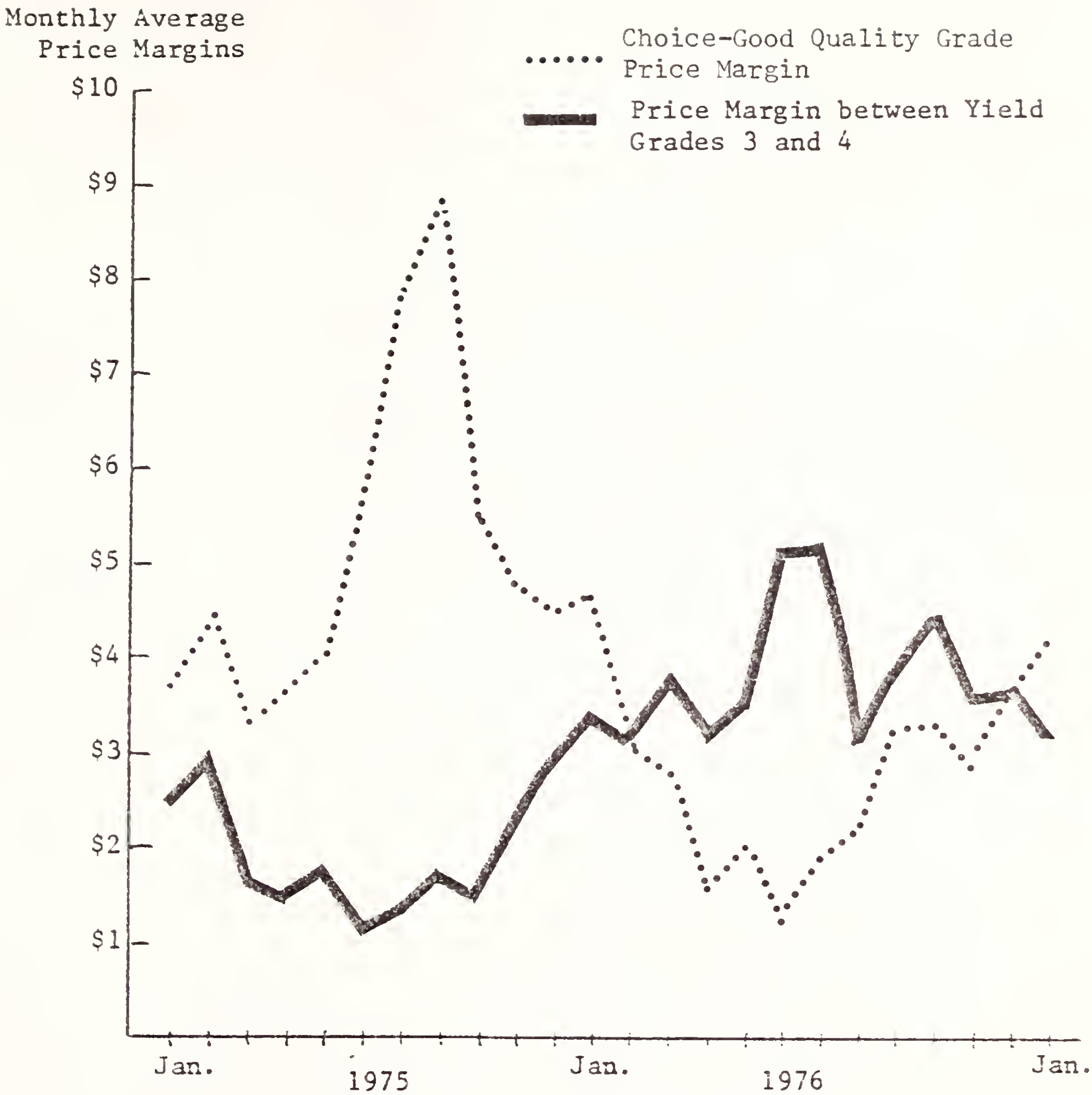

Figure 3.5. Monthly Average Price Margins Between Quality Grades Choice and Good and Yield Grades 3's and 4's for Steer Carcasses on the Midwest River Market Weighing 600-700 lbs. as Priced on the Yellow Sheet, 1975-1976.[22]

[22] Source of data: Yellow Sheet, The National Provisioner, Daily Market and News Service, Chicago, Ill., 1975-76.

Table 3.6. Comparison of Yields of Retail Cuts and Retail Sales Values for Choice Beef Carcasses, by Yield Grade.[24]

Yield Grades		1		2		3		4		5	
Retail Cut	Price per pound	% of carcass	Value/ Cwt. carcass	% of carcass	Value/ Cwt. carcass	% of carcass	Value/ Cwt. carcass	% of carcass	Value/ Cwt. carcass	% of carcass	Value/ Cwt. carcass
Rump boneless	1.70	3.7	6.29	3.5	5.95	3.3	5.61	3.1	5.27	2.9	4.93
Inside round, boneless	1.81	4.9	8.87	4.5	8.14	4.1	7.42	3.7	6.70	3.3	5.97
Outside round, boneless	1.73	4.8	8.30	4.6	7.96	4.4	7.61	4.2	7.27	4.0	6.92
Round tip, boneless	1.72	2.7	4.64	2.6	4.47	2.5	4.30	2.4	4.13	2.3	3.96
Sirloin, bone-in	1.79	9.1	16.30	8.7	15.58	8.3	14.86	7.9	14.14	7.5	13.42
Short loin, bone-in	2.17	5.3	11.50	5.2	11.28	5.1	11.06	5.0	10.85	4.9	10.64
Blade chuck, bone-in	.82	9.9	8.12	9.4	7.71	8.9	7.30	8.4	6.89	7.9	6.48
Rib, short cut (7"), bone-in	1.77	6.3	11.15	6.2	10.98	6.1	10.80	6.0	10.62	5.9	10.45
Chuck, arm boneless	1.22	6.4	7.82	6.1	7.44	5.8	7.08	5.5	6.70	5.2	6.34
Brisket, boneless	1.51	2.5	3.77	2.3	3.47	2.1	3.17	1.9	2.87	1.7	2.57
Flank steak	2.18	.5	1.09	.5	1.09	.5	1.09	.5	1.09	.5	1.09
Lean trim	1.08	12.3	13.28	11.3	12.20	10.3	11.12	9.3	10.04	8.3	8.96
Ground beef	.79	13.3	10.51	12.2	9.64	11.1	8.77	10.0	7.90	8.9	7.03
Kidney	.50	.3	.15	.3	.15	.3	.15	.3	.15	.3	.15
Fat	.02	7.6	.15	12.7	.25	17.8	.36	22.9	.46	28.0	.56
Bone	.01	10.4	.10	9.9	.10	9.4	.09	8.9	.09	8.4	.08
Total		100.0	112.94	100.0	106.41	100.0	100.79	100.0	95.17	100.0	89.55

Difference in retail value between yield grades — $5.63 per cwt. of carcass.

sub-primals (received from processors) increased from 51 percent of retail volume in 1972 to 69 percent in 1974, with a prediction of 79 percent by 1980.[25]

The market impacts are felt by the feedlot producer of live beef with more emphasis being placed on the lean value of beef at the retail and processor levels. Since the quality grade changes in April 1976, the producer has been able to sell cattle with generally 10 to 30 fewer days on feed to the satisfaction of the packer. Some feedlot producers estimate they are saving 5 to 10 percent of the grain normally fed before the grade

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[24]U.S., Department of Agriculture, Livestock Division, Agricultural Marketing Service, Livestock, Meat, & Wool Market News: Weekly Summary and Statistics, 45 No. 20, Washington D.C., (July 6, 1977), p. 477.

[25]William C. Helming, Market Implications of Ground Beef, Presentation for the Great Plains and Western States Outlook Conference, Colorado State University, (July 22, 1976), p. 2.

changes to make the Choice quality grade due to shorter feeding periods.[26] Also, it is known that more net feed energy is required to produce a pound of fat than a pound of lean of liveweight gain. This coupled with the grading changes causing more emphasis on the lean market value of beef, provides an incentive for producers to not only feed cattle for a shorter period of time, but also on a lower concentrate ration.

Marketing Strategy:

Lastly, the decision of what ration energy concentration to feed may be partially a decision of market strategy. A feedlot operator may choose to feed a ration energy concentration diet that will achieve a rate of gain which will coincide with his estimate of reaching a market weight at a time he expects an optimum selling price.

Economical Ration Formulation:

The question of what ration energy concentration to feed feedlot cattle at any particular time depends a great deal on three relative prices and their comparative weight effects.

(1) The price spread between quality grades, primarily Choice and Good.

(2) The price margin between Yield grades of primary Yield grades 3's and 4's.

(3) The price difference in net feed energy from alternative available sources of primarily feed grains and forages.

With this is mind, formulation of beef cattle rations has developed into a very complex and yet imperfect science in an attempt to combine feed

[26] Beef, "Minor Impact Report after First Year on New Grade Standards," Vol 13 No. 7 (March, 1977), p. 19.

ingredients in relation to all other variables that can effect maximum feedlot profits. With the objective of maximizing producer profit, the definition of the most economical ration may be stated as -- a ration that utilizes feed ingredients which fulfills an animal's nutrient requirement at the lowest possible production costs in line with the greatest possible returns.

The Objective Statement

The primary objective of this study is to compare growth rates, costs, and revenue relationships and implications between feedlot cattle fed various ration energy concentration diets. Specifically, the objectives are:

(1) to compare growth rates between different ration levels of grain and forage.

(2) to develop costs of production relationships for different ration levels fed.

(3) to determine revenue and cost relationships for each animal fed a different energy concentration ration allowing for differences in quality grade and yield grade.

(4) to determine the most profitable point during the feeding period to sell each animal under the various rations fed on a live and retail product basis, i.e. determine the optimum replacement point.

Chapter IV

The Growth Process and Cost-Revenue Implications of Feedlot Beef Cattle

Determining the Cost and Revenue Relationships of Retail Weight Basis for Cattle on Feed

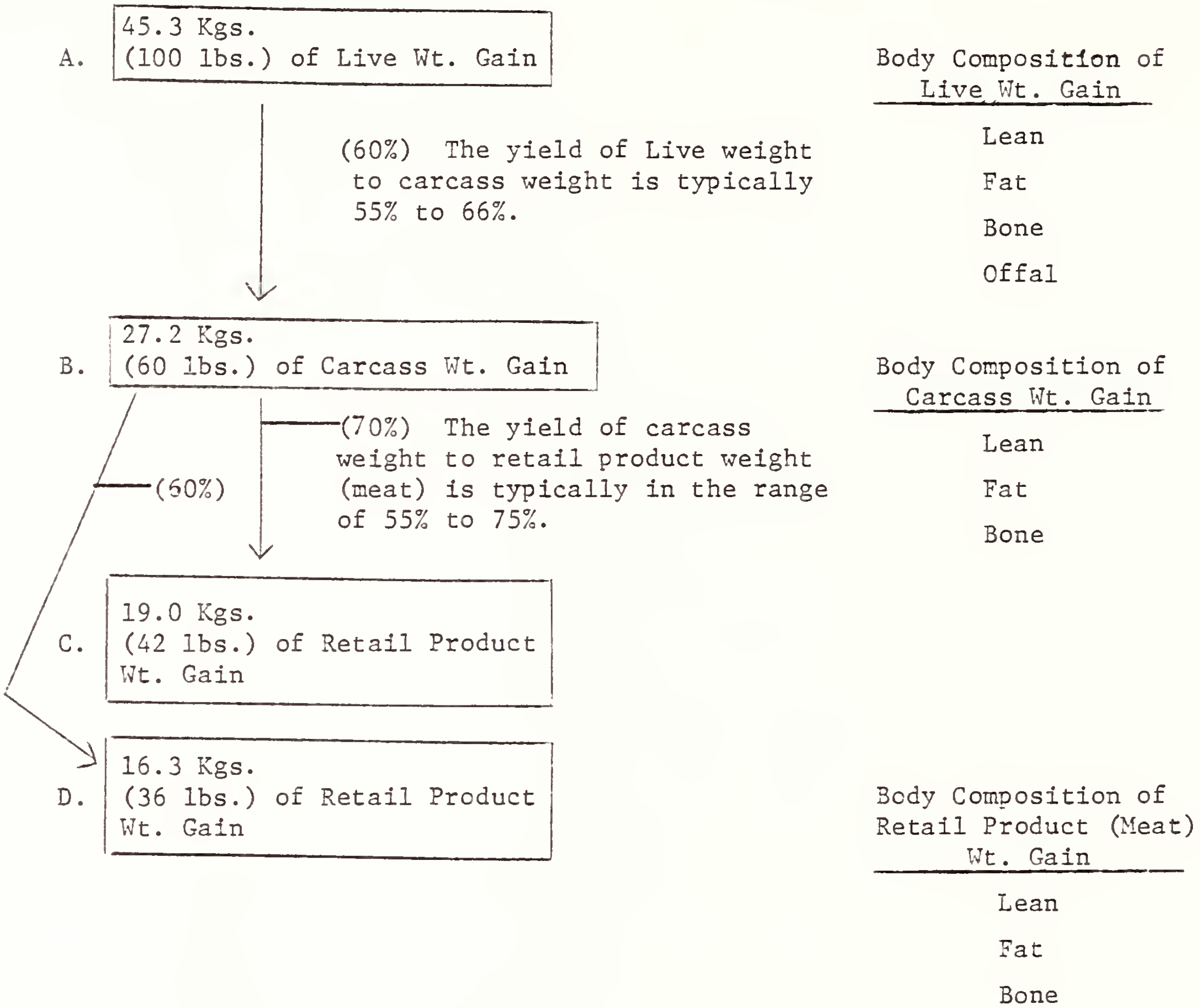
The cost and revenue relationships for live cattle based upon their production of retail product is affected by the form of body composition being deposited with each additional unit of live weight gain. If the live weight gain is largely the production of excess fat that will be trimmed away as by-product during the process of breaking a carcass into retail cuts, then the yield of retail product from that animal's live weight would be lowered. Figure 4.1, illustrates how the live feeding cost for each kilogram of retail product will become higher (from $2.10 to $2.45 Kg.) as the retail product yield decreases (from 70 percent to 60 percent of the carcass weight).

Not only does the cost of retail product gain increase as a higher proportion of the live weight gain is fat, for also, the retail sales value will generally decline when within the same quality grade. In Table 4.1 a hypothetical example is shown, where the margin between retail product cost and the retail sales value for choice beef narrows and becomes infact negative from $0.522/Kg ($0.237/lb.) to a -$0.505/Kg (-$0.229/lb.) as a greater share of the live weight gain is in the form of fat.

The Growth Process in Relation to Ration Energy Concentration Fed

The forage-grain balance fed has a direct effect upon a feedlot steer's or heifer's growth process since the energy concentration fed will largely determine the live (retail) weight rate of gain.

Figure 4.1 Comparison in cost of gain of two alternative yields, 60 percent and 70 percent, of retail meat product weight gains from 45.3 Kgs. (100 lbs.) of live weight gain equivalent to 27.2 Kgs. (60 lbs.) of carcass weight gain.



Live Cost of Retail Product (Meat) Weight Gain

A. \$40/45.3 Kgs. = \$0.88/Kg. Live Wt. Gain
(\$40/100 lbs. = \$0.40/lb.)

B. \$40/27.2 Kgs. = \$1.47/Kg. Carcass Wt. Gain
(\$40/60 lbs. = \$0.67/lb.)

C. \$40/16.3 Kgs. = \$2.45/Kg. Retail Product (Meat) Wt. Gain
(\$40/36 lbs. = \$1.11/lb.)

D. \$40/19.0 Kgs. = \$2.10/Kg. Retail Product (Meat) Wt. Gain
(\$40/42 lbs. = \$.95/lb.)

Table 4.1 The Retail Product weight Cost of Gain with Live Weight Cost of Gain at 88¢/Kg (40¢/1b.) and the Retail Sales Value per lb. of Choice Beef and Their Respective Differences at Various Yields of Retail Product Weight from 100 lbs. of Live Weight Gain.

	Units					
Live Weight Gain	Kgs. (lbs)	45.3 (100)	45.3 (100)	45.3 (100)	45.3 (100)	45.3 (100)
Carcass Yield from Live Wt. Gain[a]	%	60	61	62	63	64
Carcass Wt. from 100 lbs. Live Weight Gain	Kgs. (lbs)	27.2 (60)	27.6 (61)	28.1 (62)	28.5 (63)	29.0 (64)
USDA Yield Grade	USDA Score	1.5	2.5	3.5	4.5	5.5
Retail Product Yield from carcass wt. Gain[b]	%	75.48	70.50	65.52	60.54	55.56
Retail Product Wt. Gain from 100 lbs. Live Wt. Gain	Kgs. (lbs)	20.5 (45.3)	19.5 (43.0)	18.5 (40.6)	17.3 (38.1)	16.1 (35.6)
Retail Product Cost of Gain with Live Wt. cost of Gain @ 88.3¢/Kg. (40¢/1b.)	$/Kg ($/1b)	1.947 (.883)	2.050 (.930)	2.172 (.985)	2.315 (1.050)	2.478 (1.124)
Retail Sales Value per Kg.(1b.) of Choice Steer Carcass Beef[c]	$/Kg ($/1b)	2.469 (1.120)	2.346 (1.064)	2.222 (1.008)	2.099 (.952)	1.973 (.895)
Margin between Retail sales Value and Live Cost of Retail Product Weight Gain	$/Kg ($/1b)	.522 (.237)	.296 (.134)	.050 (.023)	-.216 (-.098)	-.505 (-.229)

[a]Assumed a 1 percent increase in dressing percent with every 1 unit increase in Yield Grade Score.

[b]Percent Retail Product is reliably predicted from the Yield Grade Score. Percent Retail Product of Carcass Weight = 82.9492 - 4.98 (Yield Grade Score)

[c]See Table 3.6 on page 37. (Prices for April 1977)

Some of the important relationships associated with growth in live cattle that are widely accepted are: (1) The growth curve or schedule of weight along a time continum has a characteristic sigmoid shape; and (2) the production of bone, muscle and fat reaches mature levels in succeeding order--ie, bone is early maturing, muscle intermediate and fat is late maturing. During the growth process fat becomes an increasing percentage of carcass weight while bone and muscle decreases in terms of percentage of carcass weight.[1]

These growth relationships are shown in the figures 4.2 and 4.3 on the following page.

> The age curve of growth may be divided into a self-accelerating phase of increasing slope and a self-inhibiting phase of decreasing slope. During the self-accelerating or unrestricted phase, the time rate of growth tends to be proportional to the size of the individual... However this geometric increase cannot go on indefinitely because of the restricting limitations...(which will) contribute to decline in growth rate of multicellular animals in later growth stages. For instance, the decrease of the ratio of surface to body weight during growth...[2]

When growth of the animal is completely inhibited by the concentration of the growth limiting factor, this point on the growth curve is referred to as the animal's mature weight.[3] At mature weight the animal is at the top, or at the level proportion of his growth curve. The mature weight for slaughter cattle is a much heavier weight than the normal

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[1]Kenneth E. Nelson and Wayne D. Purcell, "A Comparison of Liveweight, Carcass and Lean Meat Criteria for the Feedlot Replacement Decision", Southern, Journal of Agricultural Economics, (December, 1973), p. 100. (hereafter cited as Kennth E. Nelson and Wayne Purcell, "Criteria for the Feedlot Replacement Decision.")

[2]Samuel Brody, Bioenergetics and Growth, (New York: Reinhold Publishing Corporation, 1945), p. 528.

[3]Ibid, p. 528.

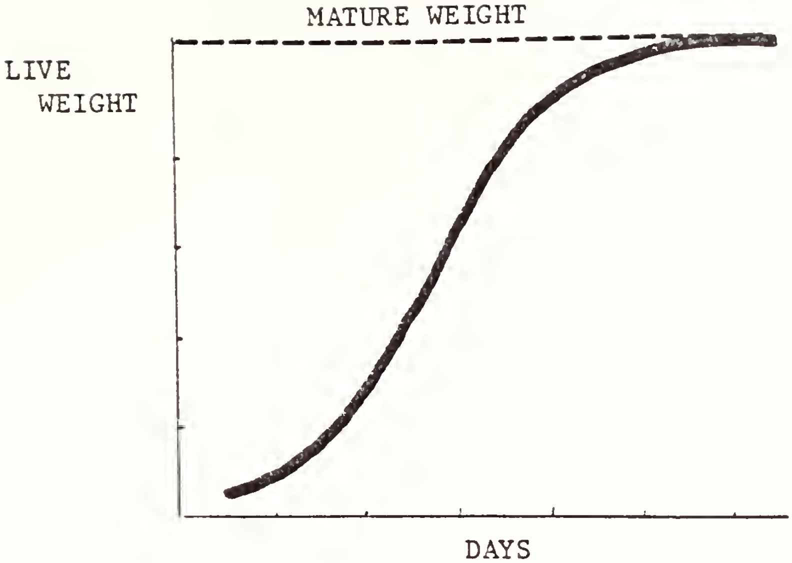

Figure 4.2. Growth Curve for Cattle[4]

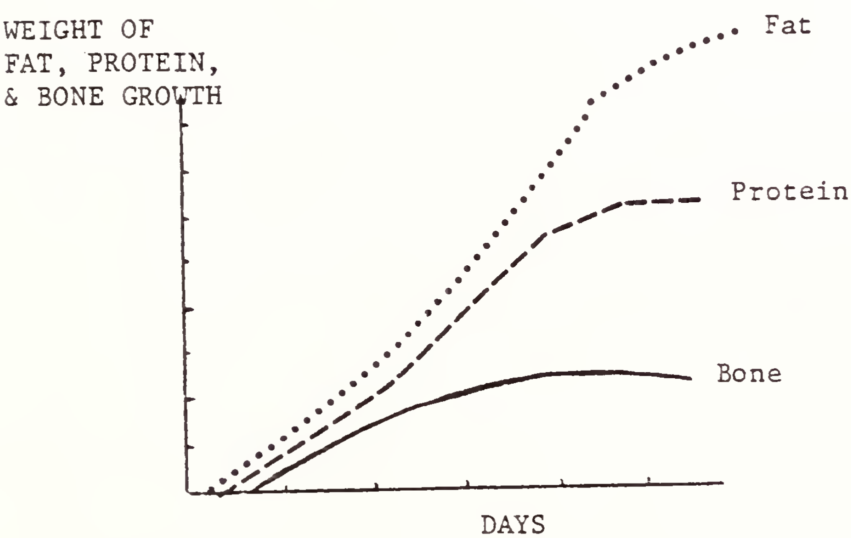

Figure 4.3. Relative Growth of Protein, Bone, and Fat in Cattle.[5]

[4]Kenneth E. Nelson and Wayne Purcell, "Criteria for the Feedlot Replacement Decision", p. 100.

[5]Ibid, p. 100.

slaughter weight. Figure 4.4 illustrates the mature weight of two identical steers fed a high versus a low ration energy concentration diet.

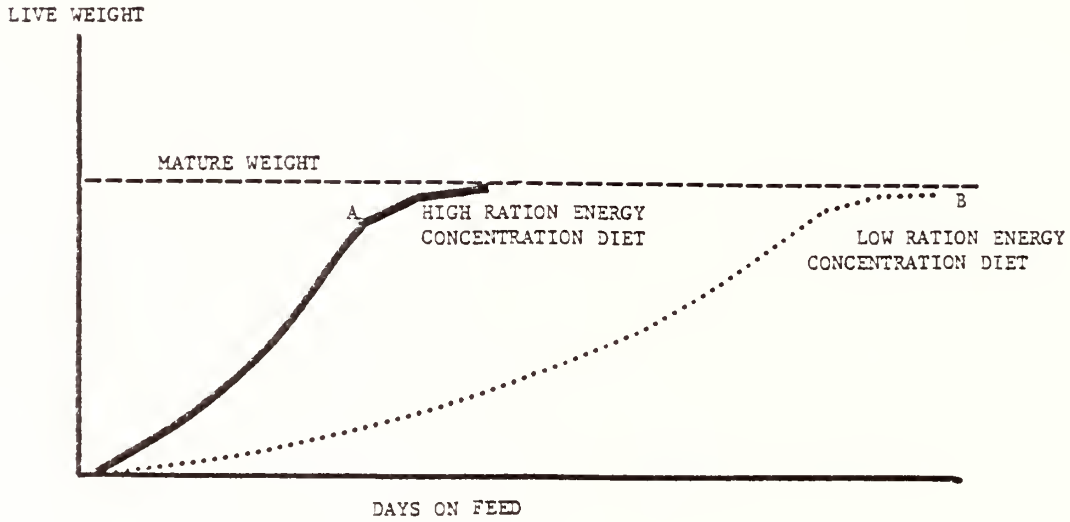

Figure 4.4 Hypothetical differences in growth curves of two identical steers fed different ration energy concentration diets.

Assuming these curves represent identical animals in which one steer was fed a higher ration energy concentration (A) and the other animal a relative lower ration energy concentration (B), we can observe how the rate of gain (slope of the curves) might differ, whereas theoretically their mature weights would be the same.[6]

[6]National Academy of Science, Nutrient Requirements for Beef Cattle, 5th Revised edition, Washington D.C., (1976) p. 6.

This source supports the above assumption of ration energy level effect on carcass composition --

"Variation in carcass composition of continuously growing young beef animals is more related to slaughter weight expressed as a proportion of mature weight than with age. Therefore, within the realm of usual economic feeding practices, the plane of nutrition will not have a major influence on the chemical composition of similar - weight carcassed from breeds with the same mature weights."

Dr. R.L. Preston, an animal scientist, has suggested that the body composition of growing cattle in terms of fat, lean and bone can be correlated to their location on the growth curve in relation to their mature weight--i.e., to their precent mature weight (PMT).

Also, from this study Dr. Preston concluded that:

> It would seem safe to conclude that plane of nutrition, within practical reality, will have little or no effect on the body composition of cattle at normal slaughter weights. Thus, instead of thinking that live weight or carcass weight determines the percentage of fat and protein, it may be more correct to say that body composition is a function of the proportion of mature body weight which has been attained at any given live weight.[7]

This could only be true for cattle of similar type.

With these two assumptions Dr. Preston constructed a functional relationship between percent mature weight and percent fat in a carcass, with the assumption that the experimental cattle of this study had a mature weight of 1500 pounds, as shown in Figure 4.5. If this is a valid way of viewing body composition in cattle, then one can use these figures to construct the picture shown in Figure 4.5d relating the influence of mature weight and slaughter weight to the composition of cattle carcasses at the time of slaughter.

From Figures 4.5 a, b, and c, it can be noted that as the slaughter animal approaches mature weight, a higher proportion of the carcass weight becomes fat and a lesser proportion is composed of protein. Similarly, one can generally state as the animal nears the mature weight, the percent of retail product obtained from the carcass weight will lessen.

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[7] R.L. Preston, Effects of Nutrition on the Body Composition of Cattle and Sheep, Paper presented at the Georgia Nutrition Conference, Ohio State University: (February 18, 1971), p. 37.

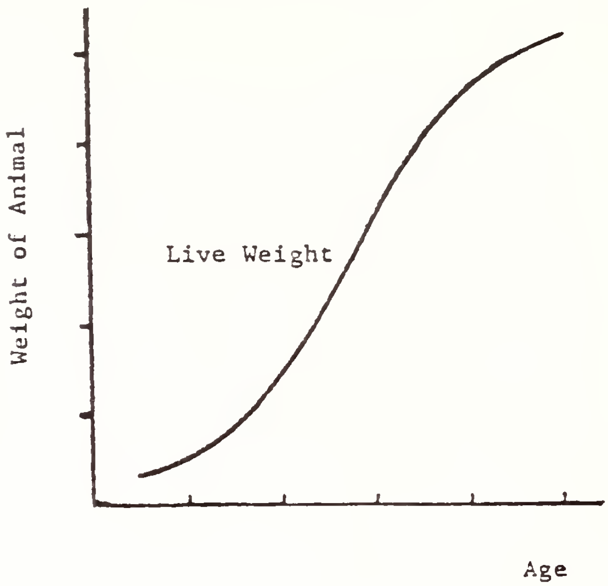

Figure 4.5a. Growth Curve for Cattle

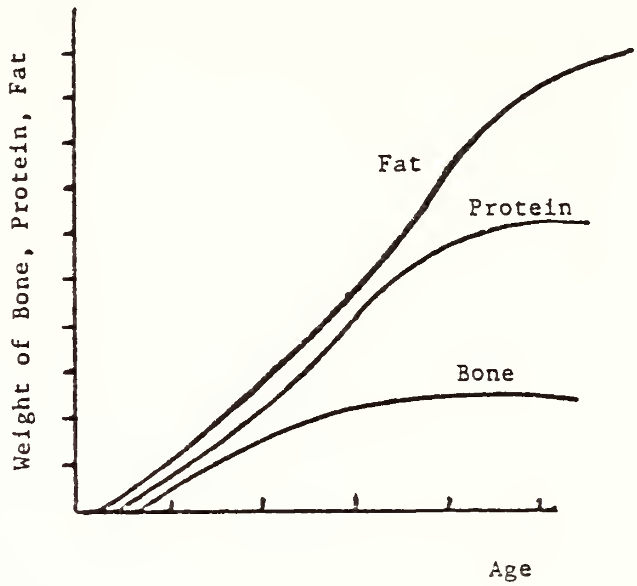

Figure 4.5b. Relative Growth of Protein, Fat and Bone in Cattle.

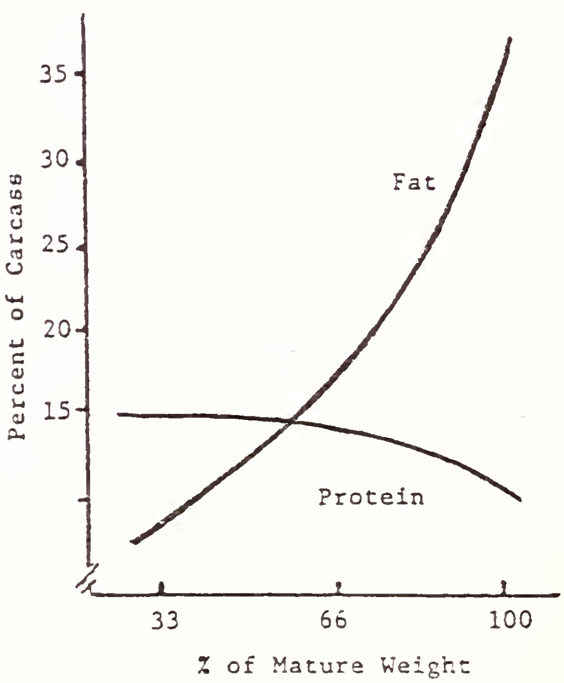

Figure 4.5c. Carcass Composition in Cattle as it may Relate to Their Mature Weight.

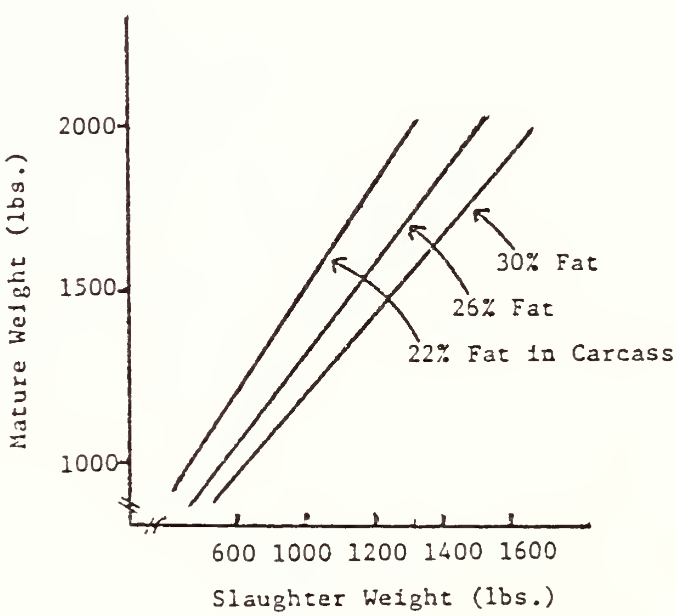

Figure 4.5d. Fat Composition in Cattle Carcasses as as Influenced by Slaughter and Mature Body Weight.

BODY COMPOSITION GROWTH OF CATTLE[8]

[8] Kenneth E. Nelson and Wayne Purcell, "Criteria for the Feedlot Replacement Decision", p. 101.

If the growth relationships of percent fat and percent protein to percent mature weight as shown in Figure 4.5b was completed by acutally calculating a mature weight value (Brody, Ch. 16) for a statistically acceptable sample of number of cattle of similar type, the relationship if 4.5c would be theoretically valid for any slaughter cattle fed of the same type. For instance, in Preston's assumed relationship an animal with a mature weight of 1500 lbs., if slaughtered at 1000 lbs. will contain 22 percent fat; and if fed to 1160 lbs. will contain 26 percent fat, as shown in Figure 4.5c.

Estimating Procedure for Retail Product Growth Using Live Weight

If a researcher desires to estimate the retail product growth of cattle that have completed a feeding trial and have been slaughtered, as a look-back type of analysis procedure, it can be accomplished without determining the mature weight of these animals. Exactly the same predictive results would be obtained by correlating the retail product weights at the time of slaughter to the live weights at the time of slaughter. Percent mature weight is determined by the live weight/mature weight and therefore, a constant relationship exists between live weight and mature weight if the mature weight is assumed the same for all cattle being considered.

This procedure would assume the cattle were of similar type and were slaughtered at various live weights, i.e., along different points on the growth curve. The steps to estimating the retail product growth are as follows.

Step 1: The retail product weight at the time of slaughter can be obtained from the yield grade score given to the carcass, which is a score to indicate the expected yield of retail product from that particular carcass. The following estimating equations will determine the retail product weight.[9]

(1) % RP = 82.9492 - 4.98 YG

(2) RPW = %RP x CW

Where: %RP = Percent Retail Product

YG = Yield Grade Score (USDA standards)

RPW = Retail Product Weight (lbs.)

CW = Hot Carcass Weight

Step 2: Correlate live weights at slaughter to the retail product weights at slaughter by a simple regression procedure.

RPW = f(LW)

Where: RPW = Retail Product Weight

LW = Live Weight

The Figure 4.6 on the following page illustrates the estimation for retail product weight used in this study for twenty head of hereford steers fed in a feeding trial on various forage-grain balanced rations.

This is a predictive model for estimating retail product weight for this set of cattle found after numerous attempts of using other variables, in various combinations as well, such as days on feed, ration energy fed, and dry matter consumption. The R^2 value indicates that 75.8 percent of the variation in retail product weight is associated with the variation in

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[9] The estimating equation for %RP was accomplished by use of data from a study of the source -- M.E. Dikeman, R.J. Lipsey and D.M. Allen, "Reliability of USDA Beef Carcass Yield Grade in Reflecting Differences in Retail Yields", <u>63rd Annual Cattlemen's Day Report</u>, Manhattan, Kansas, (March 5, 1976), p. 78.

live weight, leaving 24.13 percent of the variation due to factors such as the possible effect of the plans of nutrition fed, genetic variation and other non-measurable factors.

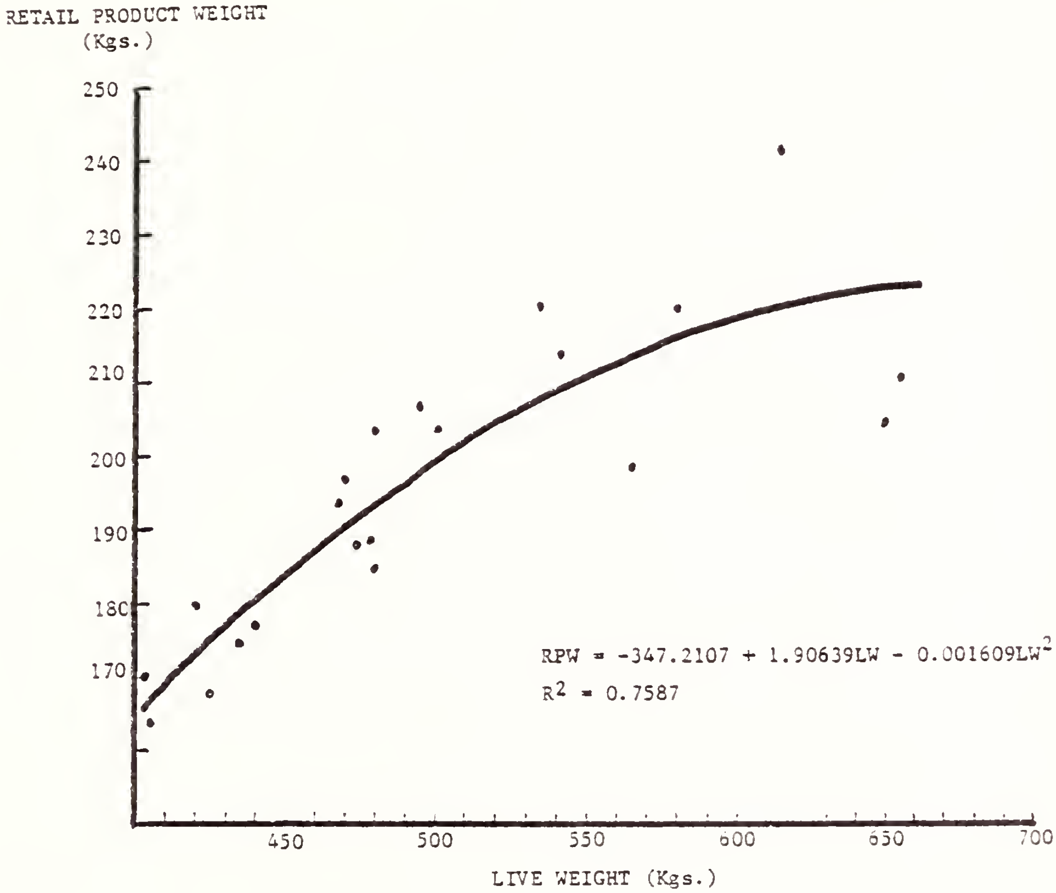

Figure 4.6. Estimated relationship between retail product weight and live weight for twenty head of Hereford feedlot steers evaluated in this study.

Chapter V

Procedure of Analysis

Data Source

The data collected for this study were acquired from a cattle feeding trial made by the Department of Animal Science and Industry at Kansas State University.[1] The feeding trial involved twenty head of Hereford steers similar in body type. Ten different energy concentration rations were fed, with two head of steers on each ration. The ration energy concentration based upon mega-calories of metabolizable energy per kilogram of dry matter (Mcal/Kg) ranged from the lowest energy ration of 2.542 Mcal/Kg to the highest of 3.199 Mcal/Kg with the between rations varying in energy concentration by increments of .073 Mcal/Kg of Metabolizable energy. All ten rations were composed of the same feedstuff ingredients of corn, corn silage, and a protein supplement, but fed in different proportions to alter the amount metabolizable energy, i.e., ten different forage-grain balanced rations were fed varying in the amount of metabolizable energy per kilogram of dry matter feed, as shown in Table 5.1. Each pair of animals fed the same ration individually were kept on the same ration until slaughtered.

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[1]Allan Chestnut, unpublished Master of Science Thesis on the topic - "Using Mathematical Models to Evaluate Performance of Feedlot Cattle as Influenced by Time and Various Corn Silage: Corn Rations," Kansas State University, Department of Animal Science and Industry, Manhattan, Kansas, (1977).

The data analyzed in the author's study was taken from the study done by Chestnut.

Table 5.1: Ration Composition Used in Feeding Trial for data of this study.

Ration #	Corn	Corn Silage	SBM Supp.	ME[a]	NEg[b]	NEm[c]	Percent Dig. P
	Percent of Ration on Dry Matter Basis				(Mcal.)		(Percent)
1	0	89.95	10.05	2.5420	1.0078	1.5788	8.21
2	9.64	80.01	10.35	2.6151	1.0554	1.6484	8.58
3	19.30	70.07	10.63	2.6882	1.103	1.7182	8.94
4	28.94	60.13	10.93	2.7613	1.1506	1.7879	9.31
5	38.64	50.13	11.23	2.8344	1.1982	1.8576	9.67
6	48.34	40.10	11.55	2.9075	1.2458	1.9273	10.04
7	58.05	30.08	11.87	2.9806	1.2934	1.9970	10.40
8	67.75	20.05	12.20	3.0537	1.3410	2.0666	10.77
9	77.47	10.03	12.50	3.1268	1.3886	2.1363	11.13
10	87.16	0	12.84	3.1999	1.4362	2.2060	11.50

	% DM
Corn	86.56
Corn Silage	35.00
Supplement	90.00

[a] metabolizable energy

[b] net energy for gain

[c] net energy for maintenance

During the feeding trial weekly animal weights and weekly dry matter feed consumption weights were kept. The animals were slaughtered at various times during the feeding trial according to their feed conversion efficiency. Once slaughtered, carcass data were obtained to determine the animal's yield grade and quality grade as summarized in Table 5.2 on the following page.

The Growth Analysis Model #1

The growth model was constructed on a weekly basis. Input data applied in this study were the weekly live animal weights and weekly ration dry matter feed consumption weights kept specifically for each steer. A three-week moving average was calculated from each steer's weekly live weights in order to minimize the effects of variation in weights due to differences in fill, as well as, to even out a steer's week to week variation in growth performance. The following live growth performance equations were used for model #1 to formulate results as presented in Table 5.3.

$$LWG_d = LW_d = LW_d - LW_0$$

$$LADG_d = \frac{LWG_d}{d}$$

$$LWG_w = LW_w - LW_{w-1}$$

$$LADG_w = \frac{LWG_w}{7}$$

$$FCV_d = \frac{DMFC_d}{LWG_d}$$

$$FCV_w = FCV_d - FCV_{d-7}$$

d = the number of days on feed (1,2,3,...,322)
d/7 or number of weeks on feed
LW = Live animal weight (3-week moving average or estimate)
LWG = Live weight gain
LADG = Live weight average daily gain
FCV = Dry matter feed conversion
DMFC = Dry matter feed Consumption

Table 5.2 Data obtained for each steer at time of slaughter.

Animal #	Ration #	Live Slaughter Weight (Kg)	Carcass Weight (Kg)	Percent Retail Product[a] (percent)	Retail Product Weight (Kg)	Yield Grade USDA score	Fat Thickness Measurement (in)	Quality Grade[b] USDA Score	Percent Mature Weight[c] (percent)
1	1	541.8	329.3	65.27	214.9	3.55	0.70	Ch^{+}	61.33
2	1	564.5	344.3	57.80	198.9	5.05	1.15	P^{-}	63.90
3	2	405.5	228.6	71.74	164.0	2.25	0.30	Gd^{+}	45.90
4	2	534.5	335.7	65.77	220.7	3.45	0.50	Ch^{o}	60.50
5	3	421.8	249.0	72.24	179.9	2.15	0.30	Ch^{-}	47.74
6	3	468.2	277.1	70.20	194.5	2.56	0.35	Ch^{-}	52.99
7	4	584.5	381.5	57.80	220.4	5.05	1.10	Ch^{+}	66.16
8	4	496.8	311.6	66.57	207.3	3.30	0.45	Ch^{+}	56.23
9	5	500.9	305.7	66.76	204.0	3.25	0.50	Ch^{-}	56.70
10	5	480.0	296.6	68.71	203.8	2.86	0.35	Gd^{+}	54.33
11	6	478.2	285.8	66.17	189.0	3.37	0.40	Ch^{-}	54.13
12	6	425.5	247.7	68.01	168.4	3.00	0.35	Ch^{-}	48.16
13	7	470.0	278.1	71.00	197.4	2.40	0.35	Ch^{-}	53.20
14	7	473.6	290.3	65.02	188.7	3.60	0.70	Ch^{-}	53.61
15	8	481.8	288.9	64.03	185.0	3.80	0.55	Ch^{-}	54.53
16	8	654.5	430.0	49.09	211.0	6.80	1.70	Ch^{-}	74.08
17	9	440.9	269.4	66.02	177.8	3.40	0.60	Ch^{o}	49.91
18	9	434.5	263.1	66.76	175.6	3.25	0.40	Ch^{-}	49.18
19	10	615.4	400.0	60.54	242.2	4.50	0.80	Ch^{+}	69.66
20	10	648.2	414.6	47.59	197.3	7.10	1.40	Ch^{o}	73.37

a/ %RP = 82.9492 - 4.98 YG where %RP is Percent Retail Product and YG is Yield Grade.

b/ Ch is Choice, Gd is Good, P is Prime, + is high, o is average, and - is low.

c/ Mature weight for these steers = 883.47 lbs. (Taken from a study done by Chestnut.)

Table 5.3. Weekly live weight growth performance data for feedlot steer #9 fed ration #5 using a corn to corn silage cost ratio of 3.0.

DAYS ON FEED	LIVEWT TO DATE (KG)	LIVE WT. GAIN TO DATE (KG)	LIVE ADG TO DATE (KG)	LIVE WT. GAIN FOR WEEK (KG)	LIVE ADG FOR WEEK (KG)	DM FEED CONVERSION TO DATE (KG)	DM FEED CONVERSION FOR WEEK (KG)	DM FEED CONSUMPTION TO DATE (KG)	3 WEEK LIVE WT. MOV. AVG. (KG)
7	351.8	17.4	2.5	17.400	2.486	3.638	3.638	63.3	350.1
14	365.9	31.4	2.2	14.000	2.000	4.217	4.936	132.4	364.1
21	374.5	43.2	2.1	11.800	1.686	4.528	5.356	195.6	375.9
28	387.3	54.3	1.9	11.100	1.586	4.757	5.649	258.3	387.0
35	399.1	64.9	1.9	10.600	1.514	5.032	6.443	326.6	397.6
42	406.4	74.3	1.8	9.400	1.343	5.327	7.362	395.8	407.0
49	415.5	82.8	1.7	8.500	1.214	5.603	8.012	463.9	415.5
56	424.5	91.8	1.6	9.000	1.286	5.723	6.833	525.4	424.5
63	433.6	102.7	1.6	10.900	1.557	5.767	6.138	592.3	435.4
70	448.2	112.1	1.6	9.400	1.343	5.882	7.138	659.4	444.8
77	452.7	121.2	1.6	9.100	1.300	6.020	7.714	729.6	453.9
84	460.9	130.9	1.6	9.700	1.386	6.089	6.959	797.1	463.6
91	477.3	140.0	1.5	9.100	1.300	6.248	8.527	874.7	472.7
98	480.0	150.3	1.5	10.300	1.471	6.333	7.485	951.8	483.0
105	491.8	157.3	1.5	7.000	1.000	6.571	11.686	1033.6	490.0
112	498.2	164.3	1.5	7.000	1.000	6.772	11.286	1112.6	497.0
119	500.9	168.2	1.4	3.900	0.557	7.058	19.128	1187.2	500.9

The following equations were applied to evaluate retail meat product weight growth during the life of the animal to formulate results as shown in Table 5.4 on the following page.

$$RPW_d = -347.2107 + 1.90639\ LW_d - 0.001609\ LW_d^2$$

$$RPWG_d = RPW_d - RPW_0$$

$$RADG_d = \frac{RPWG}{d}$$

$$RPWG_w = RPWG_w - RPWG_{w-1}$$

$$RADG_w = \frac{RPWG_w}{7}$$

$$RFCV_d = \frac{DMFC_d}{RPW_d}$$

d = number of days on feed (1,2,3,...,322)

w = d/7 or number of weeks on feed

RPW = retail meat product weight

LW = live animal weight (3-week moving average or estimate)

RPWG = retail meat product weight gain

RADG = retail meat product weight average daily gain

RFCV = dry matter feed conversion to retail meat product

DMFC = dry matter feed consumption

The Growth Analysis Model #2

Predictive equations were developed in a study by Chestnut[2] to predict live weight and dry matter feed consumption from results of feeding trials involving ten pairs of hereford steers fed ten alternative ration energy concentration diets.

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[2]See footnote #1.

Table 5.4. Weekly retail weight growth performance data for feedlot steer #9 fed ration #5 using a corn to corn silage cost ratio of 3.0.

DAYS ON FEED	RETAIL WT. GAIN TO DATE (KG)	RETAIL WT. ADG TO DATE (KG)	RETAIL WT. GAIN FOR WEEK (KG)	RETAIL WT. ADG FOR WEEK (KG)	DM FEED CONVERSION TO RPW TO DATE (KG)	RETAIL WT. TO DATE (KG)
7	14.1	2.01	14.06	2.01	4.50	123.00
14	24.7	1.76	10.60	1.51	5.37	133.60
21	33.1	1.58	8.45	1.21	5.91	142.05
28	40.6	1.45	7.54	1.08	6.36	149.58
35	47.5	1.36	6.83	0.98	6.88	156.41
42	53.2	1.27	5.75	0.82	7.44	162.16
49	58.2	1.19	4.96	0.71	7.97	167.12
56	63.2	1.13	4.99	0.71	8.32	172.11
63	68.9	1.09	5.70	0.81	8.60	177.81
70	73.5	1.05	4.61	0.66	8.98	182.42
77	77.7	1.01	4.19	0.60	9.39	186.61
84	81.8	0.97	4.17	0.60	9.74	190.78
91	85.5	0.94	3.64	0.52	10.23	194.42
98	89.3	0.91	3.80	0.54	10.66	198.21
105	91.7	0.87	2.39	0.34	11.28	200.60
112	93.9	0.84	2.23	0.32	11.85	202.83
119	95.1	0.80	1.17	0.17	12.49	204.00

The prediction equation for dry matter feed consumption was based upon the independent variables metabolizable ration energy concentration fed (ME) and time on feed (t) in days as shown below.

$$PDM = B_o + B_1 t + B_2 t^2 \qquad \text{where}$$

$$B_o = 0$$

$$B_1 = b_1 + b_2 ME + b_3 ME^2 + b_4 ME^3$$

$$B_2 = b_5 + b_6 ME + b_7 ME^2$$

The prediction equation for live animal weight was patterned after Brody's growth equation as follows.[3]

$PWT = A(1 - Be^{-tk})$ where

PWT = Predicted Live Animal Weight

A = Mature Weight

B = Intergration Constant

t = time in days

k = relative rate of growth with respect to growth yet to be made.

Definitions[4]

Mature weight (A) can be regarded as the weight at which the concentration of growth inhibiting factors becomes prevalent enough to inhibit further growth.

The intergration constant (B) represents an age-parameter employed to correct for the fact that while age is counted from birth or conception, that is, the value of (A-W) at the time of conception, where W is the weight of an animal at a given time. When a growth curve is plotted on an arithlog chart, B, would be the intercept value.

The relative rate of growth (k) is with respect to future growth yet to be made. Growth rate is proportional to the growth limiting factor, so "k" can be thought of as growth rate/maximum growth yet possible, which can be shown algebraically as: $-k = (dW/dt) / (A-W)$. The negative sign indicates a decline in growth velocity as is expected to occur with self-inhibiting growth.

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[3]For further detail see the source -- Samuel Brody, Bioenergetics and Growth, (New York: Reinhold Publishing Corporation, 1945), Ch. 16, pp. 484-574.

[4]Ibid, Ch. 16, pp. 484 - 574.

From Chestnut's prediction equations live animal weight and dry matter feed consumption estimates were made on a weekly basis for each of the ten various metabolizable energy concentration rations fed in the feeding trial applied in this study.

The application of using the predicted live animal weights and dry matter feed consumption figures was beneficial in minimizing the variation in weekly growth over the use of a three-week moving average, which provided for less variation in individual cost and revenue relationships evaluated for each ration fed. Results in using the prediction equations for live weight and feed consumption were summarized as in example Tables 5.5 and 5.6 on the following pages.

Cost and Revenue Model

The structure of the cost and revenue computer model was designed with two objectives in mind:

(1) produce tables of cost and revenue relationships on a weekly time scale so the cost of production and profitability could be easily evaluated on a live weight gain basis as well as on a retail product weight gain basis.

(2) offer maximum flexibility and simplicity in varying assumed costs and prices read into the model. (see appendix D).

Table 5.5. Predicted weekly live weight growth performance data for feedlot steers fed ration #5 using a corn to corn silage ratio of 3.0.

DAYS ON FEED	LIVE WT TO DATE (KG)	LIVE WT. GAIN TO DATE (KG)	LIVE ADG TO DATE (KG)	LIVE WT. GAIN FOR WEEK (KG)	LIVE ADG FOR WEEK (KG)	DM FEED CONVERSION TO DATE (KG)	DM FEED CONVERSION FOR WEEK (KG)	DM FEED CONSUMPTION TO DATE (KG)
7	300.0	9.0	1.3	9.000	1.286	6.444	6.444	58.0
14	311.0	20.0	1.4	11.000	1.571	6.100	5.818	122.0
21	320.0	29.0	1.4	9.000	1.286	6.310	6.778	183.0
28	330.0	29.0	1.4	10.000	1.429	6.287	6.200	245.0
35	339.0	48.0	1.4	9.000	1.286	6.375	6.778	306.0
42	349.0	58.0	1.4	10.000	1.429	6.328	6.100	367.0
49	358.0	67.0	1.4	9.000	1.286	6.388	6.778	428.0
56	367.0	76.0	1.4	9.000	1.286	6.434	6.778	489.0
63	376.0	85.0	1.3	9.000	1.286	6.471	6.778	550.0
70	384.0	93.0	1.3	8.000	1.143	6.570	7.625	611.0
77	393.0	102.0	1.3	9.000	1.286	6.578	6.667	671.0
84	401.0	110.0	1.3	8.000	1.143	6.655	7.625	732.0
91	409.0	118.0	1.3	8.000	1.143	6.720	7.625	793.0
98	417.0	126.0	1.3	8.000	1.143	6.778	7.625	854.0
105	425.0	134.0	1.3	8.000	1.143	6.828	7.625	915.0
112	433.0	142.0	1.3	8.000	1.143	6.873	7.625	976.0
119	441.0	150.0	1.3	8.000	1.143	6.907	7.500	036.0
126	448.0	157.0	1.2	7.000	1.000	6.987	8.714	097.0
133	456.0	165.0	1.2	8.000	1.143	7.018	7.625	158.0
140	463.0	172.0	1.2	7.000	1.000	7.081	8.571	218.0
147	470.0	179.0	1.2	7.000	1.000	7.145	8.714	279.0
154	477.0	185.0	1.2	7.000	1.000	7.204	8.714	340.0
161	484.0	193.0	1.2	7.000	1.000	7.254	8.571	400.0
168	491.0	200.0	1.2	7.000	1.000	7.305	8.714	461.0
175	498.0	207.0	1.2	7.000	1.000	7.348	8.571	521.0
182	504.0	213.0	1.2	6.000	0.857	7.427	10.167	582.0
189	511.0	220.0	1.2	7.000	1.000	7.464	8.571	642.0
196	517.0	226.0	1.2	6.000	0.857	7.535	10.167	703.0
203	523.0	232.0	1.1	6.000	0.857	7.599	10.000	763.0
210	529.0	238.0	1.1	6.000	0.857	7.664	10.167	824.0
217	535.0	244.0	1.1	6.000	0.857	7.721	10.000	884.0
224	541.0	250.0	1.1	6.000	0.857	7.776	10.000	944.0
231	547.0	256.0	1.1	6.000	0.857	7.832	10.167	005.0
238	553.0	262.0	1.1	6.000	0.857	7.882	10.000	065.0
245	559.0	268.0	1.1	6.000	0.857	7.929	10.000	125.0
252	564.0	273.0	1.1	5.000	0.714	8.007	12.200	186.0
259	570.0	279.0	1.1	6.000	0.857	8.050	10.000	246.0
266	575.0	284.0	1.1	5.000	0.714	8.120	12.000	306.0
273	580.0	289.0	1.1	5.000	0.714	8.187	12.000	366.0
280	585.0	294.0	1.1	5.000	0.714	8.252	12.000	426.0
287	590.0	299.0	1.0	5.000	0.714	8.314	12.000	486.0
294	595.0	304.0	1.0	5.000	0.714	8.378	12.200	547.0
301	600.0	309.0	1.0	5.000	0.714	8.437	12.000	607.0
308	605.0	314.0	1.0	5.000	0.714	8.494	12.000	667.0
315	610.0	319.0	1.0	5.000	0.714	8.549	12.000	727.0
322	615.0	324.0	1.0	5.000	0.714	8.602	12.000	787.0

Table 5.6. Predicted weekly retail meat product weight growth for feedlot steers fed ration #5 using a corn to corn silage ratio of 3.0.

DAYS ON FEED	RETAIL WT. GAIN TO DATE (KG)	RETAIL WT. ADG TO DATE (KG)	RETAIL WT. GAIN FOR WEEK (KG)	RETAIL WT. ADG FOR WEEK (KG)	CM FEED CONVERSION TO RPW TO DATE (KG)	RETAIL WT. TO DATE (KG)
7	8.6	1.23	8.60	1.23	6.74	79.90
14	18.8	1.34	10.16	1.45	6.50	90.05
21	26.8	1.28	8.02	1.15	6.83	98.07
28	35.4	1.26	8.61	1.23	6.92	106.68
35	42.9	1.22	7.47	1.07	7.14	114.15
42	50.8	1.21	7.99	1.14	7.22	122.14
49	57.8	1.18	6.92	0.99	7.41	129.06
56	64.4	1.15	6.66	0.95	7.59	135.72
63	70.8	1.12	6.40	0.91	7.77	142.12
70	76.3	1.09	5.47	0.78	8.01	147.59
77	82.2	1.07	5.91	0.84	8.16	153.49
84	87.2	1.04	5.03	0.72	8.39	158.52
91	92.1	1.01	4.82	0.69	8.61	163.35
98	96.7	0.99	4.62	0.66	8.83	167.97
105	101.1	0.96	4.41	0.63	9.05	172.38
112	105.3	0.94	4.21	0.60	9.27	176.59
119	109.3	0.92	4.00	0.57	9.48	180.59
126	112.6	0.89	3.33	0.48	9.74	183.92
133	116.2	0.87	3.61	0.52	9.96	187.53
140	119.2	0.85	2.99	0.43	10.22	190.53
147	122.1	0.83	2.84	0.41	10.48	193.36
154	124.7	0.81	2.68	0.38	10.74	196.04
161	127.3	0.79	2.52	0.36	11.00	198.56
168	129.6	0.77	2.36	0.34	11.27	200.93
175	131.8	0.75	2.21	0.32	11.54	203.13
182	133.6	0.73	1.77	0.25	11.84	204.90
189	135.5	0.72	1.91	0.27	12.12	206.81
196	137.0	0.70	1.51	0.22	12.43	208.32
203	138.4	0.68	1.40	0.20	12.74	209.72
210	139.7	0.67	1.29	0.18	13.06	211.01
217	140.9	0.65	1.17	0.17	13.37	212.17
224	141.9	0.63	1.05	0.15	13.70	213.22
231	142.9	0.62	0.93	0.13	14.03	214.16
238	143.7	0.60	0.82	0.12	14.37	214.98
245	144.4	0.59	0.70	0.10	14.72	215.68
252	144.9	0.57	0.50	0.07	15.09	216.18
259	145.4	0.56	0.49	0.07	15.45	216.67
266	145.7	0.55	0.32	0.05	15.83	216.99
273	145.9	0.53	0.24	0.03	16.21	217.23
280	146.1	0.52	0.16	0.02	16.61	217.39
287	146.2	0.51	0.08	0.01	17.01	217.47
294	146.2	0.50	-0.00	-0.00	17.43	217.47
301	146.1	0.49	-0.08	-0.01	17.85	217.38
308	145.9	0.47	-0.16	-0.02	18.28	217.22
315	145.7	0.46	-0.24	-0.03	18.72	216.98
322	145.4	0.45	-0.32	-0.05	19.17	216.66

The following cost and revenue equations were applied in this study, to formulate tabled results as shown in Table 5.7.

$$TC_d = [(PPL * LW_d * 0.97) \; (1 + r * W/52)] + [(PPL * LW_d * 0.97) \; (D)]$$
$$+ [(K) \; (1 + r * W/52)] + (FC * DMFC_d) + [((FC * DMFC_d) \; (r * W/52))/2]$$
$$+ (OC * W/ * 7).$$

$$ACL = TC_d / LW_d$$

$$ACLG = (TC_d - PPL * LW_d * 0.97)/(LW_d - LW_0)$$

$$MCL = (TC_d - TC_{d-1}) / (LW_d - LW_{d-1})$$

$$TRL_d = LW_d * 0.96 * SPL$$

$$MRL = (TRL_d - TRL_{d-1}) / (LW_d - LW_{d-1})$$

$$TNRL = TRL_d - TC_d$$

$$MNRL = MRL - MCL$$

$$ANRL = TNRL/(LW_d - LW_0)$$

$$SBEPL = TC_d/(LW_d * 0.96) \; (100)$$

$$RRL = TNRL/(TC_d * W/52)$$

$$TNRE = TC_d * RRD * W/52$$

$$ANRLD = TNRE/(LW_d - LW_0)$$

$$SPD = (TNRE + TC_d) / (LW_d * 0.96) \; (100)$$

d = number of days on feed (1,2,3,...,322)

TC = total cost

PPL = price per kilogram live weight at time of purchase

LW = live weight (3-week moving average or estimated) in kilograms

0.97 = allowance for 3% shrink in purchase of cattle r = rate of interest

W = weeks on feed

D = death rate

K = acquisition costs, such as hauling, commissions dipping, worming pill, shots and etc.

FC = cost per kilogram of dry matter ration fed

DMFC = dry matter feed consumption

OC = operating cost per head per day of the feed yard

ACL = average cost of accumulated live weight

ACLG = average cost of live weight gain

MCL = marginal cost of live weight gain

TRL = total revenue (live wt.)

0.96 = allowance for 4% shrink on sale of cattle

MRL = marginal net revenue per unit of live weight gain

ANRL = average net revenue per unit of live weight gain

SBEPL = sell breakeven price on the live weight

RRL = rate of return on total cost, i.e., dollars invested to date

TNRE = total net revenue expected based upon RRD

RRD = rate of return desired on total dollars invested to date

ANRLD = average net revenue desired per unit of live weight gain

SPD = sell price desired on live weight based upon RRD

Table 5.7. Weekly cost and revenue relation ship data for predicted live weight growth of feedlot steers fed ration #5 using a corn to corn silage cost ratio of 3.0. [a]

DAYS	TC ($)	TRL ($)	ACL ($/Kg)	ACLG ($/Kg)	MCL ($/Kg)	MRL ($/Kg)	MNRL ($/Kg)	ANRL ($/Kg)	ANFLD ($/Kg)	TNRL ($)	TNPE ($)	SBEPL (c/Kg)	SPD (c/Kg)	PRL (%)	PRD (%)
7	387.71	373.71	1.292	2.400	2.400	0.845	-1.555	-1.555	0.166	-14.00	1.49	134.62	135.13	-0.94	0.10
14	397.25	387.41	1.277	1.557	0.867	1.246	0.378	-0.492	0.115	-9.83	2.29	133.05	133.82	-0.43	0.10
21	406.42	395.46	1.270	1.390	1.019	0.894	-0.125	-0.378	0.108	-10.96	3.13	132.30	133.31	-0.35	0.10
28	415.77	407.82	1.260	1.274	0.935	1.236	0.300	-0.204	0.103	-7.96	4.00	131.24	132.50	-0.20	0.10
35	424.98	418.94	1.254	1.227	1.023	1.236	0.213	-0.126	0.102	-6.04	4.90	130.59	132.09	-0.12	0.10
42	434.19	431.30	1.244	1.174	0.922	1.236	0.314	-0.058	0.101	-2.90	5.84	129.59	131.33	-0.05	0.10
49	443.43	442.42	1.239	1.154	1.026	1.236	0.210	-0.015	0.102	-1.01	6.82	129.02	131.00	-0.01	0.10
56	452.71	432.05	1.234	1.140	1.032	-1.152	-2.184	-0.272	0.103	-20.66	7.84	128.50	130.71	-0.26	0.10
63	461.98	442.65	1.229	1.128	1.029	1.177	0.148	-0.227	0.105	-19.33	8.88	127.99	130.44	-0.22	0.10
70	471.25	452.06	1.227	1.131	1.160	1.177	0.018	-0.206	0.107	-19.19	9.97	127.84	130.54	-0.19	0.10
77	480.42	462.66	1.222	1.121	1.018	1.177	0.159	-0.174	0.109	-17.76	11.09	127.34	130.27	-0.16	0.10
84	489.77	472.08	1.221	1.124	1.168	1.177	0.009	-0.161	0.111	-17.69	12.24	127.23	130.40	-0.14	0.10
91	499.09	481.49	1.220	1.127	1.165	1.177	0.012	-0.149	0.114	-17.59	13.44	127.11	130.53	-0.13	0.10
98	503.42	490.91	1.219	1.130	1.167	1.177	0.010	-0.135	0.116	-17.51	14.67	127.00	130.66	-0.12	0.10
105	517.77	500.33	1.218	1.132	1.169	1.177	0.008	-0.130	0.119	-17.44	15.93	126.91	130.81	-0.11	0.10
112	527.14	509.75	1.217	1.134	1.171	1.177	0.007	-0.122	0.121	-17.39	17.23	126.81	130.95	-0.10	0.10
119	536.44	519.17	1.216	1.136	1.162	1.177	0.015	-0.115	0.124	-17.27	18.57	126.71	131.09	-0.09	0.10
126	545.83	557.90	1.218	1.145	1.342	5.533	4.191	0.077	0.127	12.07	19.94	126.91	131.55	0.06	0.10
133	555.24	567.86	1.218	1.146	1.176	1.245	0.069	0.077	0.129	12.62	21.36	126.84	131.71	0.06	0.10
140	564.53	576.58	1.219	1.154	1.328	1.245	-0.083	0.070	0.133	12.04	22.80	127.01	132.13	0.05	0.10
147	574.02	585.30	1.221	1.162	1.355	1.245	-0.110	0.063	0.136	11.28	24.29	127.22	132.60	0.05	0.10
154	583.47	594.01	1.223	1.169	1.351	1.245	-0.105	0.057	0.139	10.54	25.81	127.42	133.05	0.04	0.10
161	592.81	602.73	1.225	1.175	1.334	1.245	-0.089	0.051	0.142	9.92	27.36	127.59	133.47	0.04	0.10
168	602.30	611.45	1.227	1.181	1.355	1.245	-0.109	0.046	0.145	9.15	28.96	127.78	133.92	0.03	0.10
175	611.71	620.17	1.228	1.187	1.345	1.245	-0.100	0.041	0.148	8.45	30.59	127.95	134.34	0.03	0.10
182	621.22	626.86	1.233	1.198	1.585	1.116	-0.469	0.026	0.151	5.64	32.26	128.39	135.06	0.02	0.10
189	630.62	635.57	1.234	1.202	1.343	1.244	-0.099	0.022	0.154	4.95	33.96	128.55	135.47	0.01	0.10
196	640.16	643.03	1.238	1.213	1.590	1.244	-0.347	0.013	0.158	2.87	35.70	128.95	136.17	0.01	0.10
203	649.59	650.49	1.242	1.222	1.571	1.244	-0.327	0.004	0.162	0.91	37.48	129.38	136.84	0.00	0.10
210	659.21	657.96	1.246	1.232	1.603	1.244	-0.360	-0.005	0.165	-1.25	39.30	129.81	137.54	-0.00	0.10
217	668.67	665.42	1.250	1.240	1.576	1.244	-0.332	-0.012	0.169	-3.24	41.15	130.19	138.20	-0.01	0.10
224	678.14	638.50	1.253	1.248	1.578	-4.487	-6.065	-0.159	0.172	-39.63	43.04	130.57	138.85	-0.09	0.10
231	687.75	645.56	1.257	1.256	1.603	1.180	-0.422	-0.165	0.176	-42.17	44.97	130.97	139.53	-0.09	0.10
[illegible]	697.30	652.66	1.261	1.264	1.592	1.180	-0.411	-0.170	0.179	-44.64	46.93	131.35	140.18	-0.10	0.10
[illegible]	706.81	659.75	1.264	1.271	1.586	1.180	-0.405	-0.176	0.183	-47.07	48.93	131.71	140.82	-0.10	0.10
[illegible]	716.47	665.65	1.270	1.283	1.932	1.180	-0.752	-0.186	0.187	-50.83	50.98	132.33	141.74	-0.10	0.10
[illegible]	726.02	672.73	1.274	1.290	1.591	1.180	-0.410	-0.191	0.190	-53.29	53.06	132.68	142.37	-0.10	0.10
[illegible]	735.63	678.63	1.279	1.301	1.922	1.180	-0.742	-0.201	0.194	-57.00	55.17	133.27	143.26	-0.10	0.10
273	745.20	684.53	1.285	1.312	1.914	1.180	-0.734	-0.210	0.198	-60.67	57.32	133.84	144.13	-0.11	0.10
280	754.79	690.43	1.290	1.322	1.917	1.180	-0.737	-0.219	0.202	-64.35	59.51	134.40	144.99	-0.11	0.10
287	764.39	696.33	1.296	1.332	1.920	1.180	-0.740	-0.228	0.206	-68.05	61.74	134.96	145.85	-0.11	0.10
294	774.13	702.23	1.301	1.342	1.949	1.180	-0.769	-0.237	0.211	-71.90	64.01	135.53	146.73	-0.11	0.10
301	783.82	708.13	1.306	1.352	1.937	1.180	-0.757	-0.245	0.215	-75.68	66.32	136.08	147.59	-0.11	0.10
308	793.45	714.04	1.312	1.361	1.929	1.180	-0.749	-0.253	0.219	-79.43	68.67	136.62	148.43	-0.12	0.10
315	803.12	719.94	1.317	1.370	1.932	1.180	-0.752	-0.261	0.223	-83.19	71.05	137.15	149.27	-0.12	0.10
322	812.80	725.84	1.322	1.379	1.935	1.180	-0.755	-0.268	0.227	-86.96	73.46	137.67	150.11	-0.12	0.10

Footnote for Table 5.7.

[a]The large changes in values under the Marginal Revenue (MRL) and the Marginal Net Revenue (MNRL) columns are due to the adjustments made in the cattle sale price for the steer's weight class, quality grade, and yield grade. See Table 5.5 for further detail.

The following equations were used to determine cost and revenue relationships for retail meat product of the steers analyzed in this study to formulate tables, such as Table 5.8.

TNRR = TNR:

$ACR = TC_d/RPW_d$

$ACRG = (TC_d - (PPL * LW_d * 0.97))/ (RPW_d - RPW_0)$

$MC\_R = (TC_d - TC_{d-1})/ RPW_d - RPW_{d-1})$

$MR\_R = (TRL_d - TRL_{d-1}) / (RPW_d - RPW_{d-1})$

MNR_R = MR_R - MC_R

$ANRR = TNRR/ (RPW_d - RPW_0)$

d = number of days on feed (1,2,3,...,322)

TNRR = total net revenue (retail) per head

TNRL = total net revenue (live) per head

ACR = average cost per unit of retail product weight

RPW = retail product weight

TC = total cost of live production

ACRG = average cost per unit of retail product weight gain

PPL = purchase price of live animal

LW = live animal weight (3-week moving average or estimate)

0.97 = allowance for 3% shrink on live purchase weight

TRL = total revenue per head

MNR_R = marginal net revenue per unit of retail product weight gain

ANR_R = average net revenue per unit of retail product weight gain

Table 5.8. Weekly cost and revenue data for predicted retail meat product growth of feedlot steers fed ration #5 using a corn to corn silage cost ratio of 3.0.[ab]

DAYS	TNRR ($)	ACR ($/Kg)	ACRG ($/Kg)	MC_R ($/Kg)	MR_R ($/Kg)	MNR_R ($/Kg)	ANR_R ($/Kg)
7	-14.00	4.853	2.512	2.512	0.884	-1.628	-1.628
14	-9.93	4.411	1.660	0.939	1.349	0.410	-0.524
21	-10.96	4.144	1.506	1.144	1.003	-0.140	-0.409
29	-7.96	3.897	1.404	1.087	1.436	0.349	-0.225
35	-6.04	3.723	1.374	1.232	1.489	0.257	-0.141
42	-2.90	3.555	1.339	1.153	1.546	0.393	-0.057
49	-1.01	3.436	1.339	1.334	1.607	0.273	-0.017
56	-20.66	3.336	1.344	1.395	-1.557	-2.952	-0.321
63	-19.33	3.251	1.354	1.448	1.656	0.208	-0.273
70	-19.19	3.193	1.379	1.696	1.722	0.026	-0.252
77	-17.76	3.130	1.391	1.552	1.794	0.242	-0.216
84	-17.69	3.090	1.418	1.858	1.872	0.014	-0.203
91	-17.59	3.055	1.445	1.932	1.952	0.020	-0.191
98	-17.51	3.027	1.472	2.021	2.039	0.018	-0.181
105	-17.44	3.004	1.500	2.119	2.134	0.015	-0.173
112	-17.39	2.985	1.529	2.226	2.239	0.012	-0.165
119	-17.27	2.971	1.559	2.323	2.354	0.031	-0.158
126	12.07	2.968	1.596	2.820	11.625	8.805	0.107
133	12.62	2.961	1.627	2.603	2.756	0.153	0.109
140	12.04	2.963	1.664	3.105	2.912	-0.193	0.101
147	11.28	2.969	1.703	3.344	3.073	-0.270	0.092
154	10.54	2.976	1.742	3.529	3.254	-0.275	0.084
161	9.92	2.985	1.781	3.705	3.458	-0.247	0.078
168	9.15	2.998	1.822	4.013	3.689	-0.324	0.071
175	8.45	3.011	1.863	4.269	3.952	-0.316	0.064
182	5.64	3.032	1.910	5.389	3.795	-1.595	0.042
189	4.95	3.049	1.952	4.913	4.552	-0.361	0.037
196	2.87	3.073	2.000	6.303	4.929	-1.373	0.021
203	0.91	3.097	2.048	6.742	5.337	-1.405	0.007
210	-1.25	3.124	2.098	7.502	5.820	-1.682	-0.009
217	-3.24	3.152	2.149	8.106	6.397	-1.709	-0.023
224	-39.63	3.180	2.199	9.014	-25.623	-34.637	-0.279
231	-42.17	3.211	2.251	10.286	7.575	-2.711	-0.295
238	-44.64	3.244	2.305	11.661	8.647	-3.014	-0.311
245	-47.07	3.277	2.360	13.532	10.072	-3.460	-0.326
252	-50.83	3.314	2.418	19.420	11.864	-7.556	-0.351
259	-53.29	3.351	2.476	19.448	14.431	-5.017	-0.367
266	-57.00	3.390	2.536	29.982	18.412	-11.570	-0.391
273	-60.67	3.430	2.598	39.884	24.588	-15.296	-0.416
280	-64.35	3.472	2.661	60.105	36.997	-23.108	-0.441
287	-68.05	3.515	2.725	121.533	74.697	-46.835	-0.466
294	-71.90	3.560	2.792	-7458.000	-4539.308	2958.692	-0.492
301	-75.68	3.606	2.859	-118.385	-72.142	46.243	-0.518
308	-79.43	3.653	2.929	-59.427	-36.359	23.068	-0.544
315	-83.19	3.701	3.000	-39.783	-24.304	15.479	-0.571
322	-86.96	3.752	3.073	-29.541	-18.264	11.677	-0.598

Footnotes for Table 5.8

[a]The large changes in the Marginal Revenue column (MR_R) and Marginal Net Revenue column (MNR_R) are due to adjustments made in the cattle sale price for the steer's weight class, quality grade, and yield grade. See Table 5.5 for further detail.

[b]The extreme values shown in the Marginal Cost (MC_R), Marginal Revenue (MR_R) and Marginal Net Revenue (MNR_R) columns at 294 days on feed are due to the retail product gain for that week being nearly zero or negative as predicted. See Table 5.6 at 294 days on feed, which shows a zero weight gain. Since the values for retail product weight in Table 5.6 are rounded to the nearest hundredth, any lesser change in weight gain is not shown, although the calculations in determining MC_R are carried out to the precision of eight decimals to the right of the decimal point. If the predicted retail product weight is less than one/Kg this will cause a large MC_R value to be generated. For instance, the MC_R value at 294 days was calculated as follows:

$$MC\_R = (TC_d - TC_{d-1})/(RPW_d - RPW_{d-1})$$

$$MC\_R = (\$774.13 - 764.39)/(-0.00129901)$$

$$= -7498.000$$

Negative values for MC_R resulted at 294 days since the prediction equation for weight growth has previously reached its peak weight and at this time beginning to predict negative weight growth. This is merely due to the nature of the prediction equation when carried out to an extreme beyond the normal length of time cattle would be kept on feed.

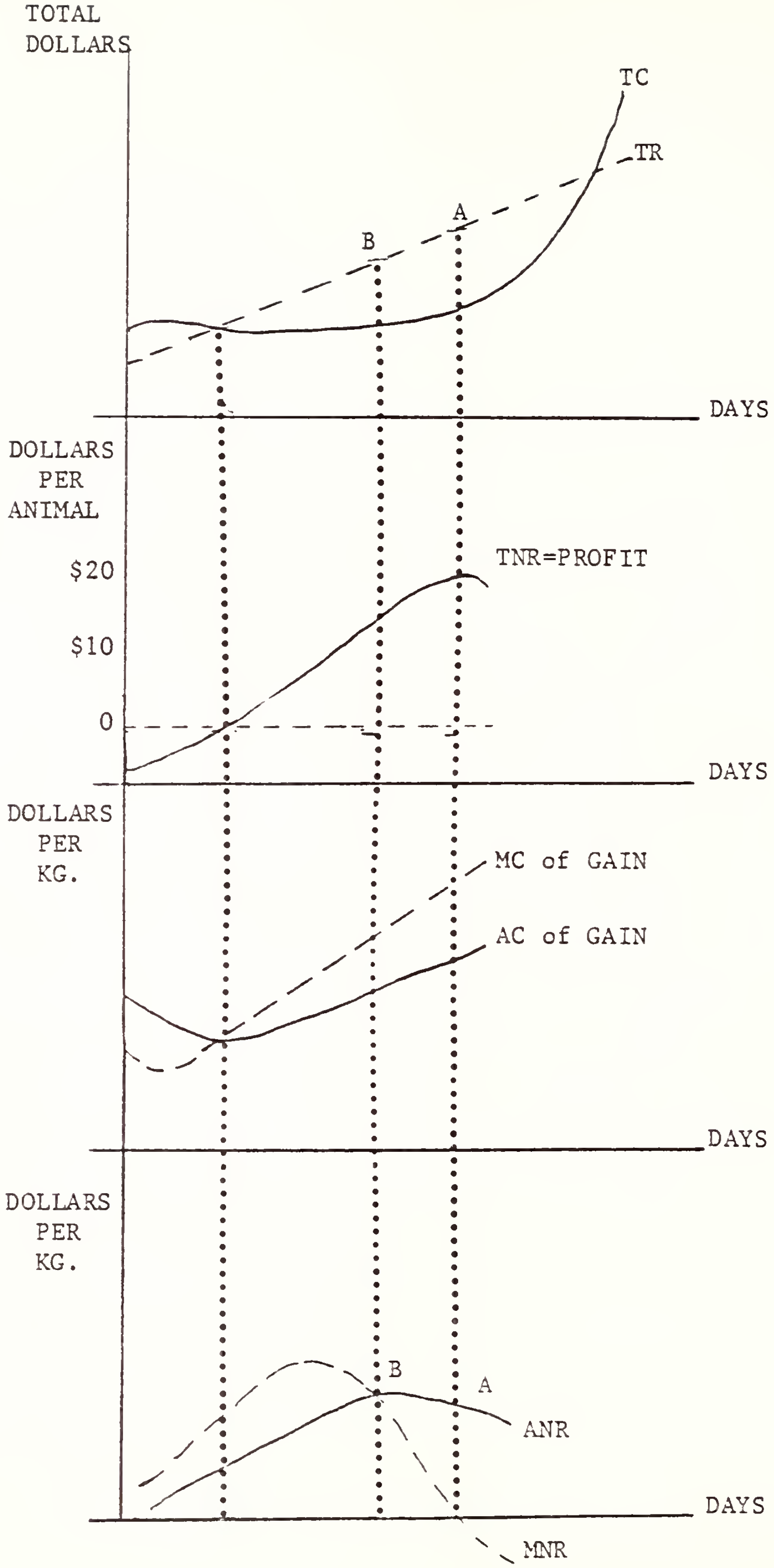

Figure 5.1. Graphical illustration of the theoretical cost and revenue relationships in the production of feedlot cattle.[ab]

Footnotes for Figure 5.1.

[a]Point A represents when maximum profit per head is obtained, as indicated by:

(1) the maximum possible difference between the Total Revenue (TR) curve and the Total Cost (TC) curve

(2) the maximum point on the Total Net Revenue (TNR) curve

(3) where the value for Marginal Net Revenue (MNR) equals zero.
MNR = MR - MC

[b]Point B represents when maximum profit per unit of time on feed is reached, as indicated by:

(1) where Marginal Net Revenue (MNR) equals Average Net Revenue (ANR)
ANR = TNR/Weight Gain

(2) where the maximum point on the ANR curve is obtained.

The growth relationships and cost-revenue relationships determined in this study are comparable in terms of live weight and by retail meat product weight between the steers fed various ration energy concentration diets. The differences that are analyzed include:

1. The marginal cost of gain during the feeding period, and particularly when the steer reached the choice quality grade.
2. The average cost of gain during the feeding period and particularly when the animal reached the choice quality grade.
3. The maximum profit per head occurred during the feeding period for each steer, as determined by:

   maximum total net revenue value (TNR)

   or

   marginal net revenue (MNR) = 0.
4. Maximum profit per unit of time, during the feeding period i.e., maximum rate of return on all invested costs, as determined by:

   maximum rate of return value

   or

   marginal net revenue (MNR) = average net revenue (ANR).
5. The breakeven price at various times during the feeding period.

Figure 5.1 illustrates graphically the theoretical cost and revenue relationships that will be analyzed as just previously stated.

Rate of return on the total invested cost can be a useful tool in analyzing the profitability per unit of time in the production of feedlot cattle for slaughter. The definitional equation for rate of return used in this study is:

$$\text{Rate of Return} = \text{Profit}/(\text{Total Cost})\ (\text{Days}/365)$$

A cattle feeder's market decision could be very much influenced by his actual rate of return as compared to his preferred rate of return. The following example will best illustrate the value of rate of return in analyzing profitability.

Situation A (a shorter feeding period) will be compared to situation B (a longer feeding period).

Feeding Period

A. 400 - 700 lbs. = 300 lb. gain @ 2.5 ADG = 120 feeding days.

B. 400 - 1050 lbs. = 650 lb. gain @ 2.8 ADG = 232 feeding days.

Cost

		Purchase Cost		42¢/lb. Cost of Gain		Total Cost
A.	400 lbs. x $0.40/lb. =	$160	+	$126	=	$286
B.	400 lbs. x $0.40/lb. =	$160	+	$273	=	$433

Revenue

	$/lb.		Sell Wt.		Gross Revenue		Total Cost		Profit
A.	$0.44	x	700 lbs.	=	$308	-	$286	=	$22.00
B.	$0.44	x	1050 lbs.	=	$462	-	$433	=	$29.00

Rate of Return

A. 23.3% = $22/($286) (120/365)

B. 10.5% = $29/($433) (232/365)

At no time would a cattle feeder wish to suffer a loss (except in a minimizing of losses situation), and likewise, certainly would wish to achieve a rate of return on his money greater than or equal to the rate of return he could receive on a low risk investment, such as from savings.

> As long as feedlot capacity is under utilized, the focus of analysis tends to be on profit maximization per animal. However, even in the case of less than full utilization of feedlot capacity, there may remain the issue of profit per unit of time for calves versus yearlings. Since yearlings are typically fed only about half as long as calves, the same profit per head would give a yearling feeding program about twice as much profit per head per unit of time as a calf feeding program. A similar point applies to optimum market weights, e.g., the same profit per head for Good and Choice grades would imply greater profit per unit time at the lower grade. The same profit per head for two different diets implies greater profit per unit time for the shorter feeding period.[5]

For these reasons it seems logical to compare rate of return values on the total invested cost to date during the feeding periods of experimental cattle being fed various ration energy concentration diets, particularly since rate of gain is directly affected by the ration energy fed.

Price and Cost Input Variables for Cost-Revenue Model

The assumed price and cost input variables which can be read into the computer cost and revenue model at the time the cattle start on feed, as well as, input variables that can be read into the model weekly are:

Initial Input Variables

1. feedlot operating cost per head per day
2. purchase price for the cattle
3. rate of interest to pay on all costs
4. acquisition cost per head (hauling, commissions and etc.)

Weekly Input Variables

1. ration cost per Kg. of dry matter fed.
2. sell price for the live animal for that week
3. rate of return desired on the total cost acurred to that week.

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[5]Ray Brokken et. al., "Framework for Economic Analysis of Grain versus Harvested Roughage for Feedlot Cattle", American Journal of Agricultural Economics, 58 No. 2 (May 1976), p. 253.

Ration Cost

All ten rations in the feeding trial were composed of the same three feed ingredients of corn, corn silage and a protein supplement. The primary intent of this study was to analyze the cost effect of animal production and profitability between different energy concentration rations fed to feedlot steers when the price of corn relative to the price of corn silage became higher. Three different ratios of corn to corn silage cost were used. The ratios were based upon the corn to corn silage cost per kilogram of dry matter. A ratio of 1.5 was a rough approximation of the normal historical relationship between the cost of corn to corn silage. In this study the cost of corn silage was kept fixed at $20.00 per ton while letting the cost of corn vary to alter the ratio. The ration ingredient costs used are shown in Table 5.9. The cost of corn to corn silage column shows that if corn silage cost $20.00/ton ($0.062989 per Kg. of dry matter) and if corn was twice as expensive as corn silage, the cost of corn (2 x $0.062989 = $0.125978 per Kg. of DM) would equal $2.77 per bushel.

Table 5.9 Ration Ingredient Costs

	$/Unit	$/KgDM	%DM	Cost of Corn to Corn Silage per Kg. of Dry Matter
Corn Silage	$20.00/ton	$0.062989	35.0%	---
Corn	2.08/bu.	0.094484	85.6%	1.5
	2.77/bu.	0.125978		2.0
	4.15/bu.	0.188967		3.0
	5.54/bu.	0.251956		4.0
Protein Supplement	8.00/cwt.	0.195967	90.0%	---

In this study the corn to corn silage cost per Kg. of dry matter ratios evaluated were 2.0, 3.0, and 4.0. Table 5.10 shows the ration cost per Kg. of dry matter feed and the respective unit cost for corn (per bushel) and corn silage (per ton) for the ratios considered for each of the ten different ration energy concentrations fed.

Cattle Prices

A cattle price margin study, that covered 72 weeks (Jan. 1, 1976 to May 14, 1977) of cattle prices, was made in order to determine an average price difference between various weight classes of live steers with price adjustments made for differences in quality grades and yield grades. Oklahoma City Auction feeder steer prices were used along with Omaha prices for Good and Choice slaughter steers. In this study the steers were priced as Choice feeder steers till they obtained the weight of 362.3 Kg. (800 lbs.). In the weight interval from 362.3 Kg. to 442.5 Kg. steers were priced as Good quality grade slaughter steers. The criterion of pricing the steers as Choice slaughter steers at 442.6 Kg. (976 lbs.) was determined by correlating live weight at the time of slaughter to the external fat thickness measurements taken over the carcass rib eyes. This procedure was done after an evaluation of the carcass data obtained from the twenty steers slaughtered from the feeding trial. It appeared the breaking point between carcasses grading Good$^+$ and Choice$^-$ occurred approximately when the external fat thickness measurement was 0.35 inches. The correlation equation obtained between external fat thickness and live animal weight at slaughter was: $FT = -1.7235 + 0.004685\ LW$, where FT is the external fat thickness measurement and LW is live weight. Alternatively the same equation is $LW = (FT + 1.8235)/0.004685$. Plugging in 0.35 inches for FT revealed that the Choice live weight was 442.0 Kg. (972 lbs.).

Table 5.10: Ration Cost According to Corn to Corn Silage Cost Ratios Based upon Cost per Kg. of Dry Matter Feed and Cost per Unit of Metabolizable Energy.

Ration No.	Ration Energy Concentration in Units of ME/KgDM	Dry Matter Basis Corn	Dry Matter Basis Corn Silage	Dry Matter Basis Protein Suppl.	Corn $/bu	Corn Silage $/ton	Ration Cost per Kg. of Dry Matter	Corn to Corn Silage: Cost per Kg. of Dry Matter Ratio[a]	Corn to Corn Silage: Cost per Unit of Metabolizable Energy Ratio[b]
1	2.5420	---	89.95	10.05	$2.08	$20.00	$.0764	1.5	1.15
					2.77	20.00	.0764	2.0	1.54
					4.15	20.00	.0764	3.0	2.30
					5.54	20.00	.0764	4.0	3.08
2	2.6151	9.64	80.01	10.35	2.08	20.00	.0798	1.5	1.15
					2.77	20.00	.0827	2.0	1.54
					4.15	20.00	.0888	3.0	2.30
					5.54	20.00	.0949	4.0	3.08
3	2.6882	19.30	70.07	10.63	2.08	20.00	.0832	1.5	1.15
					2.77	20.00	.0892	2.0	1.54
					4.15	20.00	.1014	3.0	2.30
					5.54	20.00	.1135	4.0	3.08
4	2.7613	28.94	60.13	10.93	2.08	20.00	.0866	1.5	1.15
					2.77	20.00	.0958	2.0	1.54
					4.15	20.00	.1140	3.0	2.30
					5.54	20.00	.1322	4.0	3.08
5	2.88344	38.64	50.13	11.23	2.08	20.00	.0900	1.5	1.15
					2.77	20.00	.1023	2.0	1.54
					4.15	20.00	.1266	3.0	2.30
					5.54	20.00	.1510	4.0	3.08

[a] Corn to corn silage cost per Kg of Dry Matter ratio equals the cost of corn per Kg of dry matter divided by the cost of corn silage per Kg of dry matter.

[b] Corn to corn silage cost per Kg of metabilizable energy (ME) ratio equals the cost of corn per ME divided by the cost of corn silage per ME, using NRC ME values of 3.29 Mcal/Kg for corn and 2.53 Mcal/Kg for corn silage.

Continued

Table 5.10: Ration Cost According to Corn to Corn Silage Cost Ratios Based upon Cost per Kg. of Dry Matter Feed and Cost per Unit of Metabolizable Energy.

Ration No.	Ration Energy Concentration in Units of ME/KgDM	Dry Matter Basis			Corn $/bu.	Corn Silage $/ton	Ration Cost per Kg. of Dry Matter	Corn to Corn Silage	
		Corn	Corn Silage	Protein Suppl.				Cost per Kg. of Dry Matter Ratio	Cost per Unit of Metabolizable Energy Ratio
6	2.9075	48.34	40.10	11.55	$2.08	$20.00	$.0935	1.5	1.15
					2.77	20.00	.1087	2.0	1.54
					4.15	20.00	.1391	3.0	2.30
					5.54	20.00	.1690	4.0	3.08
7	2.9806	58.05	30.08	11.87	2.08	20.00	.0970	1.5	1.15
					2.77	20.00	.1152	2.0	1.54
					4.15	20.00	.1518	3.0	2.30
					5.54	20.00	.1884	4.0	3.08
8	3.0537	67.75	20.05	12.20	2.08	20.00	.1006	1.5	1.15
					2.77	20.00	.1219	2.0	1.54
					4.15	20.00	.1645	3.0	2.30
					5.54	20.00	.2072	4.0	3.08
9	3.1268	77.47	10.03	12.50	2.08	20.00	.1040	1.5	1.15
					2.77	20.00	.1283	2.0	1.54
					4.15	20.00	.1770	3.0	2.30
					5.54	20.00	.2259	4.0	3.08
10	3.1999	87.16	---	12.84	2.08	20.00	.1075	1.5	1.15
					2.77	20.00	.1349	2.0	1.54
					4.15	20.00	.1898	3.0	2.30
					5.54	20.00	.2447	4.0	3.08

Price was also adjusted for yield grade changes to determine the Choice weight criterion. An external fat thickness measurement of 0.8 inches indicated a preliminary Yield Grade score of 4.0 and a 1.2 inch measurement indicated a Yield Grade score of 5.0. By use of the previous equation a criterion was set that the steers were considered to be Yield Grade 4 when they obtain the weight of 538.6 Kg. (1187 lbs.) and Yield Grade 5 when they reached the weight of 624 Kgs. (1375 lbs.). Live steers in the feeding trial that reached the Yield Grade 4 weight were decreased in price by $3.00/cwt and Yield Grade 5 steers deducted an additional $2.00/cwt.

Coordinating the Yield Grade price adjustments with the price margin study results, the following cattle price and price margins were used in this study as shown in Table 5.11.

Other Cost Assumptions

Acquisition Costs

	Cost/Head	
Dipping	$ .25	
Growth Hormone (DES)	.30	
Worming Dose	.70	
IBR - BUD shot	.26	
Blackleg	.12	
Ear Tag	.35	
	1.98	$1.98
Hauling @ 61¢/cwt for 200 mile haul Truck will hold 75 head of 650 lb. cattle =		3.96
Total Acquisition Cost		$5.94

Other Costs Assumptions

Rate of Interest = 10%

Feedlot operating Cost per Head per Day = $0.10

Table 5.11 Cattle prices by weight groups adjusted for Quality Grade and Yield Grade used in the cost and revenue analysis of 20 head of Hereford steers fed various ration energy concentration diets.a/ b/

	Weight Groups		Cattle Price Margins		Cattle Prices		
Quality Grade	lbs.	Kgs.	$/cwt.	$/Kg.	$/cwt.	$/Kg.	
Choice Feeder Steers	500 - 599	226.8 - 271.7	----	----	$60.00	$1.3228	Base Price
Choice Feeder Steers	600 - 699	271.8 - 317.1	-1.1429	-0.02520	58.86	1.2976	
Choice Feeder Steers	700 - 799	317.2 - 362.4	-0.4678	-0.01031	58.39	1.2873	
Good Slaughter Steers	800 - 975	362.3 - 442.5	-2.7657	-0.06097	55.62	1.2263	
Choice Slaughter Steers	976 - 1099	442.6 - 498.5	+3.2171	+0.07092	58.84	1.2972	
Choice Slaughter Steers	1100 - 1186	498.6 - 623.9	-0.0742	-0.00164	58.77	1.2956	
Choice Slaughter Steers YG 4	1187 - 1374	538.6 - 623.9	-3.0000	-0.06614	55.77	1.2294	
Choice Slaughter Steers YG 5	1375 +	624.0 +	-2.0000	-0.04400	53.77	1.1854	

a/ A cattle price margin study was made that covered 72 weeks (Jan. 1,1976 to May 14, 1977) of cattle prices to determine the average cattle price margins.

b/ A high base price of $60.00/cwt. ($1.3228/Kg.) was used to help compensate against high feed cost applied in the analysis. The price margins between weight groups of cattle are the factors that can alter the comparative results between steers fed different rations.

Chapter VI

Summary and Conclusion

Summary

Conclusions were made by evaluating the cost and revenue factors of: average cost of live weight gain, average cost of retail meat product weight gain, rate of return on the total invested cost and the dollar profit per head calculated from the cost-revenue models described in this study, which are shown graphically with the following stated conclusions.

Economic Differences Between Rations at the Choice Weight of 442.6 Kgs. for Various Corn to Corn Silage Cost Ratios Analyzed.

The profitability and cost of gain changes as the corn to corn silage cost ratio increased from 2.0 to 3.0 to 4.0. Figure 6.1 illustrates that at the 2.0 cost ratio the animals fed the high energy concentration rations (#9 and #10) showed the most profitability and the lowest cost per unit of retail and live weight gain.[1] However, as the cost ratio is increased to 3.0, where the cost of corn increases relative to the cost of corn silage, the economic advantage shifts from rations #9 and #10 to rations #3 and #2. The economic advantage continues to shift more so towards the high forage rations #1, #2, and #3 with the cost ratio of 4.0.

These results indicate that the corn to corn silage cost ratio of nearly 3.0 ($4.15/bu. corn and $20/ton corn silage) is needed to justify a switch from feeding high energy rations above 70 percent concentrate to the

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[1]Cost ratio refers to the corn to corn silage cost ratio based upon their values per Kg. of dry matter. See Table 5.4 for a breakdown of the cost ratio into cost per unit for each feed ingredient fed.

other extreme of low energy rations below 20 percent concentration when feeding to the choice slaughter weight.

Comparison Between Rations in the Economical Differences in Feeding to the Good Quality Grade Versus Feeding to the Choice Quality Grade.

For any ration fed, maximum profit per head or per unit of time always occurred within the Choice quality grade in this study for each corn to corn silage cost ratio used. Figures 6.2 and 6.3 show the comparison of rate of return between Good and Choice to always be in favor of feeding to Choice. Not until the 4.0 cost ratio was used was there an instance where feeding an animal to the Good slaughter grade weight on a low energy concentrate ration was more profitable than feeding an animal on a high energy concentrate ration to the Choice slaughter weight. For instance, in Figure 6.3, the rate of return from feeding an animal to the Good quality grade on ration #2 (10 percent corn: 80 percent corn silage: 10 percent supplement) was higher than feeding an animal to Choice on ration #8 (68 percent corn: 20 percent corn silage: 12 percent supplement) by approximately 50 percent. However, it would be more advantageous to continue to feed the animal on ration #2 to the Choice weight since a further increase in rate of return of approximately 16 percent would be realized.

For every corn to corn silage cost ratio applied to the feed cost of each ration fed, the results showed the marginal revenue in feeding the steers from the Good quality grade to the Choice quality grade always exceeded the marginal cost of doing so. The assumed positive price margin used in the study of \$0.071 per Kg. (\$3.22 per cwt.) between the sale price of Good versus Choice quality grade steers was the primary reason it was always more profitable to feed to the Choice quality grade.[2] The increase

[2]See Table 5.5.

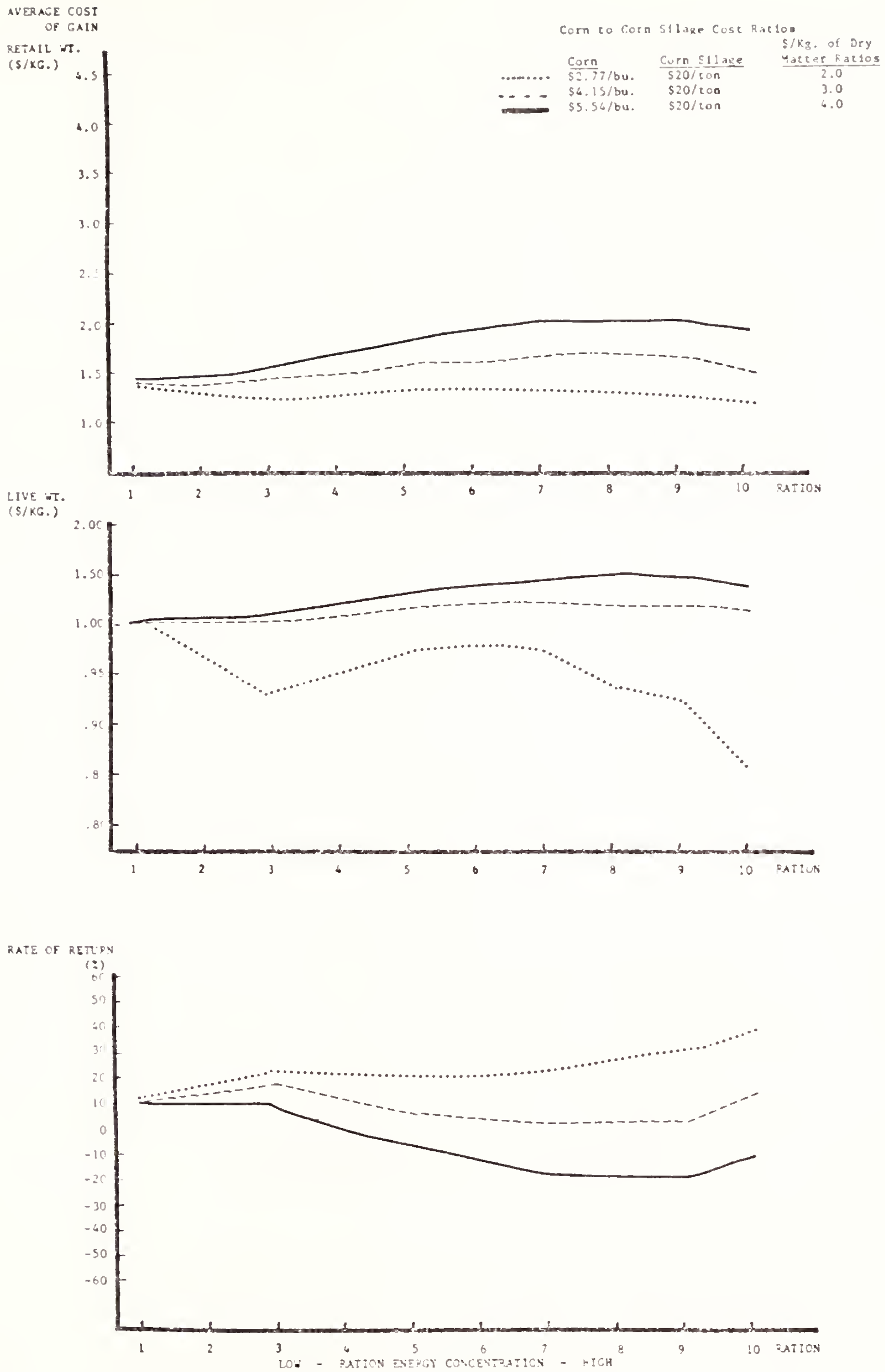


Figure 6.1. Comparisons at the Choice quality grade between the effects of corn to corn silage cost ratios 2.0, 3.0, and 4.0 upon the average cost of gain for retail weight and live weight growth and the rate of return on the total invested cost for feeding trial steers fed rations #1 through #10.

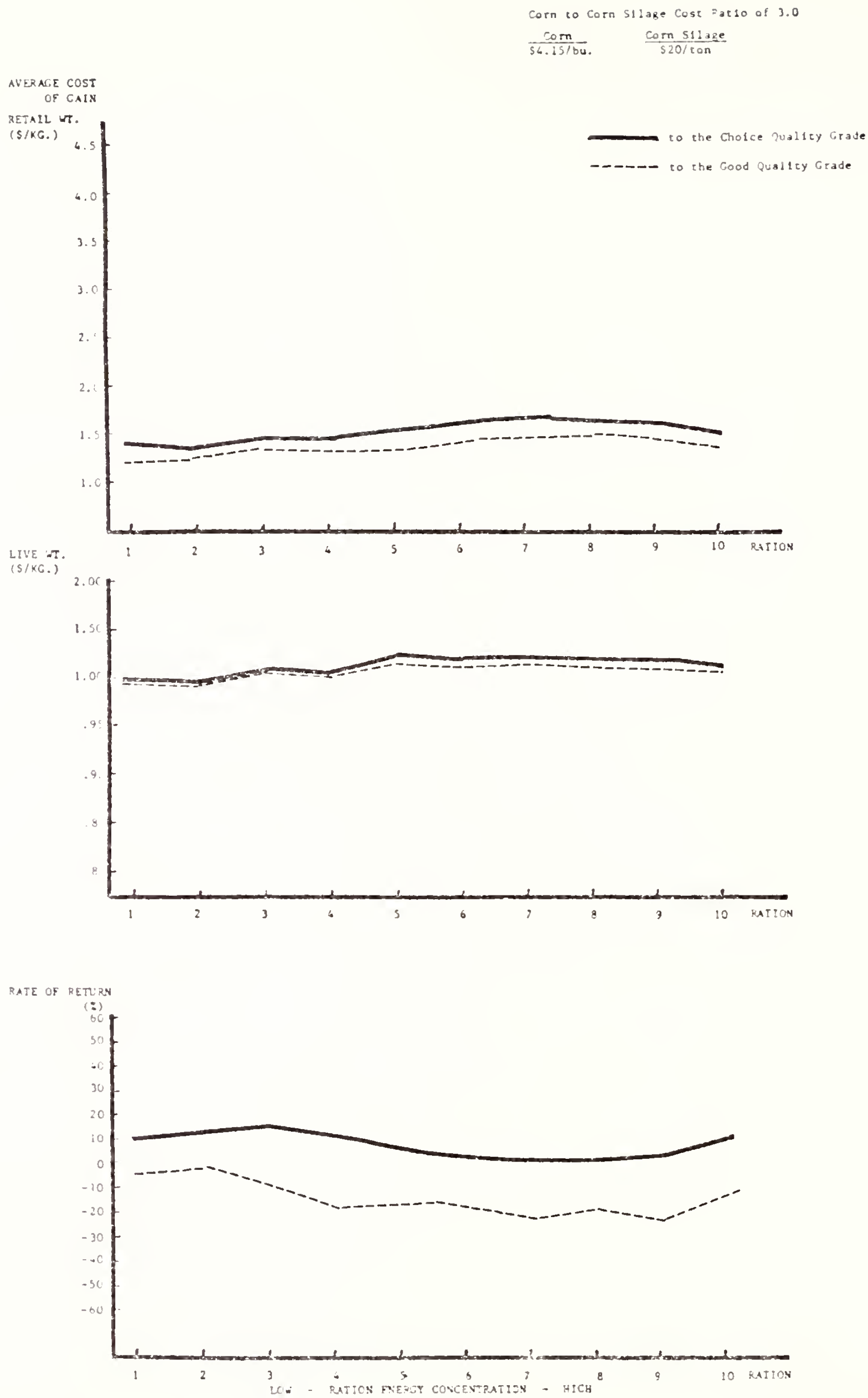


Figure 6.2. Comparisons at the Good quality grade versus at the Choice quality grade the factors of average cost of gain for retail weight and live weight growth, and the rate of return on the total invested cost for steers fed feeding trial rations #1 through #10 when using a corn to corn silage cost ratio of 3.0.

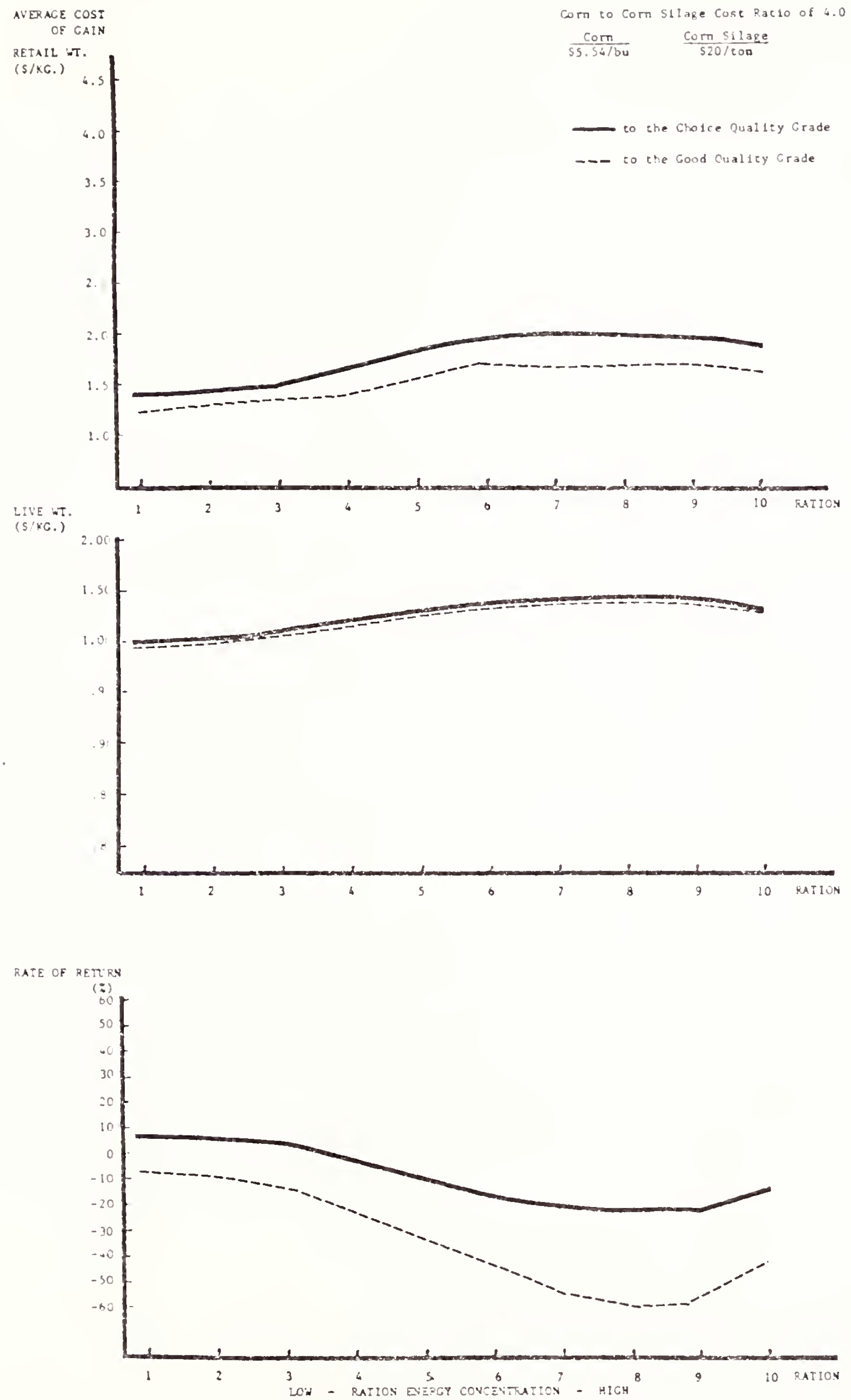


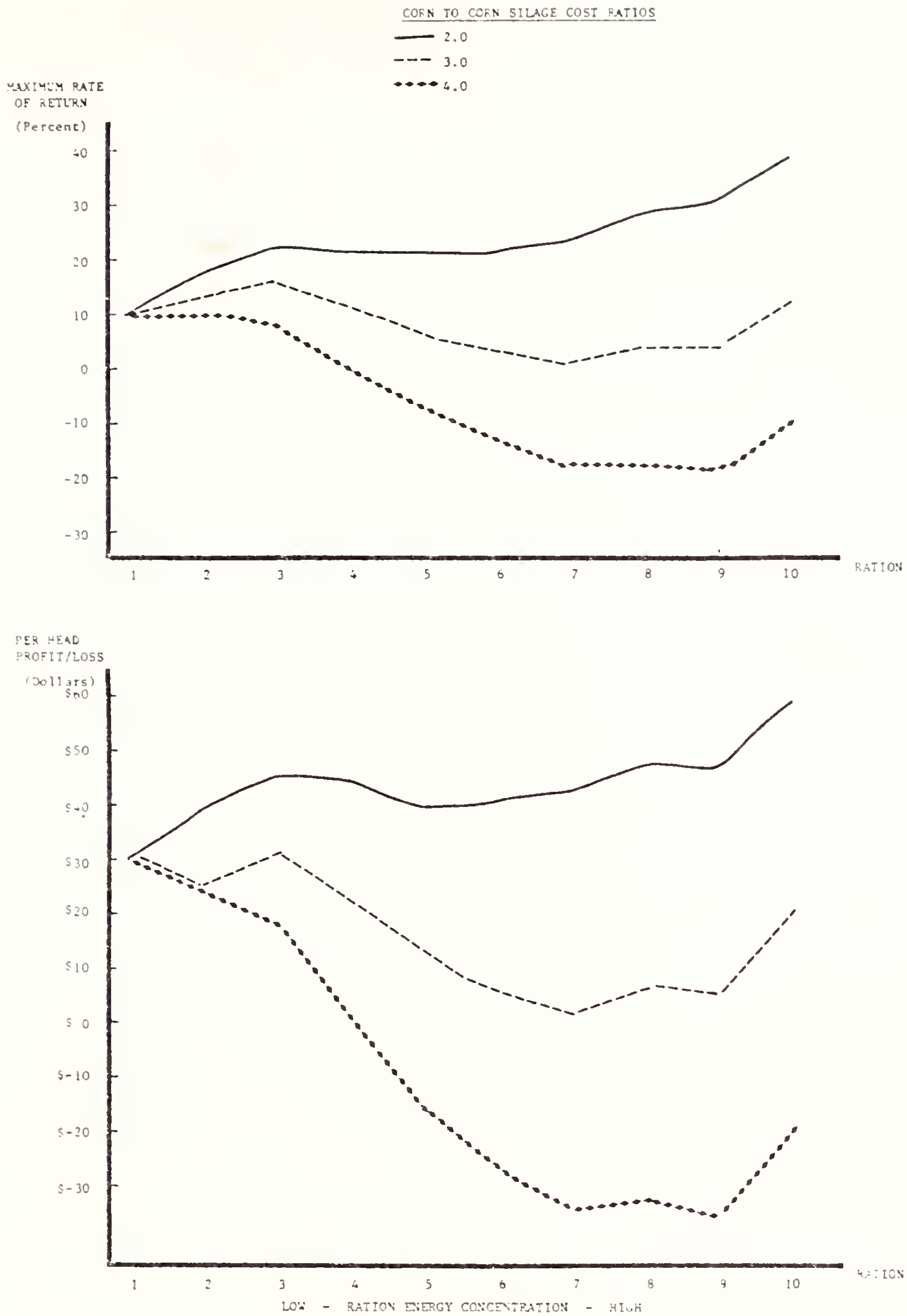
Figure 6.3. Comparisons at the Good quality grade versus at the Choice quality grade the factors of average cost of gain for retail weight and live weight growth, and the rate of return on the total invested cost for steers fed feeding trial rations #1 through #10 when using a corn to corn silage cost ration of 4.0.

in profitability when a steer reached the Choice quality grade can be seen by the sudden increase in the rate of return, as shown in the bottom graph in figure 6.6 for steers #1, #5, and #10, at days on feed of 182, 119, and 98, respectively.

For most steers in this study the average cost of gain curves for live weight were increasing at the time the Choice quality grade was reached (such as seen in Figure 6.6). Some of the benefit of increased revenue realized from the Good to Choice positive price margin was decreased by the increase in the cost of gain necessary to achieve the Choice quality grade when the corn to corn silage cost ratios of 2.0, 3.0, and 4.0 were used. The impact of changes in the Good to Choice price margin on profitability in feeding to the Good quality grade versus feeding to the Choice quality was not investigated in this study.

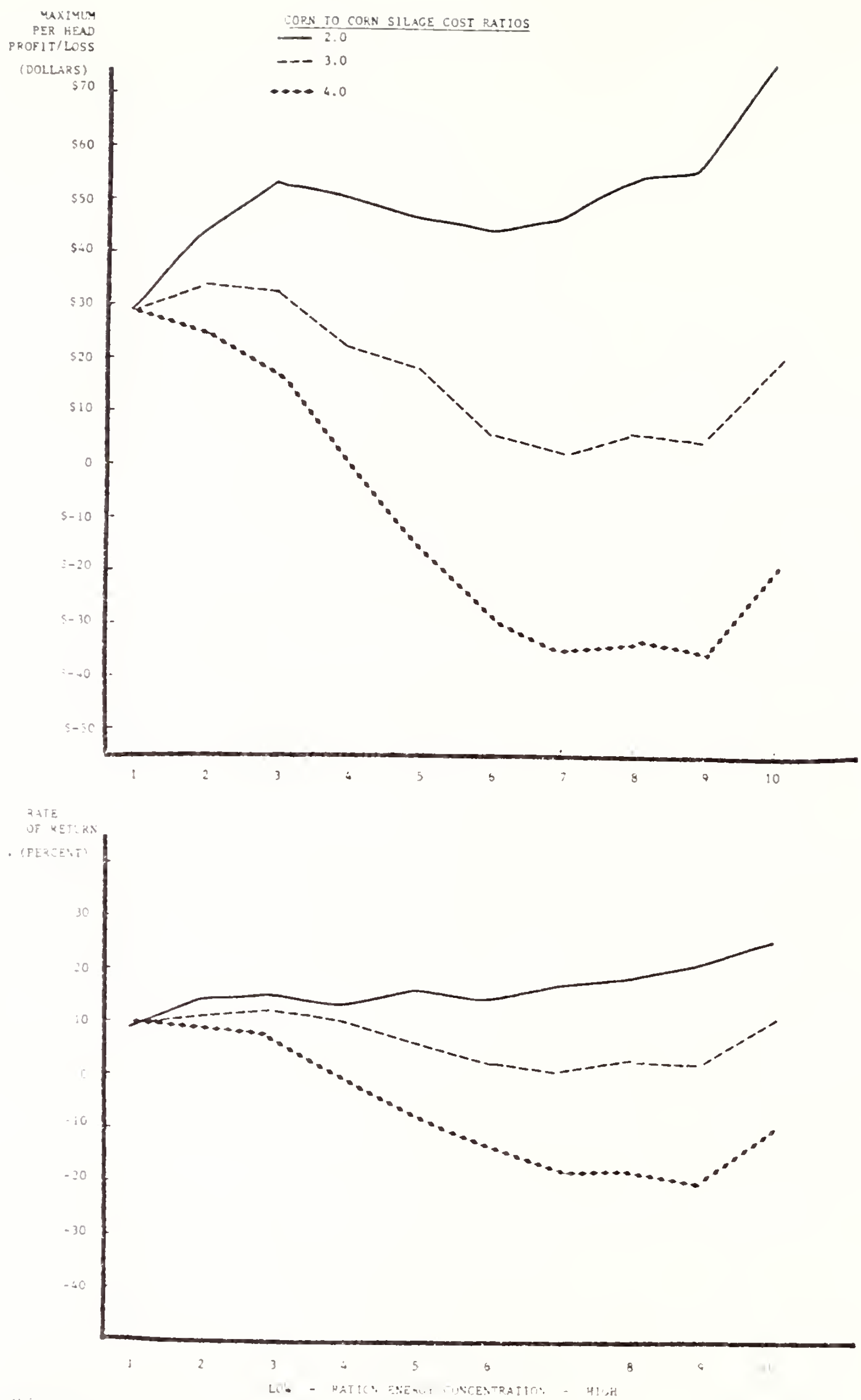
Differences Between Rations in Profitability

The maximization of profitability when evaluated by either the criterion of maximum profit per head or maximum profit per unit of time on feed for the animals fed in this study came about when the animals reached the Choice quality grade, or soon after, as shown in Figures 6.2 and 6.3. Figure 6.4 shows the maximum rate of return on the total invested cost for each ration, as well as the corresponding profit per head at that time. Alternatively, Figure 6.5 illustrates the maximum profit per head for each ration fed and the rate of return on total invested cost at that time. The criterion of maximizing profits per unit of time (i.e., by rate of return) often dictated the need to market the feedlot cattle sooner than if the producer desired to maximize profits per head. The difference in feeding days between the two methods of determining maximum profitability for each corn to corn silage cost ratio are shown in Table 6.1



DAYS TO: MAXIMUM RATE OF RETURN FOR	1	2	3	4	5	6	7	8	9	10	RATION
RATIOS - 2.0	196	161	140	140	126	126	119	112	105	105	
3.0	196	168	140	133	133	126	119	105	105	105	
4.0	196	161	140	133	126	114	112	105	105	105	
CHOICE QUALITY	182	161	140	133	126	119	112	105	105	105	

Figure 6.4. Maximum rate of return on the total invested cost and the corresponding profit per head, as well as, the number of days on feed when the maximum rate of return and the Choice quality grade were obtained for each ration fed for the corn to corn silage cost ratios of 2.0, 3.0, and 4.0.



DAYS MAXIMUM PROFIT PER HEAD FOR	1	2	3	4	5	6	7	8	9	10	RATION
RATIOS - 2.0	203	203	213	217	175	182	161	175	161	182	
3.0	203	189	168	147	133	119	119	105	105	112	
4.0	203	175	140	133	126	126	112	105	112	105	
[illegible] QUALITY	182	161	140	133	126	119	112	105	105	105	

Figure 6.5. Maximum profit per head and the corresponding rate of return on the total invested cost, as well as, the number of days on feed when the maximum profit per head and the Choice quality grade were obtained for each ration fed for the corn to corn silage ratios of 2.0, 3.0, and 4.0.

Table 6.1. Difference in number of days on feed when determining maximum profitability by basis of maximum profit per head versus maximum profit per unit of time for each corn to corn silage cost ration used in this study.

Corn to Corn Silage Cost Ratio	Days to Maximum (Profit/Head - Days to Maximum Profit/Unit of Time) — Rations 1	2	3	4	5	6	7	8	9	10	Average
($/Kg)											
2.0	7	42	77	77	49	56	42	63	56	77	54.6
3.0	7	21	28	7	0	-7	0	0	0	7	6.3
4.0	7	14	0	0	0	7	0	0	7	0	3.5

In this study, maximizing profits per head resulted in a lower rate of return on the total invested cost than feeding to the maximum rate of return since more days on feed were required to obtain maximum profit per head than to obtain the maximum profit per unit of time.

<u>The Nature of the Shift in the Most Economical Ration to Feed with Increases in the Corn to Corn Silage Cost Ratio.</u>

The shift in the technical substitution of corn silage for corn in determining the most economical feedlot ration to feed as the corn to corn silage cost ratio increased proved to be large, i.e., from nearly one extreme of high energy concentrate rations (#9 and #10) to nearly the other extreme of low energy concentrate rations (#3, #2, #1) rather than being a process of gradual substitution.

The mid-range energy concentration rations, #4 through #7, were generally less economical in respect to profitability and cost of gain to feed than the high energy concentration rations (#8, #9, #10) when the corn to corn silage cost ration was 2.0. The same held true with the lower energy concentration ration (#1, #2, #3) when the ratio was 3.0 or 4.0.

In terms of profitability, the nature of the shift can be noted in Figures 6.4 and 6.5. The average cost of gain curves also showed the need of an extensive shift from one forage-grain balance extreme to the other in order to obtain the lowest cost of gain as a change in the corn to corn silage cost ratio occurs. The average cost of gain curves can be comparatively viewed in Figure 6.1 between all rations to Choice for each cost ration, or by comparing the average cost curves for the entire feeding period for animals on each ration between rations for each cost ratio in Figures 6.6, 6.7, and 6.8. Results compared in Figure 6.6 between feeding rations #1, #5, and #10 when a corn to corn silage cost ratio of 2.0 was used, shows the lowest average cost of live weight gain ration to be #10 (87 percent corn: 0 percent corn silage: 13 percent supplement) with #5 (39 percent corn: 50 percent corn silage: 11 percent supplement) being the second lowest and #1 (0 percent corn: 90 percent corn silage: 10 percent supplement) having the highest cost of gain. The results comparing the 3.0 cost ratio from the order of lowest to highest average cost of live weight gain became #1 to #10 to #5 for most of the feeding period, Figure 6.7. Lastly, Figure 6.8, summarizing the comparison of using the corn to corn silage cost ratio of 4.0, the ration order to be #1 to #5 to #10 in terms of cost of gain from the lowest to the highest. Similar comparisons can be made with Figures 6.9 through Figure 6.14.

<u>The Nature of the Average Cost of Gain Curve for Retail Meat Product Weight Gain and Live Weight Gain Between Rations.</u>

The shift in the average cost of gain curves for live weight and retail product weight, along with the rate of return curves were greater for the high energy concentrate rations than the low concentrate rations when the corn to corn silage cost ratio was increased. Figures 6.15, 6.16,

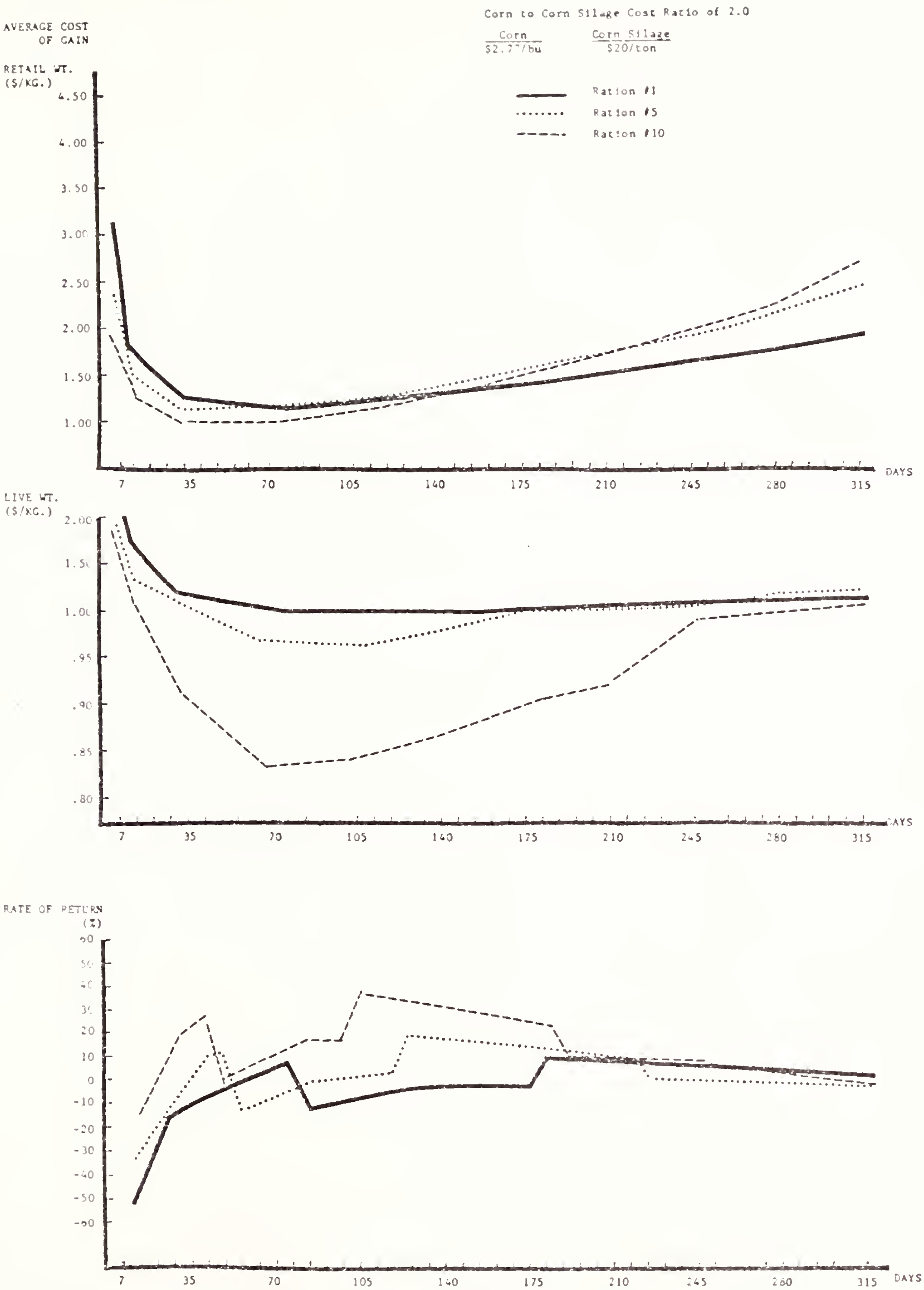


Figure 6.6. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #1 (0% corn: 90% corn silage: 10% supplement), ration #5 (39% corn: 50% corn silage: 11% supplement), and ration #10 (87% corn: 0% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 2.0.

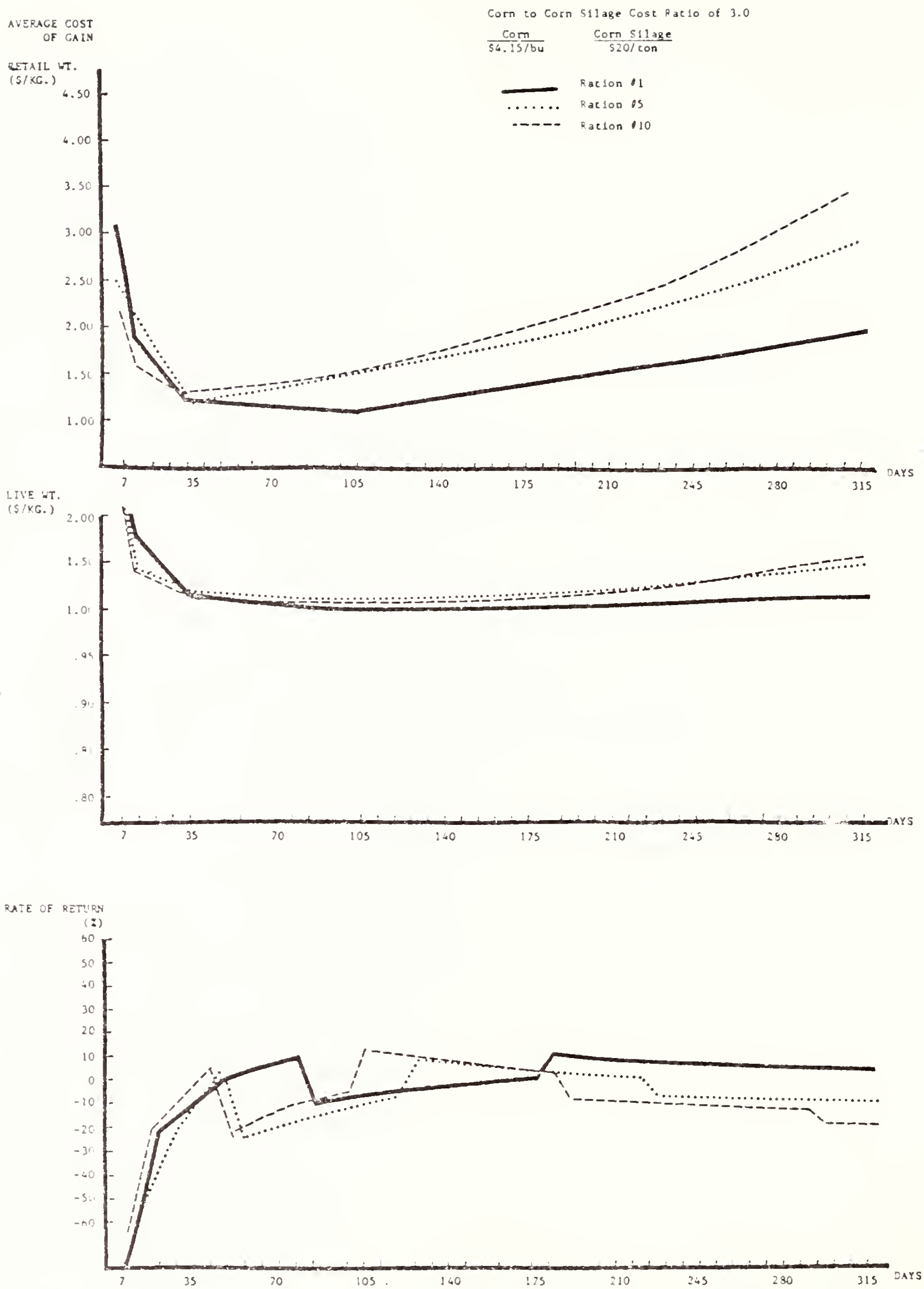


Figure 6.7. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #1 (0% corn: 90% corn silage: 10% supplement), ration #5 (39% corn: 50% corn silage: 11% supplement) and ration #10 (87% corn: 0% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 3.0.

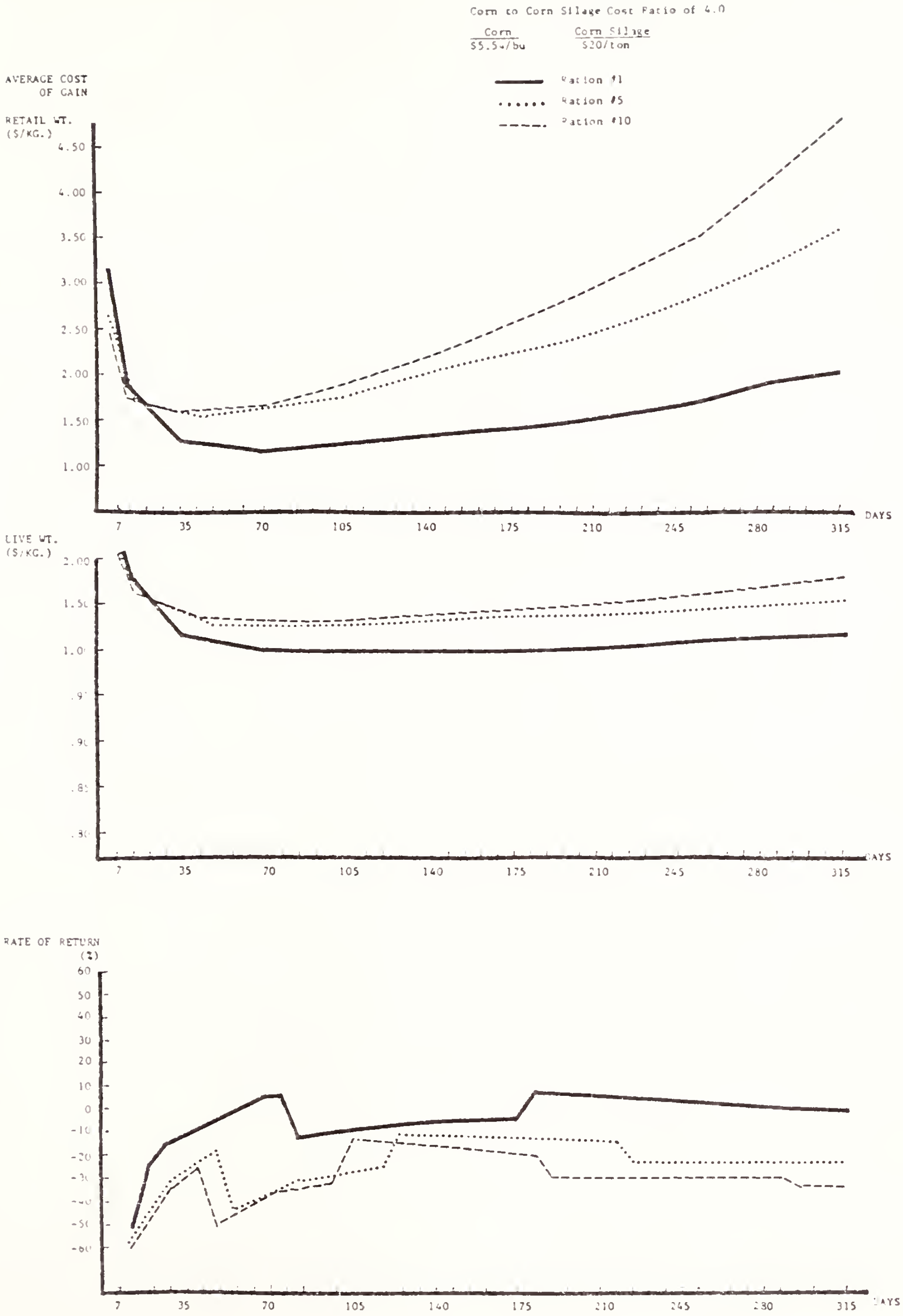


Figure 6.8. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #1 (corn: 90% corn silage: 10% supplement), ration #5 (39% corn: 50% corn silage: 11% supplement), and ration #10 (87% corn: 0% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 4.0.

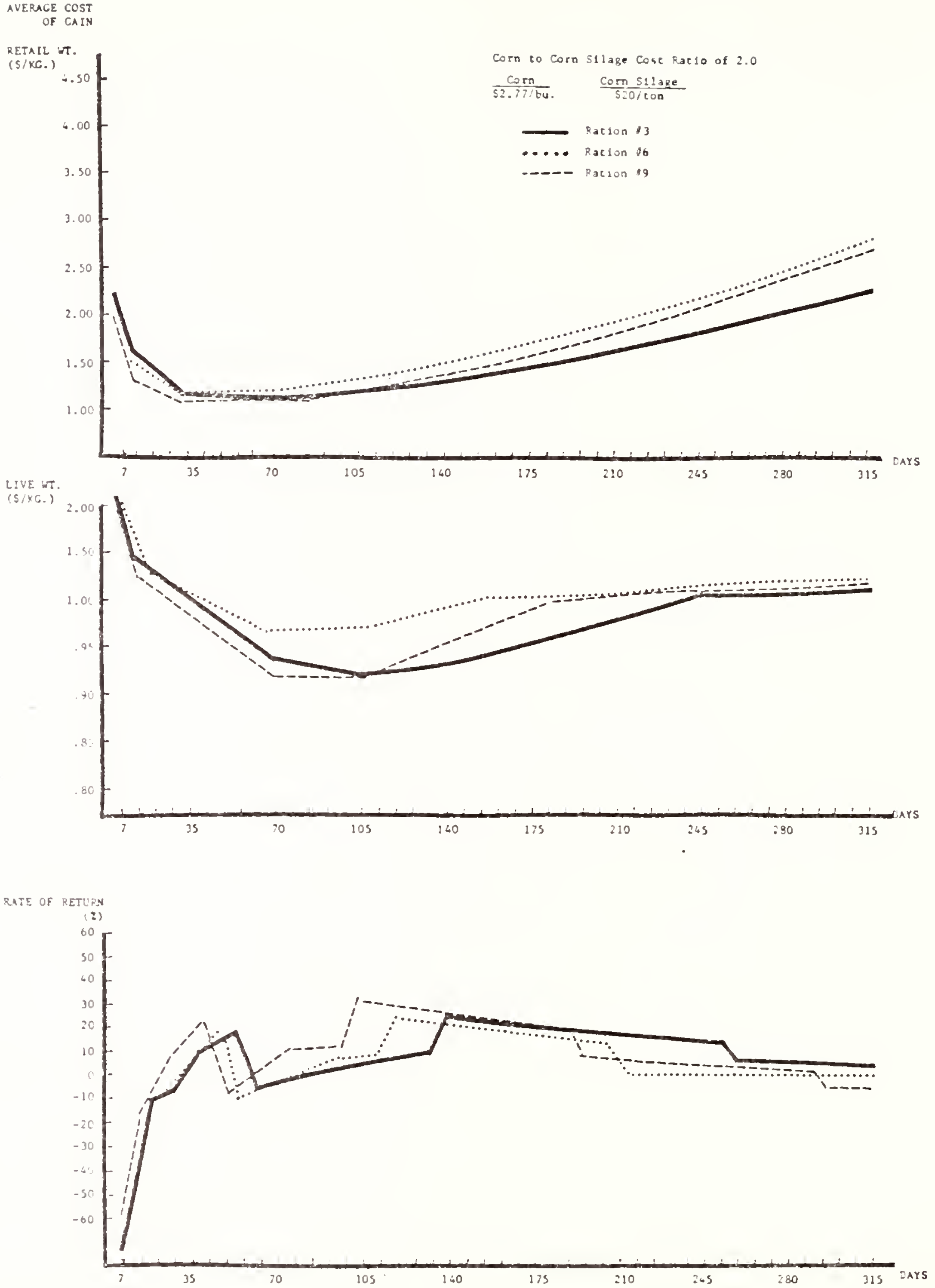


Figure 6.9. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #3 (19% corn: 70% corn silage: 11% supplement), ration #6 (48% corn: 49% corn silage: 12% supplement), and ration #9 (77% corn: 10% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 2.0

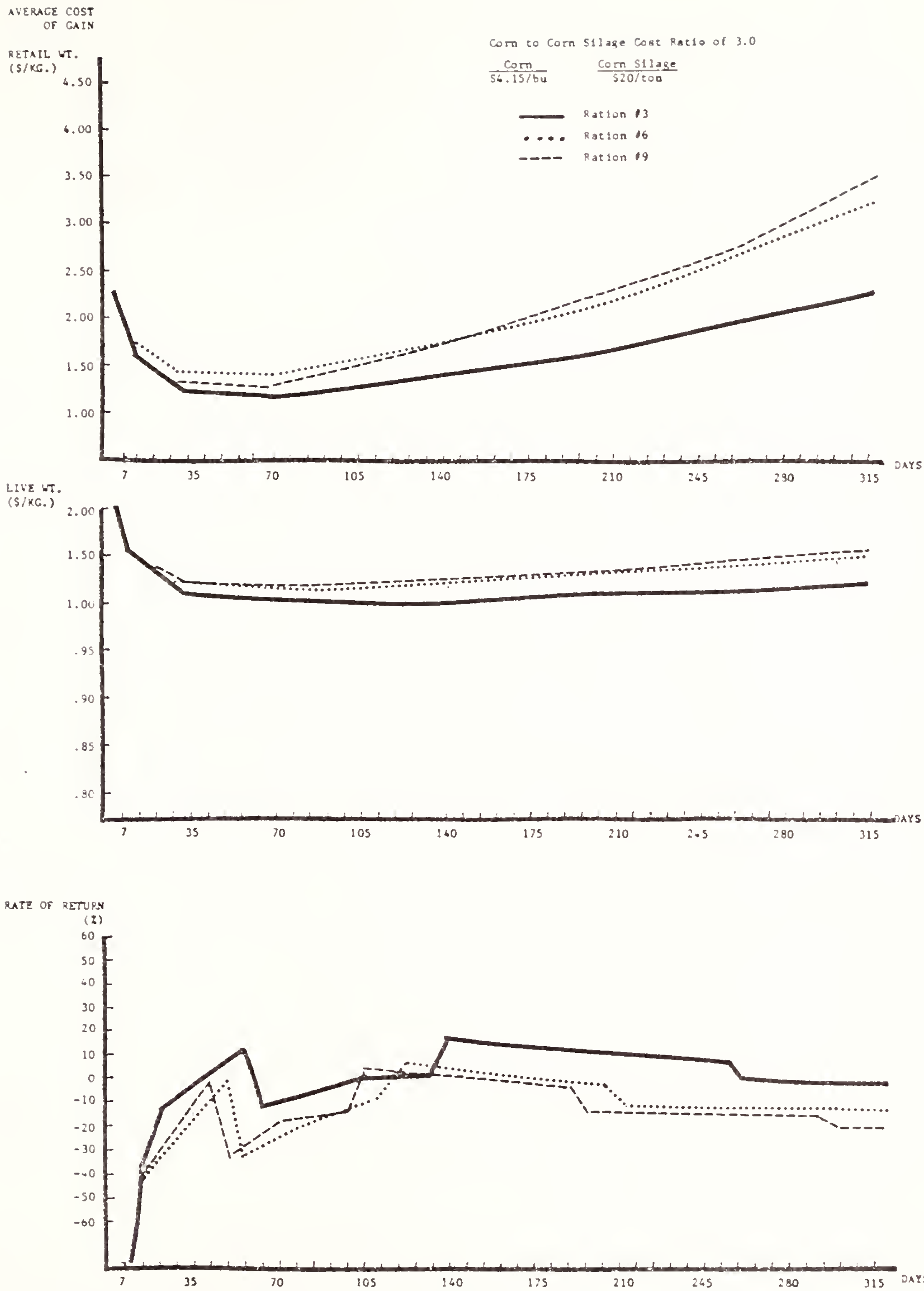


Figure 6.10. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #3 (19% corn: 70% corn silage: 11% supplement), ration #6 (48% corn: 49% corn silage: 12% supplement), and ration #9 (77% corn: 10% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 3.0.

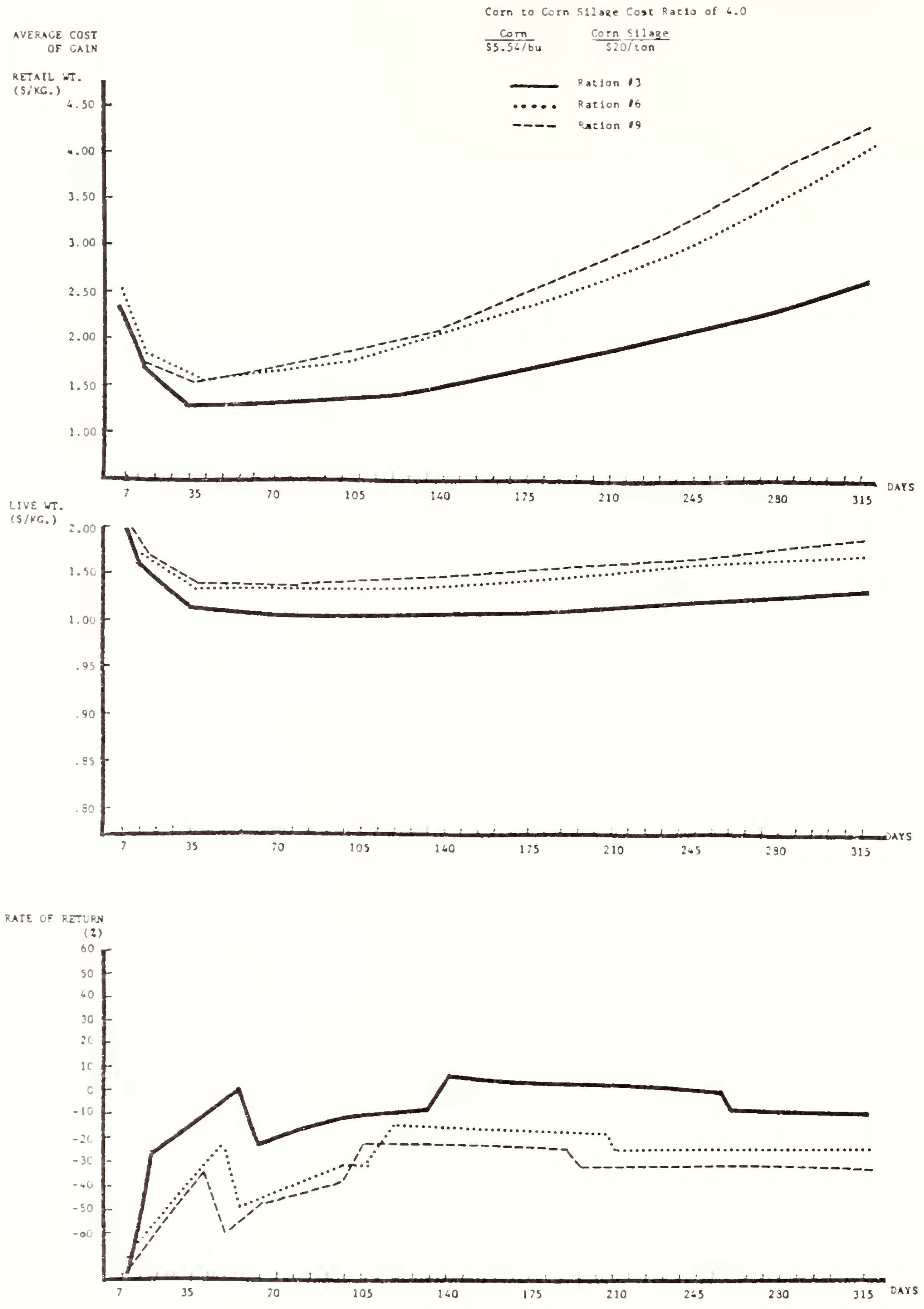


Figure 6.11. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #3 (19% corn: 70% corn silage: 11% supplement), ration #6 (48% corn: 49% corn silage: 12% supplement), and ration #9 (77% corn: 10% corn silage: 13% supplement) when using a corn to corn silage cost ratio of 4.0.

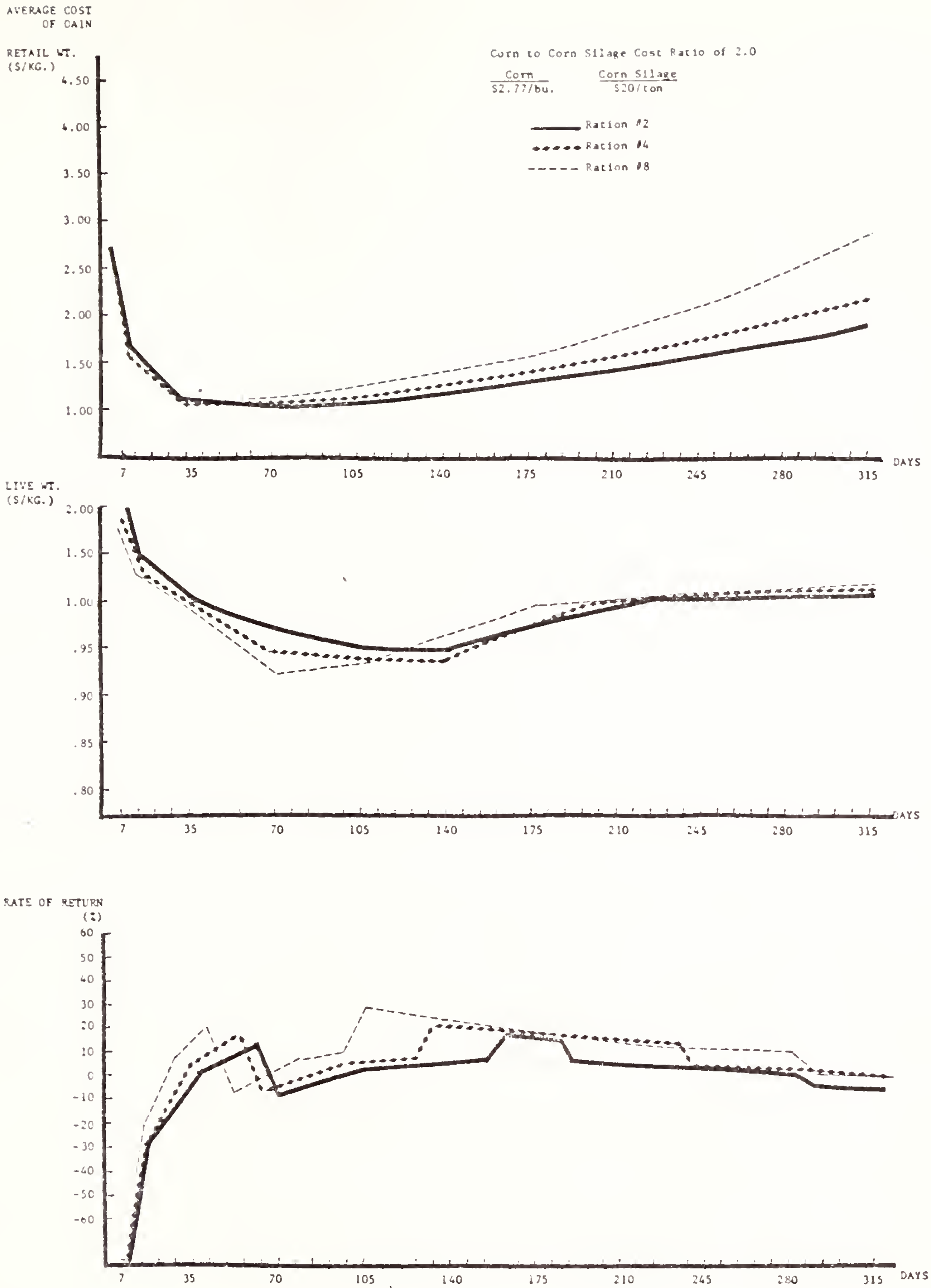


Figure 6.12. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #2 (10% corn: 80% corn silage: 10% supplement), ration #4 (29% corn: 60% corn silage: 11% supplement), and ration #8 (68% corn: 20% corn silage: 12% supplement) when using a corn to corn silage cost ratio of 2.0.

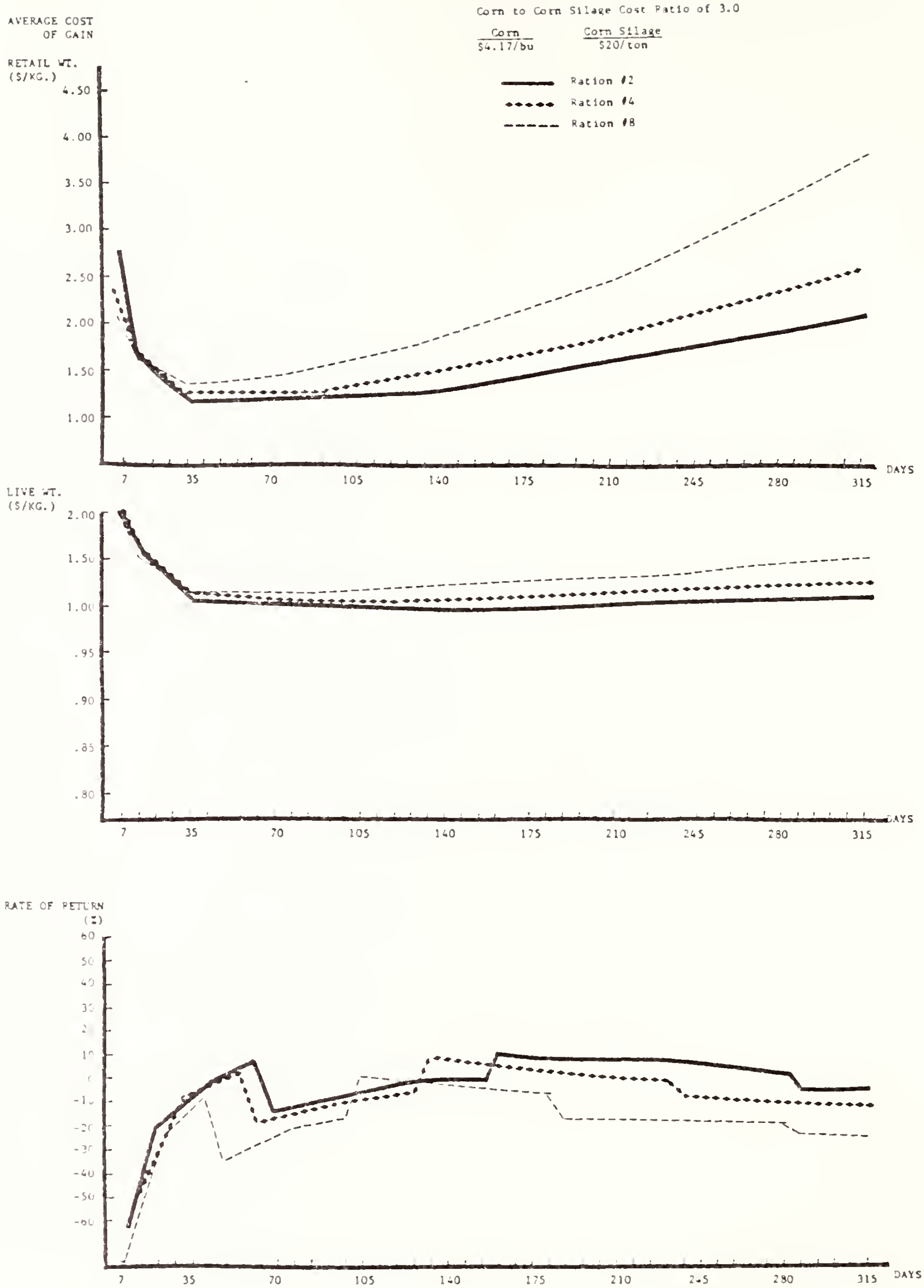


Figure 6.13. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #2 (10% corn: 80% corn silage: 10% supplement), ration #4 (29% corn: 60% corn silage: 11% supplement), and ration #8 (68% corn: 20% corn silage: 12% supplement) when using a corn to corn silage cost ratio of 3.0.

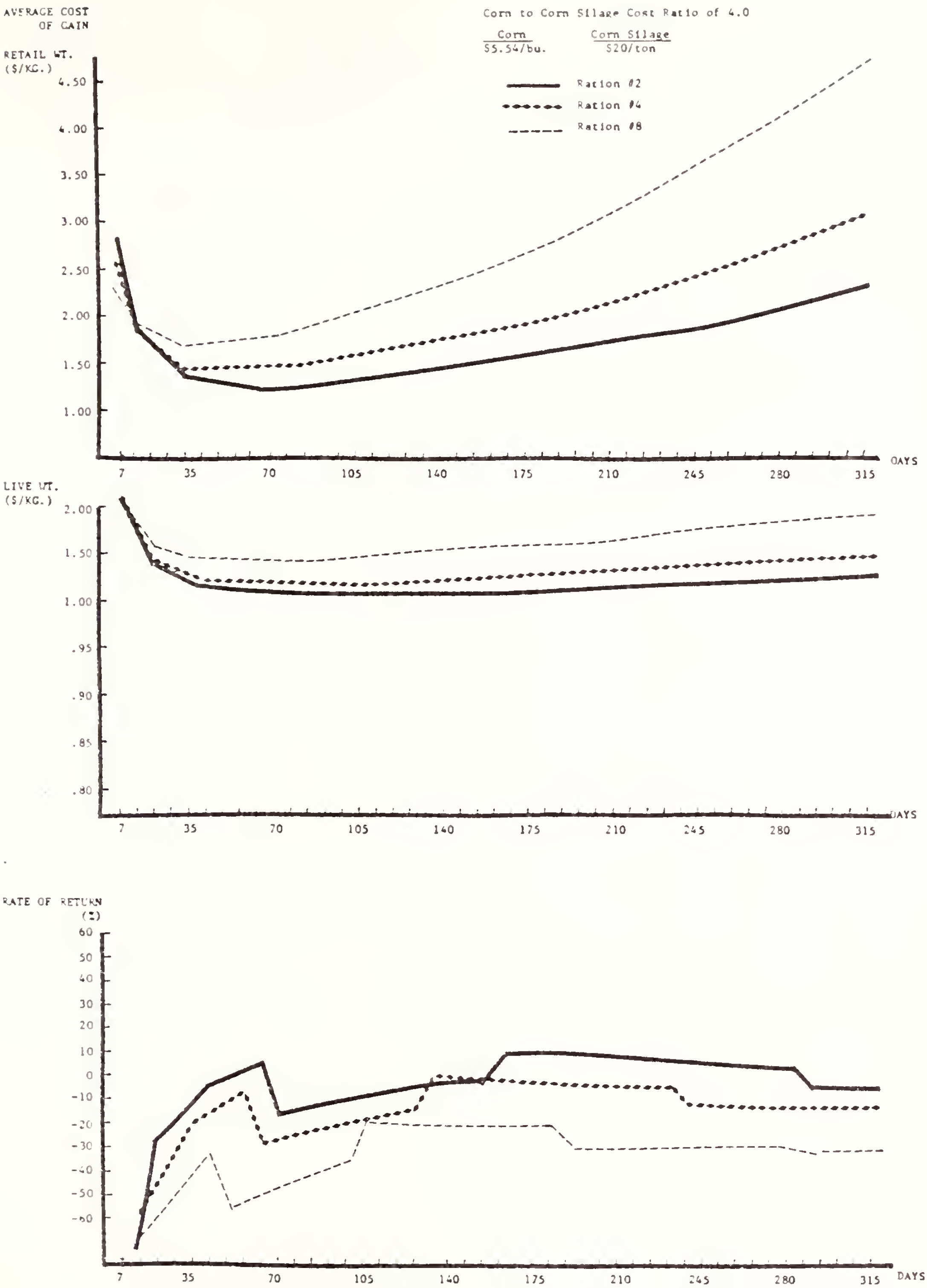


Figure 6.14. Comparisons of average cost of gain of retail weight and live weight growth, as well as, the differences in rate of return on the total invested cost for feedlot steers fed ration #2 (10% corn: 80% corn silage: 10% supplement), ration #4 (29% corn: 60% corn silage: 11% supplement), and ration #8 (68% corn: 20% corn silage: 12% supplement) when using a corn to corn silage cost ratio of 4.0.

and 6.17 show the shift in the cost and rate of return curves for animals fed rations #2, #6 and #9 respectively. The #2 ration showed the least amount of increase shift in average cost of gain and decrease shift in rate of return in going from a corn to corn silage cost ratio of 2.0 to 4.0 since it contained the lowest proportion of corn. The shift in the average cost and rate of return curves for ration #6 were definitely more dramatic, and then even more so for ration #9 than ration #2. With the increase in proportion of corn to corn silage in the higher energy concentration rations, the effect of higher price corn was enough greater at the corn to corn silage cost ratios of 3.0 and 4.0 to more than offset the economic advantage of better weight gains from feeding the higher energy concentration rations.

After the animals on different rations had been on feed for 175 to 210 days the average daily cost of live weight gain tended to converge when the 2.0 corn to corn silage cost ratio was used (see Figures 6.6, 6.9, and 6.12). In comparing average cost of gain curves when the higher corn to corn silage cost ratios were applied, it is noted that the curves tend to diverge with the higher energy concentration rations shifting higher more rapidly than the lower energy concentrate rations (See Figures 6.7, 6.8, 6.10, 6.11, 6.13, and 6.14). The switch from convergence to divergences was realized with an increase in the corn to corn silage cost ratio was simply a continual phenomenon of the cost curves representing the high energy rations shifting up more rapidly with an increase in the cost of corn relative to the cost of corn silage than realized by the low energy rations containing a larger proportion of roughage. For instance, in the comparisons of Figures 6.6, 6.7, and 6.8 for rations #1, #5 and #10 at the corn to corn silage ratios of 2.0, 3.0, and 4.0 respectively, the curves for average

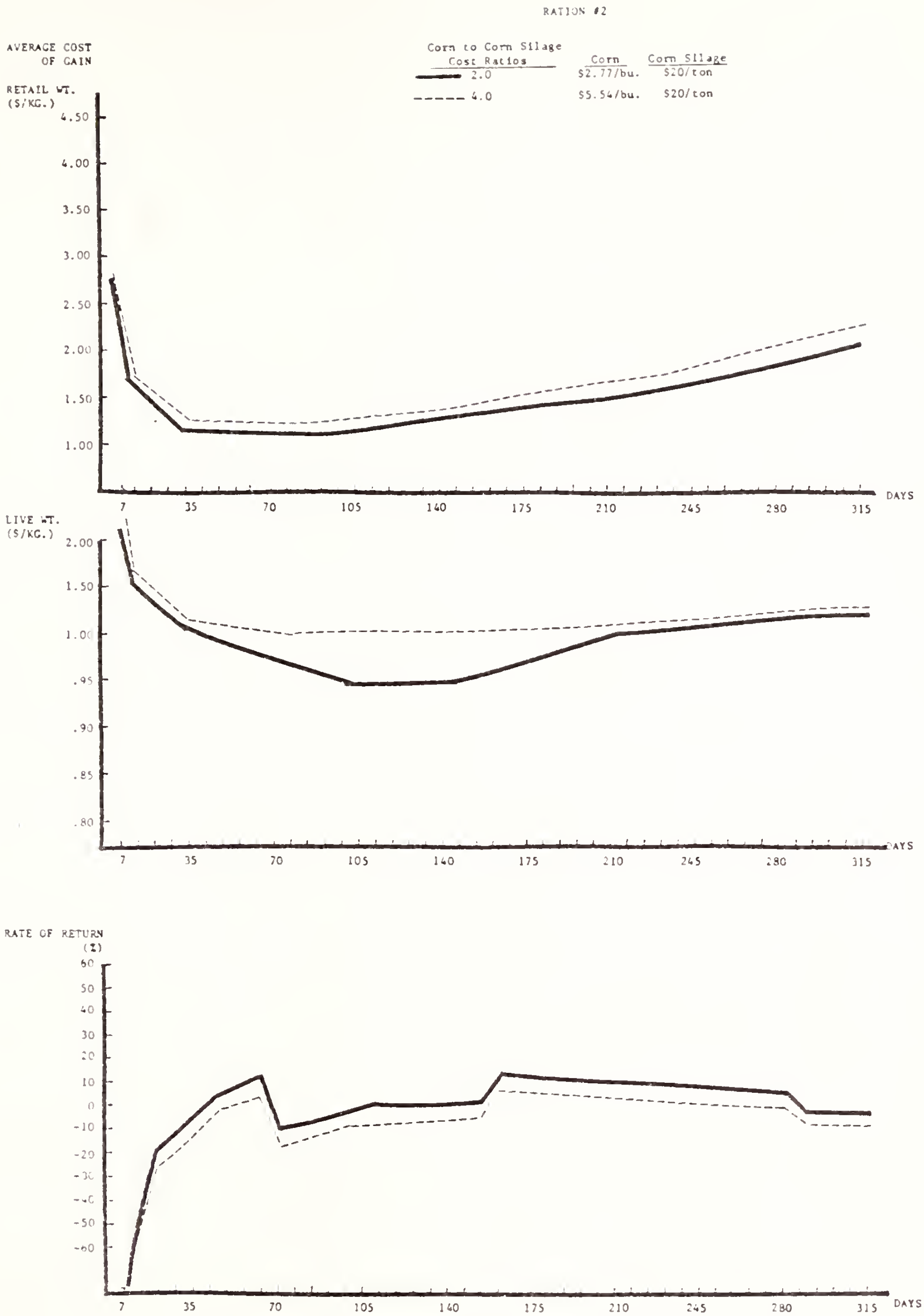


Figure 6.15. Average cost of gain of retail weight and live weight growth, as well as, the rate of return on the total invested cost for a feedlot steer fed ration #2 (10% corn: 80% corn silage: 10% supplement) when using corn to corn silage cost ratios of 2.0 and 4.0.

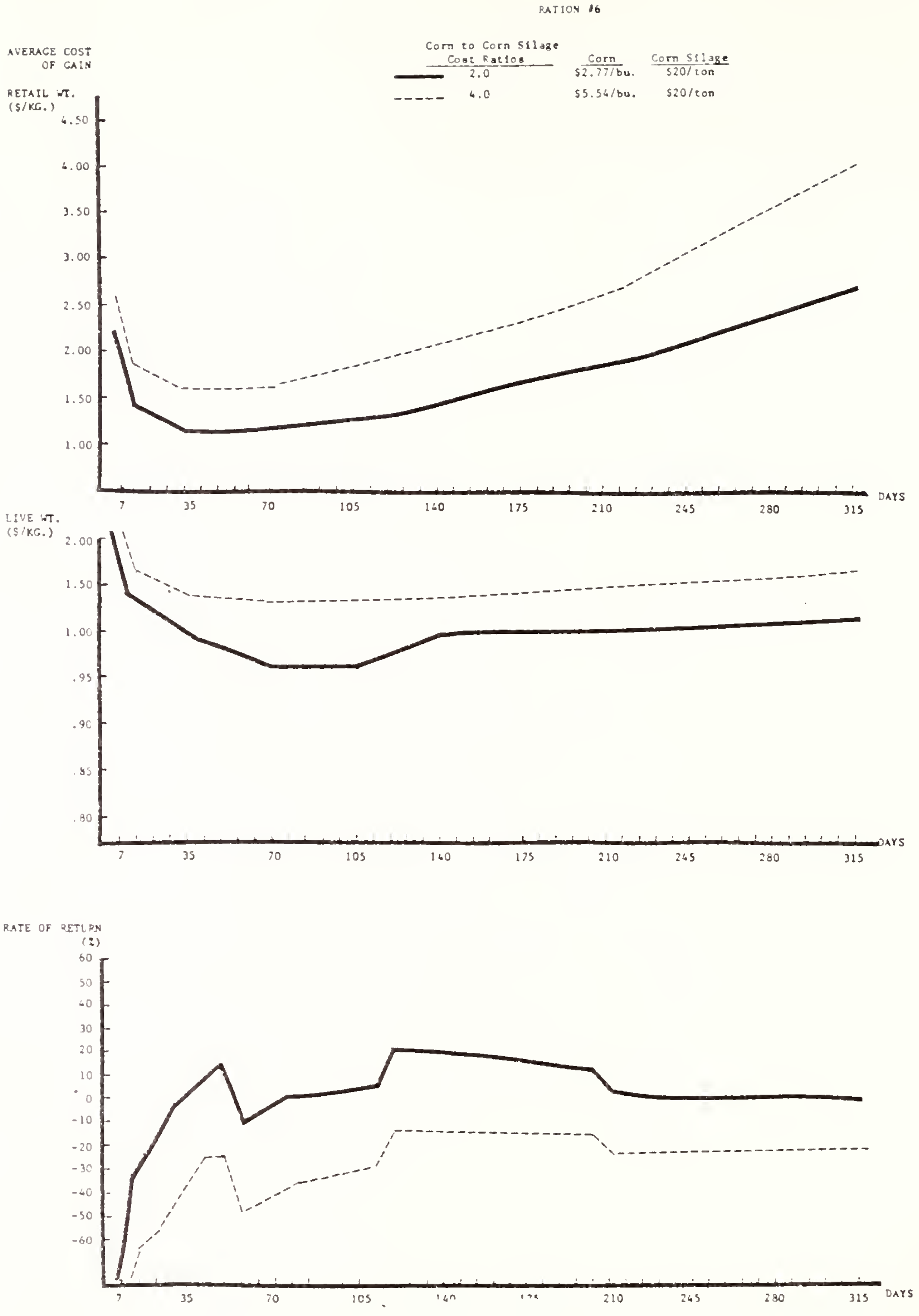


Figure 6.16. Average cost of gain of retail weight and live weight growth, as well as, the rate of return on the total invested cost for a feedlot steer fed ration #6 (48% corn: 40% corn silage: 12% supplement) when using corn to corn silage cost ratios of 2.0 and 4.0.

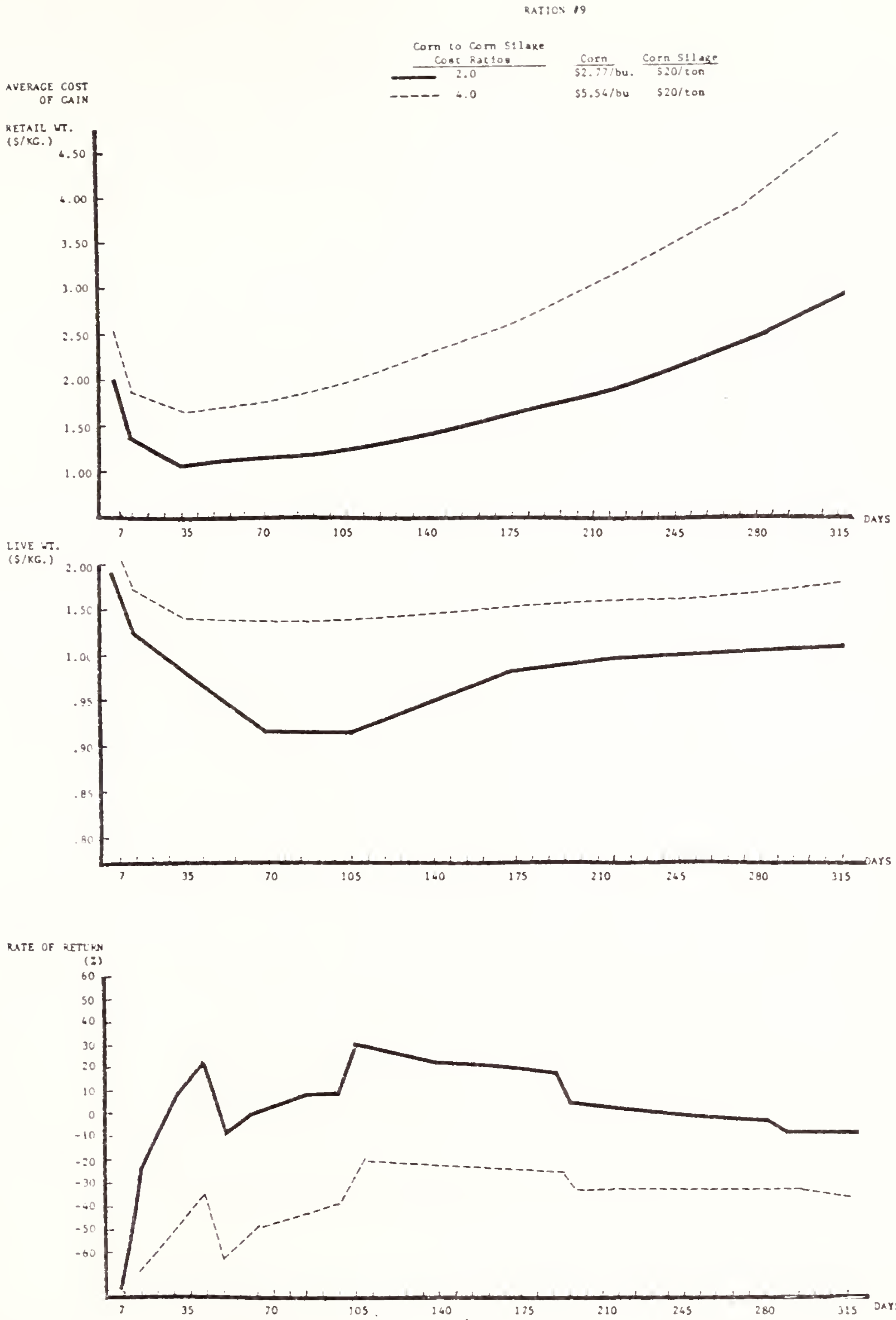


Figure 6.17. Average cost of gain of retail weight and live weight growth, as well as, the rate of return on the total invested cost for a feedlot steer fed ration #9 (77% corn: 10% corn silage: 13% supplement) when using corn to corn silage cost ratios of 2.0 and 4.0.

cost per Kg. of live weight illustrate the converging to diverging shift between rations. Figure 6.6 shows that at 245 days on feed the cost of gain curves have converged within $0.02 (4 squares) from a spread of $0.165 (33 squares) at 70 days on feed with the #10 ration being the lowest cost ration per Kg. of live weight gain followed by the #5 ration, then by the #1 ration. In Figure 6.7 and 6.8 at a corn to corn silage cost ratio of 3.0 and 4.0 respectively, the average cost curves tend to diverge, in which the #1 ration was the lowest cost ration per Kg. of live weight gain followed by ration #5, then ration #10.

This phenomenon can be explained by the difference in animal performance on different energy concentration rations. The average daily rate of gain for animals fed the high energy concentration rations, though initially higher, dropped off faster during the feeding period than animals fed the lower energy concentration rations. Since the cost per unit of ration is higher for the high energy rations, the average cost of daily gain for the animals fed a high energy ration is affected more dramatically as their rate of gain decreases more rapidly.

The rate of increase of the average cost per Kg. of retail product weight gain was greater than the corresponding average cost per Kg. of live weight gain for all animals. This is a result of the feedlot animal gaining less retail product weight per unit of live weight gain since a larger proportion of the live weight gain became trimmable fat and other by-product weight gain the longer the animal is on feed.

Results of Using a 3-Week Moving Average on Live Weight on Cost and Revenue Relationships.

Figure 6.18 shows the results graphically of applying a 3-week moving average to the live weight raw data collected for steers fed on rations #1,

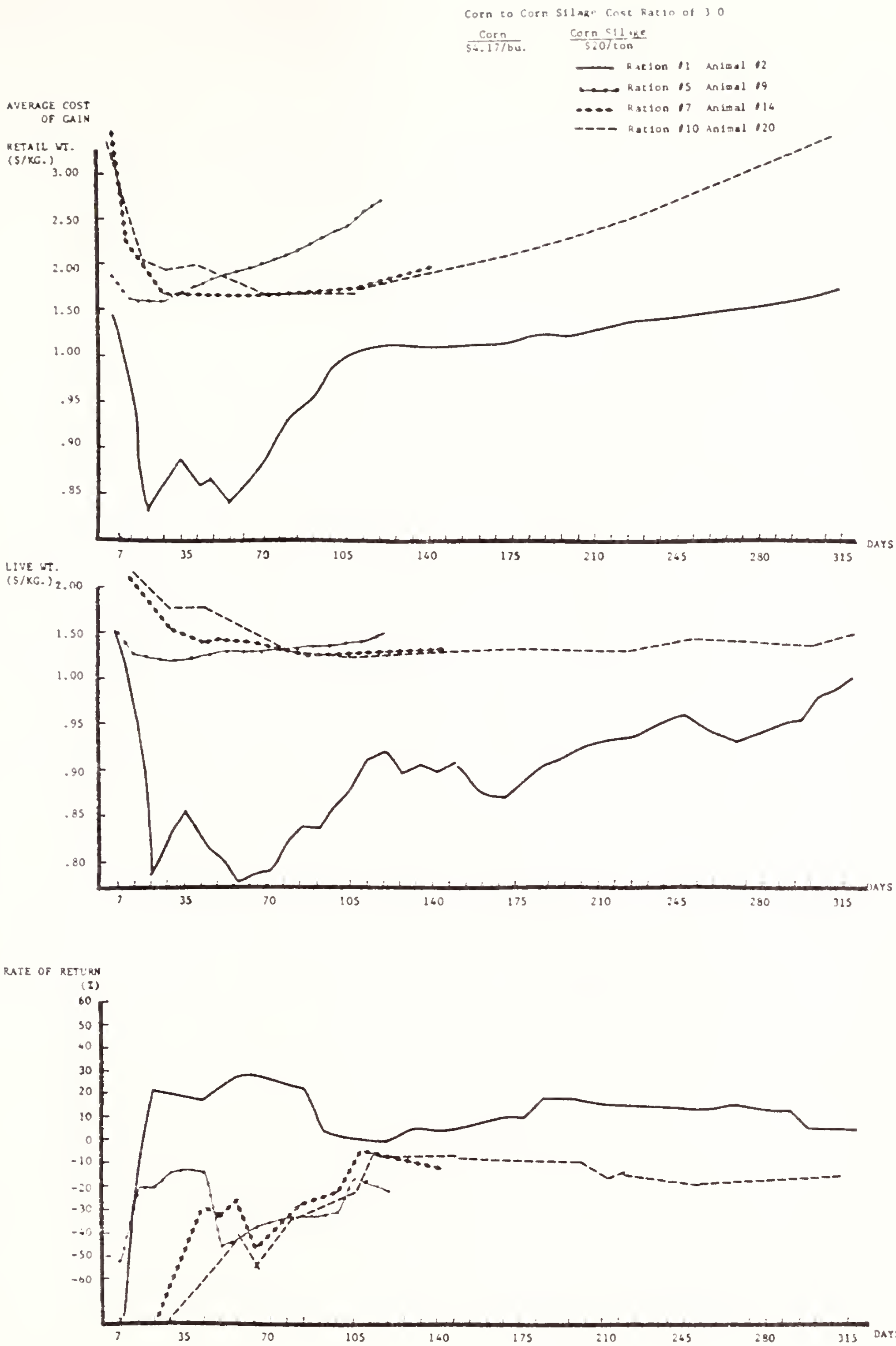


Figure 6.18. Comparisons of the average cost of gain for retail weight and live weight growth, as well as, rate of return on the total invested cost for feeding trial steers #2, #9, #14, and #20 fed rations #1, #5, # . and #10 respectively (used a three week moving average for live weight for calculation of cost and revenue relationships).

#5, #7, and #10. These results were more erratic, and therefore, more difficult to evaluate for general relationships of cost and profitability than the predicted live weight and feed consumption procedure that was used to draw the conclusions of this study.

Application of Cost and Revenue Relationships in Determining the Optimum Time for Marketing Slaughter Cattle.

Several cost and revenue relationships were calculated in order to evaluate the use of such relationships in detecting the optimum time to market slaughter cattle by foresight rather than hindsight. In theory, when marginal net revenue (MNR) equals 0, which is when marginal cost (MC) equals marginal revenue (MR), the point of maximum profit per head is reached.[3] Profit maximization per unit of time is theoretically when marginal net revenue equals average net revenue (ANR).[4] The author found it to be difficult to apply the above theoretical principles for assisting in the marketing of feedlot cattle. The difficulty is created from the variation from week to week in animal performance which directly affects the degree of consistency of the cost and revenue relationships evaluated. An attempt was made to even out the weekly variation effect by using a 3-week moving average of live weight. This procedure eliminated some variation, but not enough to make it possible to effectively use MNR and ANR in determining time to market slaughter cattle.[5] Perhaps better results could have been achieved by using a 3-week moving average of dry matter feed consumption, as well as, for live weight. Also, the data of this study were taken for individual animals. The variation due to fill differences

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[3] MNR = MR - MC.

[4] ANR = TNR/Unit of Weight Gain.

[5] See Figure 6.18.

at weekly weighings, environmental effects, and animal performance could be partially eliminated by working with a larger sample size of cattle per ration fed.

A rate of return desired (RRD) factor was also computed by the market decision model. From the RRD, sel price desired (SPD) values and total net revenue expected (TNRLE) values were calculated. This study used a RRD of .10 to compare with the actual rate of return (RRL). The RRD figure could be a useful tool in marketing feedlot cattle by providing a goal of level of profitability for a cattle feeder which adjust for the time span of the investment, as well as the variation in the total invested cost between different groups of feedlot cattle. The generated TNRLE and SPD figures calculated from RRD can provide an immediate market guide comparable to market knowledge at that time, such as the actual breakeven price (SBEPL) and the actual total net revenue that could be obtained at that time.

Conclusion

The results of this study support the practice that it is most profitable to feed feedlot cattle to the Choice quality grade under either criterion of maximum profit per head or maximum profit per unit of time on feed. The marginal revenue in going from the Good quality grade to the Choice quality grade always exceeded the marginal cost of doing so using a Good to Choice positive price spread of $0.071 per Kg. Maximizing profit per unit of time indicated a faster turnover rate of feedlot cattle than if the criterion of maximum profit per head was used. The average costs of live weight gain and retail meat product weight gain were found to be increasing in most all cases evaluated at the point where maximum profitability and/or where the Choice quality grade were realized. The average cost per Kg. of retail meat product weight gain reacted more dramatically to changes in the ration cost than live weight cost of gain, as well as, increased at a faster rate indicating the decision to market feedlot cattle could occur sooner (probably within the Choice quality grade) if cost and revenue relationships were formulated and evaluated on the retail weight basis.

Furthermore, this study indicates that the rate of substitution between grain and forages in feedlot rations in search for the most economical ration to feed with changes in the price of grain relative to the price of roughage goes from one forage - grain balance extreme to the other. The rate of substitution was not found to be gradual with a change in the relative price of corn to corn silage since the mid-range rations containing 30 percent to 60 percent concentrate were less economical to feed resulting in less profit and higher cost of gain than to feed one of the more extreme forage - grain balanced rations fed.

The study also found the price of grain relative to roughage must be much higher than what has occurred historically to justify a switch from feeding a high energy concentrate ration above 60 percent grain to a low energy concentrate ration below 20 percent grain. In this study, the shift did not occur until the corn to corn silage cost ratio, on basis of cost per Kg. of dry matter feed, reaches 3.0. This ratio represented $0.1634 per Kg. ($4.15 per bushel) cost for corn and $0.0220 per Kg. ($20.00 per ton) cost for corn silage. Generally in the past the corn to corn silage cost ratio has been approximately 1.5, equivalent to $2.08 per bushel corn and $20.00 per ton corn silage, and in many instances less.

Suggested Areas of Further Research Relating to the Implications of Feeding Alternative Forage - Grain Balanced Rations to Feedlot Cattle.

Several advanced studies and improved procedures can be constructed from this study. One suggestion is to investigate the effects of change in cattle price margins, such as between Good and Choice quality grades and between the purchase and sell price, on the cost and revenue relationships developed in this study. Further emphasis could be placed on making live cattle marketing and feeding decisions from carcass and retail cost and revenue relationships. This would require more precision in predicting retail product weight gain from factors during the live feeding period. A similar study is suggested with application of results from a feeding trial containing a larger sample size of feedlot cattle. Feeding cattle various combinations of energy concentrate rations should be investigated as well. If possible, a method of comparing concentrates and roughages on an equivalent feed value basis could be incorporated so the results can be comparable to most any feedstuff and not pertain merely to the feedstuff used in the study. The price relationship between grain and roughages, as affected by future energy usage and costs for their production, could be studied in consideration of their feed value to cattle. Research in the area of ration formulation for feedlot cattle could be made for various types of cattle in terms of small frame type cattle versus large frame type cattle, since the animal feedlot performance could be different between such types of cattle when fed similar rations.

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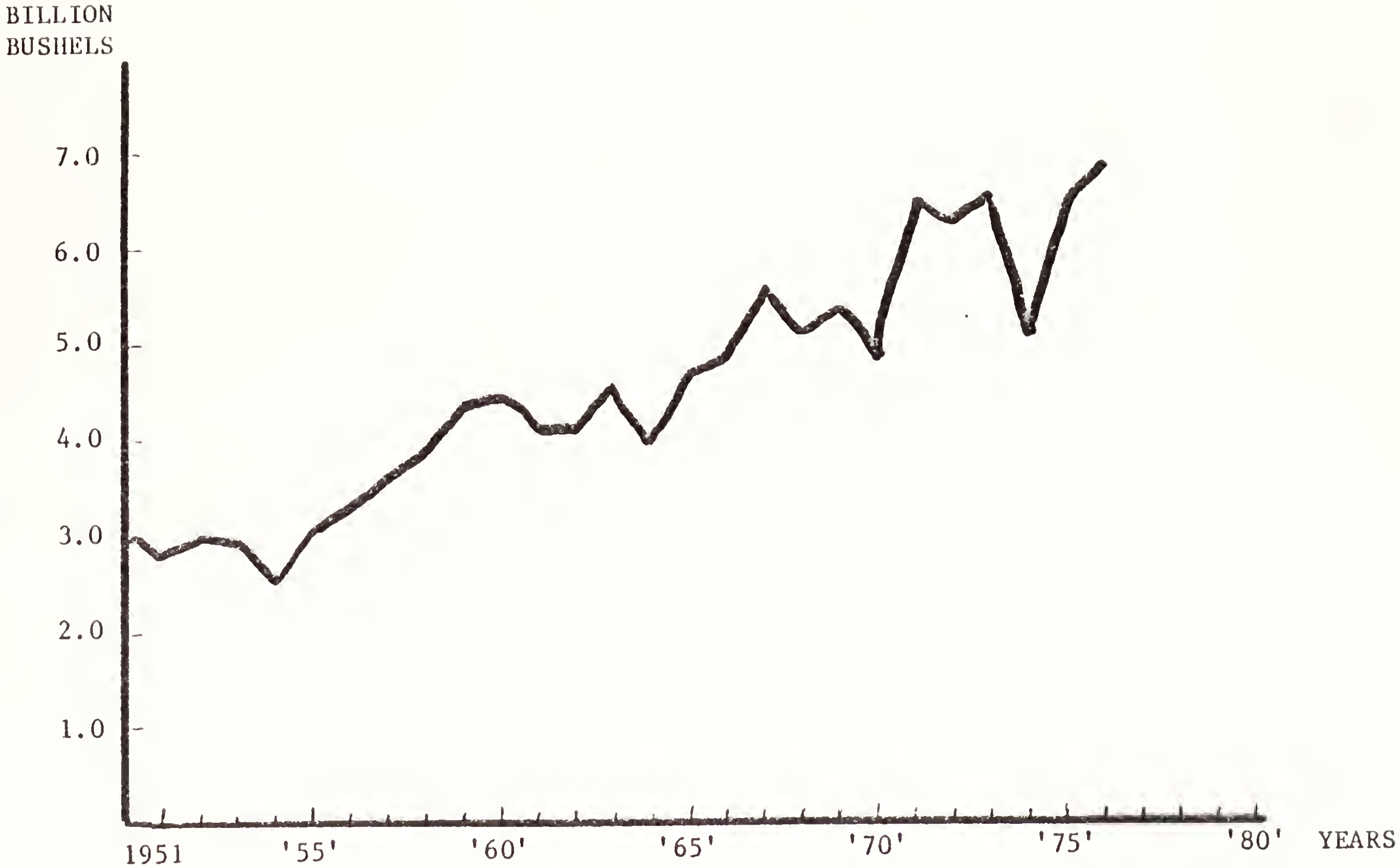
Appendix A

Growth of Feedlot Production

Appendix Table 1: Number of cattle feedlots and fed cattle marketed, 23 State, 1962 to 1976.[1]

Year	Total All Feedlots	
	Lots	Cattle Marketed
	Number	1,000 Head
1962	230,804	14,560
1963	227,263	15,918
1964	219,244	17,366
1965	215,422	17,926
1966	208,510	19,534
1967	201,173	20,942
1968	195,247	22,662
1969	185,527	23,860
1970	176,817	24,884
1971	165,237	25,281
1972	154,536	26,853
1973	146,220	25,304
1974	137,737	23,330
1975	137,029	20,504
1976	134,417	24,180

[1]U.S., Department of Agriculture, Economic Research Service - Statistical Research Service, Livestock and Meat Statistics, Statistical Bulletin No. , Washington D.C.



Appendix Figure 1. United States total corn and grain sorghum production, 1950-1976.[2]

[2] U.S.,Department of Agriculture, Crop Reporting Board, Statistical Reporting Service, _Crop Production: Annual Summary - Acreage, Yield, Production_, Washington D.C. (1950-1976).

Appendix B

Feed Resource Utilization by Cattle

Appendix Table 2. Total feed consumption measured in feed units by all beef cattle, cattle on feed for the slaughter market, and other beef cattle, selected years 1965/66 to 1976/77. [a]

Year beginning Oct. 1	Feed grains: Corn	Feed grains: Sorghum grains	Feed grains: Oats	Feed grains: Barley	Feed grains: Wheat and rye	Byproduct feed ingredients	Total feed concentrates	Harvested roughage	Pasture	Total all feed
	- - - - Thousand tons - - - -									
All beef cattle:										
1965/66	17,932	7,255	981	1,653	923	4,431	33,175	32,550	169,973	235,698
1966/67	12,552	10,604	875	3,620	1,017	4,241	32,909	34,195	172,277	239,381
1967/68	18,166	9,173	920	2,032	1,709	4,897	36,897	35,412	171,210	243,519
1968/69	21,062	11,080	1,099	2,384	2,266	5,880	43,771	37,296	167,660	248,727
1969/70	26,186	11,761	1,148	2,640	3,126	6,621	51,482	38,183	180,061	269,726
1970/71	21,456	13,264	1,286	3,241	3,469	6,798	49,514	43,563	186,747	279,824
1971/72	26,662	13,920	1,415	3,279	4,469	7,502	57,247	36,630	192,184	286,061
1972/73	34,886	13,628	1,125	2,769	2,905	7,904	63,217	37,422	196,448	297,087
1973/74	37,299	13,952	1,437	3,094	1,328	8,989	66,099	40,341	206,493	312,933
1974/75 1/	19,977	6,437	990	1,794	1,250	6,994	37,442	49,863	230,338	317,643
1975/76*	24,619	8,343	1,076	2,001	2,709	6,480	45,228	61,795	208,630	315,653
Cattle on feed:										
1965/66	13,425	6,343	321	1,275	857	2,569	24,790	8,825	6,203	39,818
1966/67	9,061	8,717	280	2,922	949	2,895	24,824	10,152	7,499	42,475
1967/68	13,982	8,179	320	1,624	1,625	3,070	28,750	10,809	3,515	43,074
1968/69	16,931	10,055	433	1,969	2,178	3,804	35,370	11,382	626	47,378
1969/70	21,229	10,702	460	2,193	3,010	4,397	41,991	8,099	---	50,090
1970/71	16,792	11,943	479	2,645	3,325	4,407	39,591	8,946	---	48,537
1971/72	21,893	12,737	588	2,751	4,312	5,057	47,338	5,459	---	52,797
1972/73	28,926	12,543	490	2,352	2,812	5,462	52,585	2,658	---	55,243
1973/74	29,466	12,509	523	2,499	1,254	5,656	51,907	524	---	52,431
1974/75 1/	14,428	5,422	275	1,327	1,153	3,853	26,458	12,229	---	38,687
1975/76*	18,476	7,242	333	1,530	2,568	3,666	33,815	19,544	---	53,359
Other beef cattle:										
1965/66	4,507	912	660	378	66	1,862	8,385	23,725	163,770	195,880
1966/67	3,491	1,130	595	698	68	2,103	8,085	24,043	164,778	196,906
1967/68	4,184	994	600	408	84	1,877	8,147	24,603	167,695	200,445
1968/69	4,131	1,025	666	415	88	2,076	8,401	25,914	167,034	201,349
1969/70	4,957	1,059	688	447	116	2,224	9,491	30,084	180,061	219,636
1970/71	4,664	1,321	807	596	144	2,391	9,923	30,470	186,747	227,140
1971/72	4,769	1,183	827	528	157	2,445	9,909	31,171	192,184	233,264
1972/73	5,960	1,085	635	417	93	2,442	10,632	34,764	196,448	241,844
1973/74	7,833	1,443	914	595	74	3,333	14,192	39,817	206,493	260,502
1974/75 1/	5,729	1,015	715	467	97	2,961	10,984	37,634	230,338	278,956
1975/76*	6,143	1,101	743	471	141	2,814	11,413	42,251	208,630	262,294

1/ Preliminary. *Projected.

Fds-262, September 1976

[a] Source: U.S., Department of Agriculture, Economic Research Service, Feed Situation, Fds-264, Washington, D.C. (Feb. 1977), 4.

Appendix Table 3. Total feed unit consumption to liveweight beef production 1965/66-1975/76.[a]

Year beginning Oct. 1	Total feed unit consumption	Total liveweight production	Feed units to liveweight production
	Thousand tons	Million pounds	Pounds
All beef cattle:			
1965/66	235,698	34,658	13.60
1966/67	239,381	35,768	13.39
1967/68	243,519	36,365	12.90
1968/69	248,727	36,923	13.47
1969/70	269,726	38,700	13.94
1970/71	275,677	39,296	14.03
1971/72	286,152	40,702	14.06
1972/73	297,087	41,073	14.47
1973/74	312,933	42,269	14.31
1974/75 1/	317,643	41,119	15.45
1975/76 1/	311,425	40,170	15.51
Cattle on feed:			
1965/66	39,818	9,889	8.05
1966/67	42,475	10,394	8.17
1967/68	43,074	11,471	7.51
1968/69	47,378	12,161	7.79
1969/70	50,090	12,417	8.07
1970/71	48,537	12,725	7.63
1971/72	52,797	13,631	7.75
1972/73	55,243	12,894	8.57
1973/74	52,431	10,922	9.60
1974/75 1/	38,686	8,973	8.62
1975/76 1/	49,131	11,800	8.33
Other beef cattle:			
1965/66	195,880	24,769	15.82
1966/67	196,906	25,374	15.52
1967/68	200,445	24,894	16.10
1968/69	201,349	24,762	16.26
1969/70	219,636	26,283	16.71
1970/71	227,140	26,571	17.10
1971/72	233,264	27,071	17.23
1972/73	241,844	28,179	17.16
1973/74	260,502	31,347	16.62
1974/75 1/	278,956	32,146	17.36
1975/76 1/	262,294	28,370	18.49

1/ Preliminary.

[a] Source: U.S., Department of Agriculture, Econ. Research Service, Feed Situation, Fds-264, Washington, D.C. (Feb. 1977), 4.

Appendix C

Energy Resource Utilization in Beef Production

Appendix Table 4. Cultural energy inputs for Colorado feed crops (All figures in Mcal - 1000 Kcal. - per acre unless otherwise noted).

	Irrigated Corn	Irrigated Corn Silage	Irrigated Alfalfa Hay	Irrigated Pasture	Dryland Wheat	Dryland Milo	Dryland Forage Pasture
Preharvest Fieldwork	260	260	45	19	160	160	120
Fertilizer	760	760	43	990		280	
Irrigation Power	2000	1700	4700	3400			
Harvest	130	82	240		78	79	
Grain Drying	250[2]						
Machinery Depreciation	370	320	640	400	74	88	33
Total Input:	3800	3100	5600	4900	300	600	160
Yield (lb./A)[3]	6000	11000[4]	8600	9000	1500	1600	2400
Input (Mcal/lb.)	0.63	0.27	0.65	0.54	0.19	0.38	0.06
Mcal cultural energy/Mcal net energy gain	0.70	0.44	1.48		—	0.64	0.26
Assumptions[1]							
Irrigation							
(A-in. Net Application)	12	10	28	18	—	—	—
Fertilizer (per yr.)							
lb. N per A	120	120	—	170	—	40	—
lb. P_2O_5 per A	50	50	33	50	—	20	—

1. All irrigation is sprinkler with electric power and well depth of 190 ft. (after draw down)
2. Initial moisture content assumed of 22%.
3. Yields based on Colorado averages (1975 Colorado Agri. Statistics.)
4. Field weight of 34,000 lb. per A. reduced to 90% dry matter composition.

Appendix Table 5. Energy inputs for alternate beef production systems.

Production System	Energy Use Mcal/lb. Gain
Cow-Calf	
Range - High Plains - No supplement	0.71
Range - High Plains - Min. supplement	2.95
Dairy bull calves	1.24
Confinement year around	5.97
Yearling	
Range - High Plains - No supplement	0.70
Range - Mountains - No supplement	0.78
Mountain meadow pasture	2.35
Sprinkler irrigated pasture	6.10
Feedlot	
Feedlot operation	0.30
Corn silage ration (well irrigation)	2.35
Corn silage (surface irrigation)	1.98
Corn grain (90%) ration (well irrigation)	3.07
Corn grain ration (from Nebraska)	2.18
Flaked corn ration (sprinkler irrigation)	5.00

Appendix Table 6. Energy use by some combinations of management systems and efficiency of conversion to edible beef.

Growth Period: Birth-100 lb.	400-700 lb.	700-1,100 lb.	Total	Mcal input / Mcal retail beef
Range-no suppl 284	Range-no suppl 230	Range 403	967	1.9
Range-suppl 885	Range 290	Feedlot-silage 1060	2230	4.4
Range suppl 885	Irrigated pasture 1830	Feedlot-corn (Irr.) 1348	4060	8.1
Dairy Calf 398	Range-min 260	Feedlot-corn 1348	2030	4.0
Confinement 2788	Irrigated pasture 1830	Feedlot-flaked corn 2120	6740	13.4

Appendix D

Explanation of the Use of the JBEEF Computer Model Constructed and Applied in this Study

Input Data Cards #1

Weekly Animal Performance Input Cards

Columns	Label	Below Example Values 1st Card	Below Example Values 2nd Card
1-2	Animal Number	07	07
3-4	Ration Number	04	04
5-6	Weeks on Feed	01	02
7-10	Animal Live Wt. (Kgs.)	278.2	229.8
11-15	Dry Matter Feed Consumption (Kgs.)	45.5	97.9
39-43	3-Week Live Wt. Moving Average (Kgs.)	280.0	294.9

Computer Cards

```
070401278200455                                                   280.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

070402298200979                                                   294.9
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
```

Input Data Card #2

Cost and Price Assumptions
Kept Constant for Complete
Feeding Trial Input Cards

Columns	Label	Below Example Value
2-4	Rate of Interest	.10
9-12	Death Rate	.015
17-20	Acquisition Cost ($)	$5.94
25-27	Rate of Return Desired	.10
31-36	Purchase Price ($/kg.)	1.3229

Computer Cards

.10 .015 5.94 .10 1.3228

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Input Data Cards #3

Weekly Assumed Ration Cost, Cattle Price and Expected Rate of Return Input Cards

Columns	Label	Below Example Values 1st Card	2nd Card	3rd Card
2-6	Ration Cost ($/Kg.)	.1140	.1140	.1140
9-14	Cattle Sell Price ($/Kg.)	1.3228	1.3228	1.2976
18-20	Expected Rate of Return	.10	.10	.10

Computer Cards

```
 .1140      1.3228             .10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

 .1140      1.3228             .10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

 .1140      1.2976             .10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
```

LISTING OF COMPUTER PROGRAMS

```
//XPRS6269 JOB (XXXXXXXX,XXXXXXXX,,9,,1602),'ERICKSON'                    JOB 178
//TWO EXEC PL1LFCLD
//PL1L.SYSIN DD -

KSU0031 REGION SIZE -  256K, MAXIMUM CORE USED -  256K,  TIME =  15.05.58
KSU0041 EXCP COUNT - UR 342     378,  UR 380       0,  DA 251       0,  DA 251       0,  DA 252       8,  UR 301      144
KSU0011 STEP   1 PL1L      EXECUTION TIME =           7.53 SEC    RETURN CODE =     8

//GO.SYSPRIN2 DD SYSOUT=A
//GO.SYSPRIN3 DD SYSOUT=A
//GO.SYSIN DD *
//GO.SPECIN DD *

KSU0031 REGION SIZE -  256K, MAXIMUM CORE USED -  256K,  TIME =  15.06.42
KSU0041 EXCP COUNT - DA 250     165,  DA 254       0,  UR 342      64,  DA 252      10,      DUMMY      ,  UR 346      101
KSU0041 EXCP COUNT - UR 380      46,  UR 347       0,  UR 348      57,  UR 349      51,  UR 303      49,  UR 304       50
KSU0011 STEP   2 GO       EXECUTION TIME =           3.29 SEC    RETURN CODE =     0

KSU0021 JOB XPRS6269 EXECUTION TIME =          10.82 SEC


 HASP-II V3.1 JOB STATISTICS --    247 CARDS READ --     680 LINES PRINTED --     46 CARDS PUNCHED --    COPY   1 OF   1
```

THE LIVE WEIGHT 3-WEEK MOVING AVERAGE PROGRAM

```
JBELF:PROC OPTIONS(MAIN);
DCL 1 TABLE(20),
2 RATION BIN FIXED,
2 WEEK BIN FIXED,
2 WEEKS(0:70),
3 ANIMAL_WT_CM FIXED DEC(8,4),
3 DMFC_CM FIXED DEC(8,4),
3 MAAW FIXED DEC(8,4);
DCL RPW(70) FIXED DEC(8,4);
DCL(SYSPRIN2,SYSPRIN3) FILE PRINT;
DCL (X1,X2,X3,X4,X5,X7,X8,X9) DEC FIXED(8,4);
DCL(R,D,K,CC,PPL,SPL,FC,TNRE,RRD,SPD)FIXED DEC(8,4);
DCL(TC(70),AC_AW,AC_G,MC,TRL(70),TNRL,MRL,MNRL,ANRLD,ANRL,SBEPL,RRL)
FIXED DEC(8,4);
DCL J DEC FIXED;
TABLE=0;
ON ENDFILE(SPECIN) GO TO THERE;
ON ENDFILE(SYSIN) GOTO HERE;
GET FILE(SYSIN) EDIT (INDEX,RATION(I),ANIMAL_WT_CM(I,1),
DMFC_CM(I,1),MAAW(I,1))(COL(1),F(2),F(2),X(2),F(4,1),F(5,1),
COL(39),F(5,1));
DO I=1 TO 1;
DO J=2 BY 1 WHILE(INDEX¬=0);
GET FILE (SYSIN) EDIT (INDEX,RATION(I),ANIMAL_WT_CM(I,J),
DMFC_CM(I,J),MAAW(I,J))(COL(1),F(2),F(2),X(2),F(4,1),F(5,1),
COL(39),F(5,1));
END;
ANIMAL_WT_CM(I+1,1)=ANIMAL_WT_CM(I,J-1);
DMFC_CM(I+1,1)=DMFC_CM(I,J-1)
MAAW(I+1,1)=MAAW(I,J-1);
WEEK(I)=J-2;
END;
HERE:
DO I=1 TO I;
PUT PAGE FILE (SYSPRINT) EDIT ('LIVE WT.','LIVE','LIVE WT.','LIVE',
'DM FEED','DM FEED','DM FEED','3 WEEK','DAYS','LIVEWT','GAIN','ADG',
'GAIN','ADG','CONVERSION','CONVERSION','CONSUMPTION','LIVE WT.',
'DM FEED','TO DATE',
'TO DATE','TO DATE','FOR WEEK','FOR WEEK','TO DATE','FOR WEEK',
'TO DATE','MOV. AVG.',
'(KG)','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)')
(COL(21),A,COL(33),A,COL(41),A,COL(54),A,COL(65),A,COL(78),A,COL(91),A,
COL(104),A,
SKIP,COL(3),A,COL(11),A,COL(22),A,COL(33),A,COL(43),A,COL(54),
A,COL(63),A,COL(76),A,COL(89),A,COL(103),A,SKIP
,A,COL(11),A,COL(21),A,COL(31),A,COL(41),A,COL(52),A,COL(65),A,COL(77),
A,COL(91),A,COL(103),A,SKIP,COL(12),A,COL(22),A,COL(32),A,COL(43),A,
COL(54),A,COL(66),A,COL(79),A,COL(92),A,COL(105),A))
```

```
 26          DO J=2 TO WEEK(I);
 27          PUT SKIP FILE(SYSPRINT) EDIT(((J-1)*7),
             ANIMAL_WT_CM(I,J),
             MAAW(I,J)-MAAW(I,1),
             (MAAW(I,J)-MAAW(I,1))/((J-1)*7),
             MAAW(I,J)-MAAW(I,J-1),
             (MAAW(I,J)-MAAW(I,J-1))/7,
             DMFC_CM(I,J)/(MAAW(I,J)-MAAW(I,1)),
             (DMFC_CM(I,J)-DMFC_CM(I,J-1))/(MAAW(I,J)-MAAW(I,J-1))


                                                                                   PAGE     1
VERSION 5.4                        OS/360 PL/I COMPILER (F)                        DATE 77.202

THE COMPLETE LIST OF OPTIONS USED DURING THIS COMPILATION IS--   EBCDIC
                                                                 CHAR60
                                                               NOMACRO
                                                                 SOURCE2
                                                               NOMACDCK
                                                                 COMP
                                                                 SOURCE
                                                                 ATR
                                                                 XREF
                                                               NOEXTREF
                                                               NOLIST
                                                                 LOAD
                                                               NODECK
                                                                 FLAGW
                                                                 STMT
                                                                 SIZE=0256260
                                                                 LINECNT=060
                                                                 OPT=01
                                                                 SORMGIN=(002,072)
                                                               NOEXTDIC
                                                               NONEST
                                                                 OPLIST
                                                                 SYNCHKT

*OPTIONS IN EFFECT*     EBCDIC,CHAR60,NOMACRO,SOURCE2,NOMACDCK,COMP,SOURCE,ATR,XREF,NOEXTREF,NOLIST,LOAD,
*OPTIONS IN EFFECT*     NODECK,FLAGW,STMT,SIZE=0256260,LINECNT=060,OPT=01,SORMGIN=(002,072),NOEXTDIC,
*OPTIONS IN EFFECT*     NONEST,OPLIST,SYNCHKT
```

```
            ,DMFC_CM(I,J),MAAW(I,J))
            (F(5),COL(11),F(6,1),COL(21),F(6,1),COL(31),F(6,1),COL(42),
            F(8,3),COL(51),F(8,3),COL(63),F(8,3),COL(77),F(8,3),COL(90),F(6,1),
            COL(104),F(6,1));
28          END;
29          END;
30          DO WHILE ('1'B);
31          GET FILE(SPECIN) EDIT (R,D,K,DC,PPL) (COL(1),5 F(7,3));
32          DO I=1 TO 1;
33          RPW=0;
34          RPW(1)=-347.2107+1.90639*ANIMAL_WT_CM(I,1)-
            0.001609*ANIMAL_WT_CM(I,1)**2;
35          TC(1)=(PPL*ANIMAL_WT_CM(I,1)*0.97);
36          TRL(1)=(PPL*ANIMAL_WT_CM(I,1)*0.97);
37          PUT PAGE FILE(SYSPRINT) EDIT('DAYS','TC','TRL','AC/AW','AC/G','MC',
            'MFL','MNRL','ANRL','ANRLD','INRL','INRLE','SBEPL','SPD','RRL','RRD')
            (A,COL(8),A,COL(17),A,COL(23),A,COL(30),A,COL(40),A,COL(47),
            A,COL(55),A,COL(64),A,COL(71),A,COL(80),A,COL(88),A,COL(96),
            A,COL(105),A,COL(112),A,COL(118),A);
38          PUT PAGE FILE(SYSPRIN2)EDIT('RETAIL WT.','RETAIL WT.','RETAIL WT.',
            'RETAIL WT.','DM FEED','DAYS','GAIN','ADG','GAIN','ADG',
            'CONVERSION','RETAIL WT.','ON FEED','TO DATE','TO DATE','FOR WEEK',
            'FOR WEEK','TO RPW TO DATE','TO DATE','(KG)','(KG)','(KG)',
            '(KG)','(KG)','(KG)')
            (COL(11),A,COL(25),A,COL(37),A,COL(50),A,COL(66),A,SKIP,
            COL(2),A,COL(14),A,COL(28),A,COL(40),A,COL(54),A,COL(65),A,
            COL(81),A,SKIP,
            COL(1),A,COL(13),A,COL(26),A,COL(38),A,COL(51),A,COL(63),A,
            COL(83),A,SKIP,
            COL(14),A,COL(27),A,COL(40),A,COL(53),A,COL(67),A,COL(84),A);
39          PUT PAGE FILE(SYSPRIN3) EDIT('DAYS','INRR','AC/R','AC/G_R','MC_R',
            'MR_R','MNR_R','ANR_R')(COL(1),A,COL(9),A,COL(17),A,COL(24),A,
            COL(34),A,COL(43),A,COL(52),A,COL(61),A);
40          PUT SKIP(2)FILE(SYSPRINT);
41          PUT SKIP(2)FILE(SYSPRIN2);
42          PUT SKIP(2)FILE(SYSPRIN3);
43          DO J=2 TO WEEK(I);
44          RPW(J)=-347.2107+1.90639*MAAW(I,J)-0.001609*MAAW(I,J)**2;
45          GET FILE (SPECIN) EDIT (FC,SPL,RRD)(COL(1),3F(7,3));
46          X1=(PPL*ANIMAL_WT_CM(I,1)*0.97);
47          X2=(1+R*J/52);
48          X3=(D);
49          X4=(K);
50          X5=(FC*DMFC_CM(I,J));
51          X6=J/52;
52          X7=(DC*J*7);
53          X8=(R*J/52);
54          TC(J)=(X1*X2)+(X1*X3)+(X4*X2)+X5+((X5*X8)/2)+X7;
55          AC_AW=TC(J)/MAAW(I,J);
56          AC_G=(TC(J)-X1)/(MAAW(I,J)-MAAW(I,1));
57          MC=(TC(J)-TC(J-1))/(MAAW(I,J)-MAAW(I,J-1));
58          TRL(J)=MAAW(I,J)*0.96*SPL;
59          INRL=(TRL(J)-TC(J));
```

```
60          MFL=(TRL(J)-TRL(J-1))/(MAAW(1,J)-MAAW(1,J-1));
61          MNRL=MFL-MC;
62          TNRE=TC(J)*RRC*X6;
63          ANRLD=TNRE/(MAAW(1,J)-MAAW(1,1));
```



```
64          SPD=((TNPL+TC(J))/(MAAW(1,J)*.96))*100;
65          ANRL=TNPL/(MAAW(1,J)-MAAW(1,1));
66          SBEPL=TC(J)/(MAAW(1,J)*0.96)*100;
67          RRL=TNPL/(TC(J)*X6);
68          PUT SKIP FILE(SYSPRINT) EDIT ((J-1)*7,TC(J),TRL(J),AC_AW,AC_G,MC,MRL,
            MNRL,ANRL,ANRLD,TNRL,TNRE,SBEPL,SPD,RRL,RRD)
            (F(4),2 F(8,2),2 F(7,3),F(9,3),F(7,3),2 F(9,3),
            F(7,3),F(9,2),3 F(8,2),F(7,2),F(5,2));
69          PUT SKIP FILE(SYSPRIN2) EDIT((J-1)*7,RPW(J)-RPW(1),
            (RPW(J)-RPW(1))/((J-1)*7),
            RPW(J)-RPW(J-1),(RPW(J)-RPW(J-1))/7,CMFC_CM(1,J)/(RPW(J)-RPW(1)),
            RPW(J))
            (F(5),F(12,1),F(14,2),2 F(13,2),F(16,2),F(15,2));
70          PUT SKIP FILE(SYSPRIN3) EDIT((J-1)*7,TNRL,TC(J)/RPW(J),
            (TC(J)-X1)/(RPW(J)-RPW(1)),
            ((TRL(J)-TRL(J-1))/(RPW(J)-RPW(J-1))),
            ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1))),
            ((TRL(J)-TRL(J-1))/(RPW(J)-RPW(J-1)))-
            ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1))),
            TNRL/(RPW(J)-RPW(1)))
            (COL(1),F(4),F(9,2),2 F(8,3),2 F(9,3),F(10,3),F(9,3));
71          PUT FILE (SYSPUNCH) EDIT (J-1,AC_G,MC,(TC(J)-X1)/(RPW(J)-RPW(1)),
            ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1))))
            (COL(1),F(4), 4 F(7,3));
72          END;
73          END;
74          END;
75          THERE:END;
```

```
JBEEF:PROC OPTIONS(MAIN);                                                    PAGE    5

                                        ATTRIBUTE AND CROSS-REFERENCE TABLE

DCL NO.        IDENTIFIER               ATTRIBUTES AND REFERENCES

7              AC_AH                    AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        55,68

7              AC_G                     AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        56,68,71

2              ANIMAL_WT_CM             IN WEEKS(0:70) IN TABLE(20),AUTOMATIC,ALIGNED,DECIMAL,FIXED
                                        (8,4)
                                        14,17,19,19,27,34,34,35,36,46

7              ANRL                     AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        65,68

7              ANRLD                    AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        63,68

6              D                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        31,48

2              DMFC_CM                  IN WEEKS(0:70) IN TABLE(20),AUTOMATIC,ALIGNED,DECIMAL,FIXED
                                        (8,4)
                                        14,17,20,20,27,27,27,27,50,69

6              FC                       AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        45,50

24             HERE                     STATEMENT LABEL CONSTANT
                                        13

      ********* I                       AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                        15,17,17,17,17,19,19,20,20,21,21,22,24,26,27,27,27,27,27,27,27,27,27
                                        27,27,27,27,27,27,27,27,27,32,34,34,35,36,43,44,44,46,50,55,56,56,57
                                        57,58,60,60,63,63,64,65,65,66,69

      ********* INDEX                   AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                        14,16,17

8              J                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(5,0)
                                        16,17,17,17,19,20,21,22,26,27,27,27,27,27,27,27,27,27,27,27,27,27,27
                                        27,27,27,43,44,44,44,47,50,51,52,53,54,55,55,56,56,57,57,57,57,58,58
                                        59,59,60,60,60,60,62,63,64,64,65,66,66,67,68,68,68,69,69,69,69,69,69
                                        69,69,69,69,69,70,70,70,70,70,70,70,70,70,70,70,70,70,70,70,70,70,70
                                        70,70,70,70,71,71,71,71,71,71,71

1     ********* JBEEF                   ENTRY,BINARY,FIXED(15,0)
```

```
6          K                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            31,49

2          MAAW             IN WEEKS(0:70) IN TABLE(20),AUTOMATIC,ALIGNED,DECIMAL,FIXED
                            (8,4)
```

JBEEF:PROC OPTIONS(MAIN);   PAGE 6

```
DCL NO.    IDENTIFIER       ATTRIBUTES AND REFERENCES

                            14,17,21,21,21,27,27,27,27,27,27,27,27,27,27,27,27,44,44,55,56,56,57
                            57,58,60,60,63,63,64,65,65,66

7          MC               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            57,61,68,71

7          MNRL             AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            61,68

7          MRL              AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            60,61,68

6          OC               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            31,52

6          PPL              AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            31,35,36,46

6          R                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            31,47,53

2 ********** RATION         IN TABLE(20),AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                            14,17

3          RPW              (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            33,34,44,69,69,69,69,69,69,69,69,69,69,69,70,70,70,70,70,70,70,70,70
                            70,70,70,70,71,71,71,71

6          RRD              AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            45,62,68

7          RRL              AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            67,68

7          SBEPL            AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            66,68

6          SPD              AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                            64,68

           SPECIN           FILE,EXTERNAL
                            10,31,45
```

```
 6          SPL                 AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                 45,58

            SYSIN               FILE,EXTERNAL
                                 12,14,17

 4          SYSPRIN2            FILE,EXTERNAL,PRINT
                                 38,41,69

 4          SYSPRIN3            FILE,EXTERNAL,PRINT
                                 39,42,70

        JBEEF:PROC OPTIONS(MAIN);                                   PAGE    7

DCL NO.        IDENTIFIER       ATTRIBUTES AND REFERENCES

               SYSPRINT         FILE,EXTERNAL
                                25,27,37,40,68

               SYSPUNCH         FILE,EXTERNAL
                                71

 2             TABLE            (20)AUTOMATIC,STRUCTURE
                                9

 7             TC               (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                35,54,55,56,57,57,59,62,64,66,67,68,70,70,70,70,70,70,71,71,71

 75            THERE            STATEMENT LABEL CONSTANT
                                11

 6             TNRE             AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                62,63,64,68

 7             TNRL             AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                59,65,67,68,70,70

 7             TRL              (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                36,58,59,60,60,68,70,70,70,70

 2    ******** WEEK             IN TABLE(20),AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                22,26,43

 2             WEEKS            (0:70)IN TABLE(20),AUTOMATIC,STRUCTURE

 5             X1               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                46,54,54,56,70,71

 5             X2               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                47,54,54

 5             X3               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                48,54

 5             X4               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                49,54
```

```
5              X5                       AUTCMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        50,54,54

               X6                       AUTOMATIC,ALIGNED,DECIMAL,FLOAT(SINGLE)
                                        51,62,67

5              X7                       AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        52,54

5              X8                       AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                        53,54

5              X9                       AUTCMATIC,ALIGNED,DECIMAL,FIXED(8,4)


       JBEEF:PROC CPTICNS(MAIN);                                                  PAGE     8

                          AGGREGATE LENGTH TABLE

STATEMENT NO.  IDENTIFIER               LENGTH IN BYTES

3              RPW                      350

2              TABLE                    21399

7              TC                       350

7              TRL                      350


       JBEEF:PROC CPTIONS(MAIN);                                                  PAGE     9

       STORAGE REQUIREMENTS.
       ---------------------

       THE STORAGE AREA FOR THE PROCEDURE LABELLED JBEEF IS 23180 BYTES LONG.

       THE STORAGE AREA FOR THE CN UNIT AT STATEMENT NO. 10 IS 184 BYTES LONG.

       THE STORAGE AREA FOR THE ON UNIT AT STATEMENT NC. 12 IS 184 BYTES LCNG.

       THE PROGRAM CSECT IS NAMEC JBEEF    AND IS 12724 BYTES LONG.

       THE STATIC  CSECT IS NAMED **JBEEFA AND IS 1362 BYTES LONG.

*STATISTICS*    SOURCE RECORDS =     142,PROG TEXT STMNTS =      75,OBJECT BYTES =    12724
```

```
//XPFS5515 JCB (XXXXXXXX,XXXXXXXX,,5,,1C021,'ERICKSON'                    JOB 670
//THC EXEC PLILFCLD
//PLIL.SYSIN DC *

KSUJC3I REGICN SIZE -  256K, MAXIMUM CORE USED -  256K,  TIME =  18.41.16
KSUJC4I EXCP COUNT - UR 344     367,  UR 381        0,  DA 251        0,  DA 252       0,  DA 252        8,  UR 301     137
KSUOC1I STEP   1 PLIL       EXECUTICN TIME =             7.06 SEC    RETURN CODE =     8

//GC.SYSPRIN2 CD SYSOUT=A
//GO.SYSPRIN3 CD SYSOUT=A
//CO.SYSIN DC *
//GC.SPECIN CD *

KSUJC3I REGION SIZE -  256K, MAXIMUM CORE USED -  256K,  TIME =  18.41.31
KSUOC4I EXCP COUNT - DA 250     185,  DA 254        0,  UR 344       64,  DA 252      10,     DUMMY      ,  UR 345      99
KSUOC4I EXCP COUNT - UR 381      46,  UR 346        0,  UR 347       52,  UR 348      49,  UR 303     49,  UR 304      49
KSUJC1I STEP   2 GO         EXECUTION TIME =             3.13 SEC    RETURN CODE =     0

KSUJC2I JCB XFRS5979 EXECUTICN TIME =           10.19 SEC

HASP-II V3.1 JOB STATISTICS --    239 CARDS READ --      660 LINES PRINTED --     46 CARDS PUNCHED --    COPY    1 OF    1
```

THE PREDICTED LIVE WEIGHT AND FEED CONSUMPTION PROGRAM

```
VERSION 5.4                              OS/360 PL/I COMPILER (F)                                    PAGE      1
                                                                                                     DATE 77.201

THE COMPLETE LIST OF OPTIONS USED DURING THIS COMPILATION IS--   EBCDIC
                                                                  CHAR60
                                                                NOMACRC
                                                                  SOURCE2
                                                                NOMACDCK
                                                                  COMP
                                                                  SOURCE
                                                                  ATR
                                                                  XREF
                                                                NOEXTREF
                                                                NOLIST
                                                                  LOAD
                                                                NODECK
                                                                  FLAGW
                                                                  STMT
                                                                  SIZE=0256260
                                                                  LINECNT=060
                                                                  OPT=01
                                                                  SORMGIN=(002,072)
                                                                NOEXTDIC
                                                                NONEST
                                                                  OPLIST
                                                                  SYNCHKT

*OPTIONS IN EFFECT*     EBCDIC,CHAR60,NOMACRC,SOURCE2,NOMACDCK,COMP,SOURCE,ATR,XREF,NOEXTREF,NOLIST,LOAD,
*OPTIONS IN EFFECT*     NODECK,FLAGW,STMT,SIZE=0256260,LINECNT=060,OPT=01,SORMGIN=(002,072),NOEXTDIC,
*OPTIONS IN EFFECT*     NONEST,OPLIST,SYNCHKT
```

```
1      JBEEF:PROC OPTIONS(MAIN);
2      DCL 1 TABLE(20),
       2 RATION BIN FIXED,
       2 WEEK BIN FIXED,
       2 WEEKS(0:70),
       3 ANIMAL_WT_CM FIXED DEC(8,4),
       3 DMFC_CM FIXED DEC(8,4);
3      DCL RPW(70) FIXED DEC(8,4);
4      DCL(SYSPRIN2,SYSPRIN3) FILE PRINT;
5      DCL (X1,X2,X3,X4,X5,X7,X8,X9) DEC FIXED(8,4);
6      DCL(R,D,K,CC,PPL,SPL,FC,TARE,RRD,SPD)FIXED DEC(8,4);
7      DCL(TC(70),AC_AW,AC_G,MC,TRL(70),TNFL,MRL,MNRL,ANRLD,ANRL,SBEPL,RRL)
       FIXED DEC(8,4);
8      DCL J DEC FIXED;
9      TABLE=0;
10     ON ENDFILE(SPECIN) GO TO THERE;
12     ON ENDFILE(SYSIN) GOTO HERE;
14     GET FILE(SYSIN) EDIT (INDEX,RATION(I),ANIMAL_WT_CM(I,1),
       DMFC_CM(I,1))(COL(1),F(2),F(2),X(2),F(4,1),F(5,1));
15     DO I=1 TO I;
16     DO J=2 BY 1 WHILE(INDEX¬=0);
17     GET FILE (SYSIN) EDIT (INDEX,RATION(I),ANIMAL_WT_CM(I,J),
       DMFC_CM(I,J))(COLUMN(1),F(2),F(2),X(2),F(4,1),F(5,1));
18     END;
19     ANIMAL_WT_CM(I+1,1)=ANIMAL_WT_CM(I,J-1);
20     DMFC_CM(I+1,1)=DMFC_CM(I,J-1);
21     WEEK(I)=J-2;
22     END;
23     HERE:
       DO I=1 TO 1;
24     PUT PAGE FILE (SYSPRINT) EDIT ('LIVE WT.','LIVE','LIVE WT.','LIVE',
       'DM FEED','DM FEED','DM FEED','DAYS','LIVE WT','GAIN','ADG','GAIN',
       'ADG','CONVERSION','CONVERSION','CONSUMPTION','ON FEED','TO DATE',
       'TO DATE','TO DATE','FOR WEEK','FOR WEEK','TO DATE','FOR WEEK',
       'TO DATE','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)','(KG)')
       (COL(21),A,COL(33),A,COL(41),A,COL(54),A,COL(65),A,COL(78),A,COL(91),A,
       SKIP,COL(3),A,COL(11),A,COL(22),A,COL(33),A,COL(43),A,COL(54),
       A,COL(63),A,COL(76),A,COL(89),A,SKIP
       ,A,COL(11),A,COL(21),A,COL(31),A,COL(41),A,COL(52),A,COL(65),A,COL(77),
       A,COL(91),A,SKIP,COL(12),A,COL(22),A,COL(32),A,COL(43),A,COL(54),A,
       COL(66),A,COL(79),A,COL(92),A));
25     DO J=2 TO WEEK(I);
26     PUT SKIP FILE(SYSPRINT) EDIT(((J-1)*7),
       ANIMAL_WT_CM(I,J),
       ANIMAL_WT_CM (I,J)-ANIMAL_WT_CM (I,1),
       (ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,1))/((J-1)*7),
       ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,J-1),
       (ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,J-1))/7,
       DMFC_CM(I,J)/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,1)),
       (DMFC_CM(I,J)-DMFC_CM(I,J-1))/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,J-1))
       ,DMFC_CM(I,J))
       (F(5),COL(11),F(6,1),COL(21),F(6,1),COL(31),F(6,1),COL(42),
       F(8,3),COL(51),F(3,3),COL(63),F(8,3),COL(77),F(3,3),COL(91),F(5,1));
```

```
27              END;
28              END;
29              DO WHILE ('1'B);
30              GET FILE(SPEC(N)) EDIT (R,C,K,OC,PPL) (COL(1),5 (F(7,3)));
```



```
31              DO I=1 TO I;
32              RPW=0;
33              RPW(I)=-347.2107+1.90639*ANIMAL_WT_CM(I,1)-
                0.001609*ANIMAL_WT_CM(I,1)**2;
34              TC(I)=(PPL*ANIMAL_WT_CM(I,1)*0.97);
35              TRL(I)=(PPL*ANIMAL_WT_CM(I,1)*0.97);
36              PUT PAGE FILE(SYSPRINT) EDIT('DAYS','TC','TRL','AC/AW','AC/G','MC',
                'MRL','MNRL','ANRL','ANRLD','TNRL','TNRLE','SBEPL','SPD','RRL','RRD')
                (A,COL(9),A,COL(17),A,COL(23),A,COL(30),A,COL(40),A,COL(47),
                A,COL(55),A,COL(64),A,COL(71),A,COL(80),A,COL(88),A,COL(96),
                A,COL(105),A,COL(112),A,COL(118),A);
37              PUT PAGE FILE(SYSPRIN2)EDIT('RETAIL WT.','RETAIL WT.','RETAIL WT.',
                'RETAIL WT.','CM FEED','DAYS','GAIN','ADG','GAIN','ADG',
                'CONVERSION','RETAIL WT.','CN FEED','TO DATE','TO DATE','FOR WEEK',
                'FOR WEEK','TO RPW TO DATE','TO DATE','(KG)','(KG)','(KG)',
                '(KG)','(KG)','(KG)')
                (COL(11),A,COL(24),A,COL(37),A,COL(50),A,COL(66),A,SKIP,
                COL(2),A,COL(14),A,COL(28),A,COL(40),A,COL(54),A,COL(65),A,
                COL(81),A,SKIP,
                COL(1),A,COL(13),A,COL(26),A,COL(38),A,COL(51),A,COL(63),A,
                COL(83),A,SKIP,
                COL(14),A,COL(27),A,COL(40),A,COL(53),A,COL(67),A,COL(84),A);
38              PUT PAGE FILE(SYSPRIN3) EDIT('DAYS','TNRR','AC/R','AC/G_R','MC_R',
                'MR_R','MNR_R','ANR_R')(COL(1),A,COL(9),A,COL(17),A,COL(24),A,
                COL(34),A,COL(43),A,COL(52),A,COL(61),A);
39              PUT SKIP(2)FILE(SYSPRINT);
40              PUT SKIP(2)FILE(SYSPRIN2);
41              PUT SKIP(2)FILE(SYSPRIN3);
42              DO J=2 TO WEEK(I);
43              RPW(J)=-347.2107+1.90639*ANIMAL_WT_CM(I,J)-
                0.001609*ANIMAL_WT_CM(I,J)**2;
44              GET FILE (SPEC(N)) EDIT (FC,SPL,RRD)(COL(1),3F(7,3));
45              X1=(PPL*ANIMAL_WT_CM(I,1)*0.97);
46              X2=(1+R*J/52);
47              X3=(C);
48              X4=(K);
49              X5=(FC*DMFC_CM(I,J));
50              X6=J/52;
51              X7=(CC*J*7);
52              X8=(R*J/52);
53              TC(J)=(X1*X2)+(X1*X3)+(X4*X2)+X5+((X5*X8)/2)+X7(
54              AC_AW=TC(J)/ANIMAL_WT_CM(I,J);
55              AC_G=(TC(J)-X(I)/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,1));
```

```
56        MC=(TC(J)-TC(J-1))/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,J-1));
57        TRL(J)=ANIMAL_WT_CM(I,J)*0.96*SPL;
58        TNRL=(TPL(J)-TC(J));
59        MRL=((RL(J)-TRL(J-1))/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,J-1));
60        NNRL=MRL-MC;
61        TNPE=TC(J)*RPD*X6;
62        ANFLD=TNPE/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,1));
63        SPD=((TNRE+TC(J))/(ANIMAL_WT_CM(I,J)*.96))*100;
64        ANRL=TNRL/(ANIMAL_WT_CM(I,J)-ANIMAL_WT_CM(I,1));
65        SBEPL=TC(J)/(ANIMAL_WT_CM(I,J)*0.96)*100;
66        RFL=TNFL/((C(J)*X6);
67        PUT SKIP FILE(SYSPRINT) EDIT ((J-1)*7,TC(J),TRL(J),AC_AW,AC_G,MC,MRL,
          NNRL,ANRL,ANRLD,TNRL,TNRE,SBEPL,SPD,RRL,RRD)
          (F(4),2 F(8,2),2 F(7,3),F(9,3),F(7,3),2 F(9,3),
```

JBEEF:PROC OPTIONS(MAIN); PAGE 4

```
          F(7,3),F(9,2),3 F(8,2),F(7,2),F(5,2));
68        PUT SKIP FILE(SYSPRIN2) EDIT((J-1)*7,RPW(J)-RPW(1),
          (RPW(J)-RPW(1))/((J-1)*7),
          RPW(J)-RPW(J-1),(RPW(J)-RPW(J-1))/7,DMFC_CM(I,J)/(RPW(J)-RPW(1)),
          RPW(J))
          (F(5),F(12,1),F(14,2),2 F(13,2),F(16,2),F(15,2));
69        PUT SKIP FILE(SYSPRIN3) EDIT((J-1)*7,TNRL,TC(J)/RPW(J),
          (TC(J)-X1)/(RPW(J)-RPW(1)),
          ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1))),
          ((TRL(J)-TRL(J-1))/(RPW(J)-RPW(J-1))),
          (((TRL(J)-TRL(J-1))/(RPW(J)-RPW(J-1)))-
          ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1)))),
          TNRL/(RPW(J)-RPW(1)))
          (COL(1),F(4),F(9,2),2 F(8,3),2 F(9,3),F(10,3),F(9,3));
70        PUT FILE (SYSPUNCH) EDIT (J-1,AC_G,MC,(TC(J)-X1)/(RPW(J)-RPW(1)),
          ((TC(J)-TC(J-1))/(RPW(J)-RPW(J-1))))
          (COL(1),F(4), 4 F(7,3));
71        END;
72        END;
73        END;
74        THERE:END;
```

JBEEF:PROC OPTIONS(MAIN); PAGE 5

ATTRIBUTE AND CROSS-REFERENCE TABLE

DCL NO.	IDENTIFIER	ATTRIBUTES AND REFERENCES
7	AC_AW	AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4) 54,67

```
7              AC_G             AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                55,67,70

2              ANIMAL_WT_CM     IN WEEKS(C:70) IN TABLE(20),AUTOMATIC,ALIGNED,DECIMAL,FIXED
                                (8,4)
                                14,17,19,19,26,26,26,26,26,26,26,26,26,26,26,26,26,33,33,34,35,43,43
                                45,54,55,55,56,56,57,59,59,62,62,63,64,64,65

7              ANRL             AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                64,67

7              ANRLD            AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                62,67

6              C                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                30,47

2              DMFC_CM          IN WEEKS(C:70) IN TABLE(20),AUTOMATIC,ALIGNED,DECIMAL,FIXED
                                (8,4)
                                14,17,20,20,26,26,26,26,49,68

6              FC               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                44,49

23             HERE             STATEMENT LABEL CONSTANT
                                13

     ********* I                AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                15,17,17,17,19,19,20,20,21,23,25,26,26,26,26,26,26,26,26,26,26,26,26
                                26,26,26,26,26,31,33,33,34,35,42,43,43,45,49,54,55,55,56,56,57,59,59
                                62,62,63,64,64,65,68

     ********* INDEX            AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                14,16,17

8              J                AUTOMATIC,ALIGNED,DECIMAL,FIXED(5,0)
                                16,17,17,19,20,21,25,26,26,26,26,26,26,26,26,26,26,26,26,26,26,26,26
                                42,43,43,43,46,49,50,51,52,53,54,54,55,55,56,56,56,56,57,57,58,58,59
                                59,59,59,61,62,63,63,64,65,65,66,67,67,67,68,68,68,68,68,68,68,68,68
                                68,68,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69,69
                                69,70,70,70,70,70,70,70

1    ********* JREEF            ENTRY,BINARY,FIXED(15,0)

6              K                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                30,48

7              MC               AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
```

```
DCL NO.          IDENTIFIER                 ATTRIBUTES AND REFERENCES

                                            56,60,67,70

7                MNRL                       AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            60,67

7                MRL                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            59,60,67

6                OC                         AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            30,51

6                PPL                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            30,34,35,45

6                R                          AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            30,46,52

2      ********* RATION                     IN TABLE(20),AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                            14,17

3                RPW                        (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            32,33,43,68,68,68,68,68,68,68,68,68,68,68,69,69,69,69,69,69,69,69,69
                                            69,69,69,69,70,70,70,70

6                RRD                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            44,61,67

7                RRL                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            66,67

7                SBEPL                      AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            65,67

6                SPD                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            63,67

                 SPECIN                     FILE,EXTERNAL
                                            10,30,44

6                SPL                        AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                            44,57

                 SYSIN                      FILE,EXTERNAL
                                            12,14,17

4                SYSPRIN2                   FILE,EXTERNAL,PRINT
                                            37,40,68

4                SYSPRIN3                   FILE,EXTERNAL,PRINT
                                            38,41,69
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                 SYSPRINT                            FILE,EXTERNAL
                                                     24,26,36,39,67

                 SYSPUNCH                            FILE,EXTERNAL


          JREEF:PROC OPTIONS(MAIN);                                                                   PAGE      7

DCL NO.          IDENTIFIER                          ATTRIBUTES AND REFERENCES

                                                     70

2                TABLE                               (20)AUTOMATIC,STRUCTURE
                                                     9

7                TC                                  (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     34,53,54,55,56,56,58,61,63,65,66,67,69,69,69,69,69,69,70,70,70

14               THERE                               STATEMENT LABEL CONSTANT
                                                     11

6                TNRE                                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     61,62,63,67

7                TNRL                                AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     58,64,66,67,69,69

7                TPL                                 (70)AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     35,57,58,59,59,67,69,69,69,69

2      ********* WEEK                                IN TABLE(20),AUTOMATIC,ALIGNED,BINARY,FIXED(15,0)
                                                     21,25,42

2                WEEKS                               (0:70)IN TABLE(20),AUTOMATIC,STRUCTURE

5                X1                                  AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     45,53,53,55,69,70

5                X2                                  AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     46,53,53

5                X3                                  AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     47,53

5                X4                                  AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     48,53

5                X5                                  AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)
                                                     49,53,53
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	X6	AUTOMATIC,ALIGNED,DECIMAL,FLOAT(SINGLE) 50,61,66
5	X7	AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4) 51,53
5	X8	AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4) 52,53
5	X9	AUTOMATIC,ALIGNED,DECIMAL,FIXED(8,4)

JBEEF:PROC OPTIONS(MAIN); PAGE 8

AGGREGATE LENGTH TABLE

STATEMENT NO.	IDENTIFIER	LENGTH IN BYTES
3	RPW	350
2	TABLE	14280
7	TC	350
7	TRL	350

THE ECONOMIC IMPLICATIONS OF FEEDING VARIOUS RATION ENERGY CONCENTRATION DIETS TO FEEDLOT CATTLE

by

JAMES C. BUCHANAN

B.S., Kansas State University, 1975

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

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1978

The circumstances of high grain prices and low cattle prices experienced in 1974 brought forth questions challenging the economic efficiency in the traditional practice of feeding feedlot cattle high energy concentration rations, i.e., rations high in the proportion of grain relative to roughage. Recent research results on this topic have not been in agreement. More conclusive findings have been presented on economic advantages of feeding high energy rations than lower energy rations under past cost and revenue relationships.

The intent of this study was to further investigate the economic implications involved in feeding various ration energy concentration diets to feedlot cattle. Weekly live weight gain and feed consumption data were taken from a feeding trial study that involved twenty head of Hereford steers fed ten different ration energy concentration diets. A simulated cost and revenue model for feedlot production was developed and used to generate weekly cost and revenue relationships for the feeding trial steers fed various corn to corn silaged balanced rations. Three corn to corn silage cost ratios of 2.0, 3.0, and 4.0 based upon their relative cost per kilogram of dry matter feed, were used in the cost-revenue feedlot model for steers fed each ration. The cost and revenue relationships were compared on the basis of retail (meat) product gain, as well as, for live weight gain during the life of steers fed each ration.

The results of this study found the most economical ration to be the high energy ration when the cost per kilogram of dry matter for corn was twice as high as for corn silage. The economical justification for substituting corn silage for corn came about when the cost of corn used was three times as high as the cost of corn silage. The substitute of corn silage for corn in determining the most economical ration was not gradual, but a dramatic switch from a high concentrate ration to a low concentrate ration. The mid-range corn to corn silage balanced rations were always found to be less economical than one of the extremes. This study also found it to be most profitable in all cases analyzed for the producer to feed to the choice weight.