ECONOMIC ANALYSIS OF ALTERNATIVE APPROACHES TO VERTICAL COORDINATION IN THE BEEF PRODUCTION-MARKETING SYSTEM

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PREFACE

This study is concerned with the efficiency of coordination within the five independent micro sectors and one vertically integrated sector of the fed beef system. The coordinated effeciveness of the fed beef system is measured in terms of the distribution of returns and compatability of initial and intermediate products of its sectors under base 1974 prices and costs, and under varying sets of feedstuff prices. Linear programming was used for modeling the sectors, and lies at the heart of the analysis.

The author owes much to many. Attempts at full recognition often prove impractical and embarrassing, as some contributors are inadvertantly omitted. Those omitted need not feel slighted, because their efforts were noted, appreciated, and not in vain. Those recognized are clearly deserving of mention.

Dr. Wayne D. Purcell, as major adviser, has both my gratitude and thanks for sound guidance in both the academic and non-academic phases of my OSU graduate program. Dr. Purcell is also recognized for extending patience, understanding, and encouragement at all times. The expertise, suggestions, guidance, and support from the members of my committee, Dr. Paul D. Hummer, Dr. Gerald Lage, and Dr. Darrell D. Kletke, were vital to my program. The contributions of all faculty members to my development, both in and out of the classroom, are also recognized.

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This study taxed the patience and abilities of many past and present members of the secretarial and statistical laboratory staffs. Many in this group cannot be appropriately recognized because the workload was divided among many over a period of time. Recognition, however, can be dutifully accorded to Mrs. Marilyn Wheeler, Mrs. Ginny Gann, and Ms. Reye Stucker. Mrs. Grayce Wynd is also recognized for excellence in typing the final draft.

The extended friendships and contributed expertise of past and present fellow graduate students is recognized. Their names, too, are best not recognized for fear of slighting. Those most deserving know who they are.

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CHAPTER I

INTRODUCTION

The Current Situation

The fed-beef industry is important to the nation, not only as the most popular source of red meat, but through its direct and indirect contributions to the GNP and employment. Beef production is crucially important to the State of Oklahoma, because it makes the best use of resources for which there is little alternative employment.

In Oklahoma, the production of fed beef is the leading contributor to agricultural income (46). In this study, reference to the fed beef system includes the entire set of feeder calf producing, feeding, packing, and carcass-breaking sectors. The suppliers of grain and non-feed inputs and the retail outlets of lean meat are exogenous in this study. If the income provided and generated to these sectors could be measured, the contributions of the fed beef system to the economy of the state would be significantly greater than that reported.

There were 73,000 cattle farms in Oklahoma in 1974 (64). These cattle farms produced 2.415 million calves in 1974 (66). The 450 feed lots in the state fed 564,000 head in 1974 (66). In addition to the calves produced in the state, 1.5 million calves were shipped into the state in 1974 (66).

The slaughter capacity within the state has also increased in recent years. In 1965, there were four federally inspected slaughter plants and 70 other slaughter plants, for a total of 74 slaughter plants in the state (70). In 1974, there were 14 federally inspected slaughter plants and 163 other plants, for a total of 177 slaughter plants in the state (68). Breaker-boner capacity has increased in the last few years.

It is readily apparent that Oklahoma is a key state in beef production. The cited statistics mean that changes in any of the endogenous or exogenous variables surrounding the organization of beef production and consumption will have direct effects upon Oklahoma's economy.

Inefficiencies in beef production and marketing have been documented by both animal scientists and agricultural economists (6)(12)(30)(51)(53)(55). The present open market systems for beef has survived because increasing gains were derived from production efficiencies and increasing consumer demand for its final product. The question of whether the present system for beef production and marketing can continue to survive in its present form is a serious one.

An open market system for any sector of the economy is characterized by self-serving entrepreneurs who adjust levels of resource utilization and production output in accordance with price signals generated from the interactions of demand and supply relationships throughout the system. A dominating characteristic of the open market system is that there are as many decision making and control points as there are entrepreneurs.

The feeder calf producing and feeding sectors of the fed beef system represent as close a real world approximation of the theoretical price system as there is to be found in any sector of the economy. The merits of the price system as the epitome of economic efficiency have been well documented by many distinguished authorities. The following comment by Hayek provides a summary of those merits.

> .....The most significant fact about this system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action. In abbreviated form, by a kind of symbol, only the most essential information is passed on, and passed on only to those concerned. It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of tele-communications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement (28, p. 526).

The fed beef system may be characterized as one in which consumers are sovereign. Their dollar votes constitute price signals for individual cuts of lean beef meat of a given quality grade. These votes become the directing and ruling force within the fed beef system as they determine gross returns at retail for the given quantity of meat available for sale.

In effect, consumer dollar votes determine the retailer's procurement program. The retailer's procurement program determines the quantity and quality dimensions of the carcass breaking sector's demand for carcasses. The carcass breaking sector's demand for carcasses determines the packing sector's demand for fed cattle. The packing sector's demand for fed cattle determines the feeding sector's demand for feeder calves. Over time, the feeding sector's demand for feeder calves determines the composition of the cow herds.

It is recognized that the relatively uncontrollable laws of nature cause lags in response to the price signals throughout all sectors of the fed beef system. In addition, the vagaries of human nature and lack of information cause excessive and undue conflicts among the entrepreneurs within the system. This contributes to both lags and distortions of responses to price signals.

Whatever the cause, lags and distortions are responsible for cycles in production and in the variable flows of products through the marketing system. The result is inefficiency as measured in terms of costs per unit of output and by the ability of the system to reallocate resources efficiently and effectively. The inevitable result of highly variable price and net revenue patterns is realized by all sectors of the fed beef system, and by the consumers of its products. These results are viewed as failures of the price system to provide for the coordination of the products both within and outside the fed beef system. These failures of the price system are not necessarily unique to the fed beef system, as at least two authors have stated that the role of the price mechanism is being diminished and is being replaced by administrative agreements within the open market system (8)(26).

Alternative arrangements of organizing the sectors of the fed beef system may or may not correct the cited ills of the open market system. At the opposite end of the open market spectrum lies the vertically integrated structure. In between these two extremes, there are any number of possible vertical coordination arrangements of the fed beef system. One such arrangment entails the use of contracts to tie two or more sectors of the fed beef system together.

The pressure for integration arises from many quarters and comes in many forms. In 1957, Clifton noted that grocery retail outlets were able to obtain a better bargaining position over packers because of their ability to substitute products. Packers, on the other hand, were not able to substitute products because their only product was meat. The net effect was that packers sought to sustain their profit levels at the feeder stage (7). If a non-optimal flow of fed steers between feeder and packer is not realized at the packer level, an incentive exists for packers to integrate backwards into cattle feeding.

In 1959, Trifton enumerated reasons why a company might try to integrate either forward or backward (62). These included the desire to establish control over either a source of supply or a distributive outlet upon which other companies in the industry depend. It also included the desire to secure an uninterrupted flow of materials (perishable or costly to store), so that a company's productive capacity could be more fully utilized when overhead costs constitute a relatively heavy burden. A prime example of the latter is found in the meat packing industry where butchers are guaranteed a full work week if they work a given number of hours at the beginning of the week.

Trifton also cited capital requirements as a major reason why contracting may be preferred to integration. In 1970, Goodwin stated that packers and feeders were not likely to integrate backward into the cow-calf sector because capital costs are too high (25).

In 1974, Williams and Farris used a set of budgets to compare the open market system against a partially integrated system. Their budgets documented cost savings of up to $10 per head by integrating the feeder calf producing and feeding sectors (74). Their study did not, however, include an overall analysis of the net benefits to be derived from either system alone, or an analysis determining which of the two systems was superior. A recent study by Farris and Couvillion identifies some of the more important considerations in an evaluation of vertical arrangements of the fed beef system (14).

In the contracturally coordinated system, many decisions are foregone conclusions by virtue of contract provisions. Quantity, quality, and flow decisions are made at fewer control points than is the case with the open market exchange system. A control point is considered to be established with every change in ownership or contract. In a vertically integrated system, all decision making regarding quantity, quality, and flow is narrowed down to a single control point.

Problem

Selection of the optimal arrangement for coordinating the sectors of the fed beef system is the key question. The opportunity cost of alternative coordination arrangements to both the sectors and the fed beef system is an important facet of the answer.

A measurable test of economic efficiency between alternative coordinating arrangements is the level of profit realized by each sector after adjustment to some shock(s). A shock constitutes a change in one of the system's endogenous or exogenous variables. Within the fed beef system, profit is a measure of performance. Changes in types of cattle and/or fed weights permit reconciliation of the conventional theory and observed facts. Reconciliation reveals whether the coordinated arrangement under analysis is both realistic and predictive.

An available feed supply is essential in the production of fed beef. Given certain minimal quantities of each, fed beef can be produced with either grain or grass, although there are optimal combinations of both which are best in terms of both nutrition and economics.

The availability of these feedstuffs at any point in time is dependent upon earlier and irreversible decisions of grain producers and the influence of nature on growing conditions. The interdependent relationship between availability and production of feedstuffs and fed beef production is well recognized throughout agriculture.

In this study, the choice of feedstuffs from a nutritional standpoint is not of overriding concern. Documentation supports the assumption that the nutritional intake does not significantly affect the value attributes of the lean cut of meat (24)(47)(50)(61)(75).

Economically, the choice of feedstuffs is important because of its effects on both feed and non-feed costs of production. The important economic questions entail not only determination of the optimum combination of feedstuffs but also the optimum combination of feedstuffs, the type of cattle, and the slaughter weight of cattle. Embodied within these optimality questions is an underlying set of technical relationships.

Technical relationships in beef production are such that a change in the fed weight effects a change in the quality grade, yield grade, and dressing percent of the animal being fed. As the animal is carried to heavier weights, the quality grade and dressing percent improve while the yield grade deteriorates. It is an established biological fact that the heavier the animal, the greater the quantity of feed required for body maintenance (72). Thus, the efficiency of gain deteriorates as the animal's weight increases. These relationships directly affect economic returns to the feeding, packing, and carcass breaking sectors of the fed beef system. By virtue of the derived demand phenomenon, they indirectly affect economic returns to the feeder calf producing sector.

Changes in fed weights are directly related to level of feedstuff consumption. The economically optimum level of feedstuff consumption is determined by the relative relationships of feedstuff prices and fed steer prices. Thus, a change in feedstuff prices, especially grain, has economic consequences for every sector of the fed beef cattle system.

Grain prices are in a constant state of flux throughout the year. The laws of nature alone prohibit the fed beef cattle system from responding to every grain price change. It is questionable whether even perfect knowledge and strict adherence to the laws of economics would have the beef cattle system making responses consistent with economic efficiency to grain price changes because the fed beef system is not a communicatively effective system. Its lack of communicative effectiveness is due to excessive conflicts among the entrepreneurs of that system, as documented by Purcell and associates (51)(53)(12)(55).

A lack of knowledge with regard to the economic implications of alternative ways of effecting coordination exists between the sectors of the fed beef system. Quantitative measures of the changes in profitability to the various sectors of the system under alternative ways of effecting vertical coordination are needed for meaningful analysis and extension efforts. Estimates of the opportunity cost of producing a product that contributes to the output of something other than the optimal type of cattle, fed for the optimal time period, and processed in the optimal fashion would provide important information to the sectors of the system. Perhaps most importantly, estimates of the potential changes in economic profits which would accrue to a coordinated system and which would be available for distribution to the sectors participating in coordination are needed to guide decisions which influence the type and level of coordination realized within the fed beef system.

Review of Literature

It has long been known that the fed beef production and marketing system was not optimal. In his Ph.D. dissertation, Purcell (51) noted how various barriers to communication created more than natural and legitimate conflicts and inconsistencies between the sectors of the system. The task of identifying more specific conflicts and their impacts on functioning of the system was undertaken by others.

In one study, Purcell and Tapp (53) found that the taking of excessive pencil shrinks on beef carcasses by packers discouraged feeders from the practice of selling their fed animals on the basis of carcass weight and grade. Presumably, carcass weight and grade selling provides for a more accurate determination of the true value of the animal, because valuation is more objective the closer it is made to the final point of consumption.

Dunn (12) studied interlevel goals and conflicts between feeders and packers. Dunn's findings suggest that feeders and packers are not aware of the impact their respective goals have upon the nature of the problem faced by the other. For example, Dunn found that the typical feeder sought to maximize net returns to each lot of cattle sold, whereas the typical packer sought to maximize returns over a year. This difference in goals could explain why many feeders prefer fluctuating to stable prices even though a fluctuating pricing pattern has a tremendous influence upon the packer's ability to obtain a regular supply of inputs for the day's kill.

Dunn also found basic mistrust between the feeder and the packer with regard to the provision of information on the type of cattle the feeder was offering to the packer. In some instances, the feeders refused to make the information available. Packers indicated that they discounted price offers to reflect the uncertainty which prevails when only minimal information is available and the value-related characteristics of the cattle must be estimated by examining the live cattle.

Rathwell (55) found that the cow-calf producers and feeders have different conceptions as to the type of feeder calf input the feeder desires. The cow-calf producer provided a calf which carried a relatively high degree of "finish" because it brought highest returns to the cow-calf producer. The feeder, on the other hand, indicated a desire for a "framey" calf. Rathwell also cited instances of such economic inefficiencies as vaccinations by both the cow-calf producer and the feeder because the system was unable to recognize and reward the cow-calf producer for providing such services as vaccination, weaning, and teaching the calf to eat prior to weaning, or bunk breaking.

Studies of the various sectors of the fed beef cattle system are not confined to Oklahoma State University. The majority of these studies, however, can be distinguished on the basis of their orientation to either production or marketing.

Production-oriented studies tend to address the question of type and profitability from the standpoint of the feeder calf producing or the feeding sectors of the fed beef system. In a relative profitability study by Brungardt of three popular breeds and size types within each breed, it was concluded that the differences in profits were due to the prices paid for feeders and received for carcasses, not to differences in physical efficiencies (6). In their professional journal, two animal scientists recognized the need for interdisciplinary cooperation between production scientists and agricultural economists (30). In the same article, the authors cited four studies by animal scientists attempting to relate breed, feeding programs, and profitability (30).

Market-oriented studies take the product as given and address the economic efficiency of product conversion or ownership transfer. For example, Johnson estimated that a teletype method of marketing fed cattle could save the feeding and packing sectors 1.0 to 1.6 billion dollars per year (31).

The overlooked consideration in either strictly production or marketing-oriented studies is that their analyses are undertaken under the implicit assumption that the requisite needs of the other sector(s) are fully satisfied. Such disjointed research parallels the referenced real world conflicts between the sectors of the fed beef system.

In separate and independent efforts, both Kohls in 1957 and Shaffer in 1968 argued that the product requirements of both producing and consuming sectors needed to be taken into consideration in order to have the most meaningful and potentially beneficial payoff from research (36)(57). This basic theme guided the Oklahoma State University subsector studies which documented the evident ills of the fed beef system (12)(53)(55).

According to McCoy, any study of production and marketing as one integrated or coordinated system constitutes a system analysis (40). Such studies were recommended by Kohls and Shaffer. Their recommendation has been followed in a number of studies as documented by Nelson and French (44)(19).

In a working paper, Crom and associates stated the case for a systems analysis as follows:

> .....Historically, economists engaged in commodity research have divided their efforts, with one group working on production efficiencies or supply response while their cohorts stressed demand (or price) analysis and efficiencies in the marketing channel. The former group made assumptions concerning price, while the latter took supply as given. Subsector analysis provides the linkage between consumer demand, distribution, processing, and production--in short, it is dynamic analysis encompassing both feedback and subsequent response through the continuum of vertical coordination (9, p. 1).

Numerous studies of the fed beef industry have been undertaken in recent years with some qualifying as systems studies, according to McCoy's definition. Two separate, but related, progress reports from South Dakota State University constitute a limited systems analysis of the fed beef system. In the first report, the emphasis was on returns to the cow-calf producers from estimates of performance traits for specific breeds under a particular environment, management situation, and existing market conditions. In the second report, the investigators reported on variations in marketing procedures and how these variables affect the choice of breed and crossbreeding systems (10). The study is limiting, as it forces feeding to either a Choice or Good quality grade, and there is no indication of whether cattle growth was simulated hypothetically or whether the production data were grounded in actual feeding trials.

A much more analytical and comprehensive study of the fed beef system has recently been completed by Nelson (44). The economic and philosophical orientation of Nelson's study was based on Purcell's conception of the fed beef system as a communications system (51). As such, it combines the tenets of both marketing and communications theory to focus on what is being communicated and how it is being communicated.

Nelson's production data on beef cattle growth and carcass composition are based on empirical findings from actual feeding and carcass evaluation trials conducted at the U. S. Meat Animal Research Center (MARC) in Clay Center, Nebraska. From these data, Nelson estimated the value related attributes of quality grade, yield grade, and dressing percent for fourteen types of beef breeds.

Nelson's literature review is an extensive treatment of the relevant types in both economics and animal science. From economics, Nelson traces the major studies and arguments for a systems analysis of the fed beef system. Nelson uses the animal science literature to support a series of related assumptions underlying the derivation of the value attributes of dressing percent, yield grade, and quality grade.

The first assumption is that the distribution of fat in the fed animal's body is the key determinant of quality grade, yield grade, and dressing percent. The second assumption is that there is a real breed difference in the distribution of fat deposits. The third and final assumption is that the measurement of the distribution of these fat deposits is a function of the ratio of live weight to mature weight.

Nelson's study is an interdisciplinary, relatively static, microanalysis of the fed beef system. Nelson's analysis identifies various communicative barriers impeding the functioning of the fed beef system. It also measures the effects of these barriers by types of cattle using profit levels and rate of return on investment.

The defined problem addresses the effects of changing feedstuff prices upon the individual and collective sectors of the fed beef system. The nutritional and economic significance of the feedstuffs used for feeding is recognized in both the animal science and agricultural economics literature. The unexpected and sudden surge in grain prices in 1974 prompted studies of the effects of high energy versus all-forage feeding regimes upon feedlot performance, carcass characteristics and other economic aspects of fed beef cattle production.

While results of those studies are highly significant for the sectors engaged in cattle feeding, the adjustments in types and fed weights are no less significant for the other sectors of the fed beef system. The results are also significant for the incentives created for alternative coordination arrangements of the fed beef system.

A recent paper develops the economic considerations important in analysis of production systems and locations of production given specified changes in energy and grain prices. In addition to a seven point summary outlining the effects of higher energy and grain prices, the paper addresses the economics of feeding forage versus grain, the impacts of integrating, and other topics bearing on alternative arrangements of the fed beef system. Citing other work, the authors noted that changes of only one cent per pound in the price of cattle had a far greater effect on net returns than did a ten cent change in the price of corn per bushel for a set of prices and costs prevailing during the 1960-64 period (16).

Any economic systems analysis of fed beef should consider the basic relationships governing growth of the animal and the composition of its carcass. These tenets of growth are contained within the growth curve and are basic to the establishment of relative economic relationships throughout all sectors of the fed beef system.

The growth curve is a relationship between live weight and time. It is a fundamental law of growth that the growth curve is similar for all species. Within a specie, the amplitude of the growth curve will differ at all points in time between types of cattle, thus giving credence to the notion of differing percents of attained mature weights between types of cattle at the same point in time.

The process of growth entails the development and accumulation of bone, fat, and protein. The order in which these body components accumulate has economic implications for the analysis. Nelson and Purcell have summarized the more important constructs of the growth curve that are significant to the analyses of this study (45).

(1) Every beef animal has a genetically inherent growth curve of S or sigmoid shape relating accumulated live weight to time. Carcass weight and carcass components are also often depicted as waving sigmoid growth curves.

(2) Some animals mature earlier or reach a given point on their growth curve at an earlier age than do others.

(3) Muscle growth matures at an earlier age than does fat. As an animal approaches maturity, a larger percentage of the increase in weight is composed of fat. This relationship is important in determining the quality grade and cutability for a given age, feeding period, and weight.

(4) Feed conversion (lb feed/lb gain) usually improves as either feed intake and/or rate of gain increases.

At any point in time, the animal is either on or off its growth curve. If the animal is off its growth curve, then compensatory gain exists. Compensatory gain is defined as the difference in realizable weight and live weight for any given age. Such gains may be either zero, positive or negative. The concept of compensatory gains is illustrated in Figure 1.

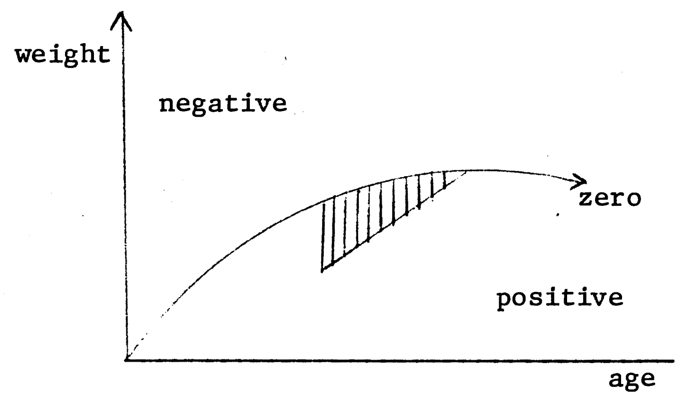


Figure 1. An Illustration of Positive, Negative, and Zero Compensatory Gain

The relationships between growth, level of nutrition, and compensatory gain are important and complex. The following quote documents those relationships:

> .....In applying this model to postnatal growth we have fitted all the data, on the assumption that small non-systematic deviations from the curve represent temporaty negative fluctuations, followed by a return of growth to its former trajectory. Such temporary failure of growth is often seen under conditions of poor nutrition, especially at weaning (Laird and Howard, 1966); subsequent acceleration of growth until the weight reaches its normal trajectory has been observed in many species (Tanner, 1962). This phenomenon may be found at the same age in different sets of data when it is associated with a normally occurring period of poor

> nutrition such as weaning, and this may be the basis for the growth "cycles" identified by some authors (Bertalanffy, 1960, p. 361)(37, p. 362).

Compensatory gain alone has important implications for this study because of its effects on feed consumption, efficiency of feed utilization, and the value attributes of quality grade, yield grade, and dressing percent. The following extracts from the animal science literature lend support to the idea that animals which exhibit positive compensatory gains do not necessarily require greater amounts of feedstuffs to obtain a given fed weight, that they are more efficient in feed conversion, and that the value attributes of the meat are not affected:

> .....The mean values in Table 4 indicated that calves subjected to normal or lower levels of nutrition during early life utilized feed more efficiently in the feedlot than those subjected to high or very high levels from birth to 8 months of age. Winchester and Howe (1955) obtained similar results (60, p. 239).

> .....Each steer was slaughtered when it reached a weight of almost 1,000 pounds. Although in most cases the retarded animals reached slaughter weight from 10 to 20 weeks later than did their co-twins, the former attained this weight on approximately the same intake of energy as the latter. This rather surprising result is explained by the fact that after reduced feeding ended, the retarded animals made more economical gains than did their co-twins.

> It is concluded that under conditions of feed scarcity, beef cattle between the ages of 6 and 12 months can be carried at an energy level as low as maintenance, if the nutritional needs other than those for energy are supplied, without later loss in efficiency of feed utilization, meat quality, or in the proportion of lean meat, as compared with fat and bone, in the carcass (75, p. 33).

Analysis of alternative coordinating arrangements of the sectors of the fed beef system can be enhanced with a framework of analysis. Fortunately, Mighell and Jones (42), by building upon earlier work by Blaich (3), provide a framework for analyzing coordination arrangements. The essential elements of Mighell and Jones' framework of analysis has been employed in a subsector study of the fed beef system at Oklahoma State University (12).

In 1968, Shaffer established certain views of systems analysis, institutions, and performance which could well be adopted as a frame of reference for this study (57). Shaffer views systems analysis as the considerations of problems in the context of the broader system such that feedback, sequences, and externalities are taken into account. Such a problem orientation provides for projections of the consequences expected to flow throughout the system as a result of expected or potential modifications to be made prior to implementation of any proposed solution.

Shaffer's definition of performance as the total flow of consequences from economic activity which directly affects the well-being of the participants could well serve as the criteria by which to assess the end results of any economic activity.

Working Hypothesis

Quantitative estimates of the impact of varying degrees of coordination on profits to each sector and to the fed beef system, to the levels of technical pricing efficiency, and to the allocation of profits within the system will provide a base for more effective decisions by sector participants and facilitate progressive movements toward a more viable, responsive, and efficient beef marketing system.

Objectives

The major objective of this study is to build a model of the fed beef system that will provide for dollar measurements of returns and inferences of adjustments in terms of types of cattle, feeding regimes, fed weights, and associated weights of carcasses and lean meat from alternative coordination arrangements of the fed beef system, given changes in input and output price relationships for both products of and inputs to the system, especially feedstuffs. The specific objectives of the study are as follows:

(1) To determine the combinations of optimum type, feeding regime, and fed weight for each sector and the fed beef system over three types of cattle, given the set of 1974 average prices and costs.

(2) To determine the combination of optimum type, feeding regime, and fed weight for the integrated (Y) sector over each type of cattle, given the set of 1974 average prices and costs.

(3) To measure the magnitude of premiums and discounts which would be available for distribution between product producing and using sectors of the fed beef system as inducement for enhancing coordination between the sectors under the set of 1974 price relationships.

(4) To measure the changes in profitability and associated adjustments in type, feeding regime, and fed weights for all types, and over all types within the cow-calf (C), feeder (F), and integrated (Y) sectors for changes in sets of corn and corn silage prices.

Procedure

All objectives will be satisfied through execution of the basic Mathematical Program System-Extended (MPSX) program and its options. Each micro sector, including the integrated (Y) sector of the fed beef system (A) is defined by the subset of activities open to it, and each merits a separate objective function.

All activities in the model are in terms of a steer unit. Activities include the production of the feeder calf, alternative sources of feeder calf acquisition, sale and purchase of feedstuffs, alternative feeding regimes, sale, purchase and slaughter of the fed steer at varying weights, sale, purchase, and breaking of carcasses of varying weights, and the sale and purchase of lean beef.

The first three objectives will be satisfied through development and application of a profit-maximizing linear programming model of the fed beef system. The final objective will be satisfied through execution of the Parametric Routine option.

The data for this study are drawn from many sources and are consolidated into coefficients for use as both objective function values and elements in the basic model. The study employs both secondary and quasi-primary data. The quasi-primary data are historical data from actual low-energy feeding trials conducted by the United States Meat Animal Research Center (MARC) on each type analyzed in this study.

The cow-calf costs and revenue data are all secondary. The weaning weights of each type were reported by the MARC (71). The Oklahoma State University (OSU) developed Beef Gain Projections Program is employed to first "track" the low energy growth curve reported for each type, and then to generate the high energy growth curve for that type. It is then used to "track" both curves under compensatory gain situations. Both curves represent a continuum of live weights which are analyzed in 25-pound weight increments. The range of fed weights varies between types.

A given fed weight for a given type has an associated unique combination of quality grade, yield grade, and dressing percent value attributes. The estimation of these value attributes is based on sets of regression equations developed by Nelson (44). The equations were developed under the assumption that these three value attributes could be predicted from the percent fat in the animal's body. The support for the assumption is documented in the Animal Sciences literature (50).

The percent fat in the animal's body is a function of the ratio of fed weight to mature weight. Mature weight is a distinguising feature between types. The numerical calculations of quality grade, yield grade, and dressing percent are accomplished with OMNITAB. The translation of the quantitative quality grade into its qualitative designation is accomplished in accordance with the legend reported by the U. S. Meat Animal Research Center (71).

Packer (P) and breaker-boner (B) revenue coefficients are the simple quality grade weighted averages of the Economic Research Service's reported values for carcasses and lean cuts. Cost coefficients represent a consensus of secondary sources adjusted by applicable indexes to a 1974 base.

The typical pen of fed steers is assumed to have a 150 pound weight range. On the basis of this assumption, a standard normal distribution of quality grades was derived for each fed weight. The yield grade and dressing percent were based on the sale weight for the particular fed weight.

The quality grade distribution determined the weighted average price. A combination of calculated yield grade, an assumed 1.5 percent hot carcass weight shrinkage, and slaughter weight determined cold carcass weight or the amount of product available for sale by the packer. The calculated yield grade was applied to estimate a cutability coefficient which, when multiplied by cold carcass weight, determined the amount of lean meat available for sale by the boner-breaker (B) and integrated (Y) sectors. The respective quantities of product produced by each sector times the applicable quality grade weighted price determined the gross return to all sectors except the feeder calf producing sectors (C, Y).

The derived coefficients are used as both objective function values and coefficients in a profit-maximizing linear programming model which contains seven objective row values, one RHS equality row value of 1, 1708 transfer rows, and 3299 columns. It is a relatively static micro model of the sectors (C, S, F, Y, P, B), and the fed beef system, (A).

CHAPTER II

BASIC ECONOMIC, ANIMAL SCIENCE, AND LINEAR PROGRAMMING CONSTRUCTS UNDERLYING THE ANALYSIS OF ALTERNATIVE FED BEEF COORDINATING SYSTEMS

Introduction

The purpose of this chapter is to integrate the more important conceptual economic, animal growth, and linear programming constructs underlying the analysis. The study addresses all sectors of the fed beef industry, and seeks to portray the industry as a communicative coordinating system of fed beef production and marketing.

The economic aspects of the presentation seek to address the theoretical role of market prices within the fed beef system and point out how failures in price performance give rise to alternative arrangements of the fed beef system. The discussions also seek to recognize and incorporate the salient relationships of growth and body composition of the fed steer into the economic analysis. Closing comments focus on the role of the linear programming tool as a technique of analysis.

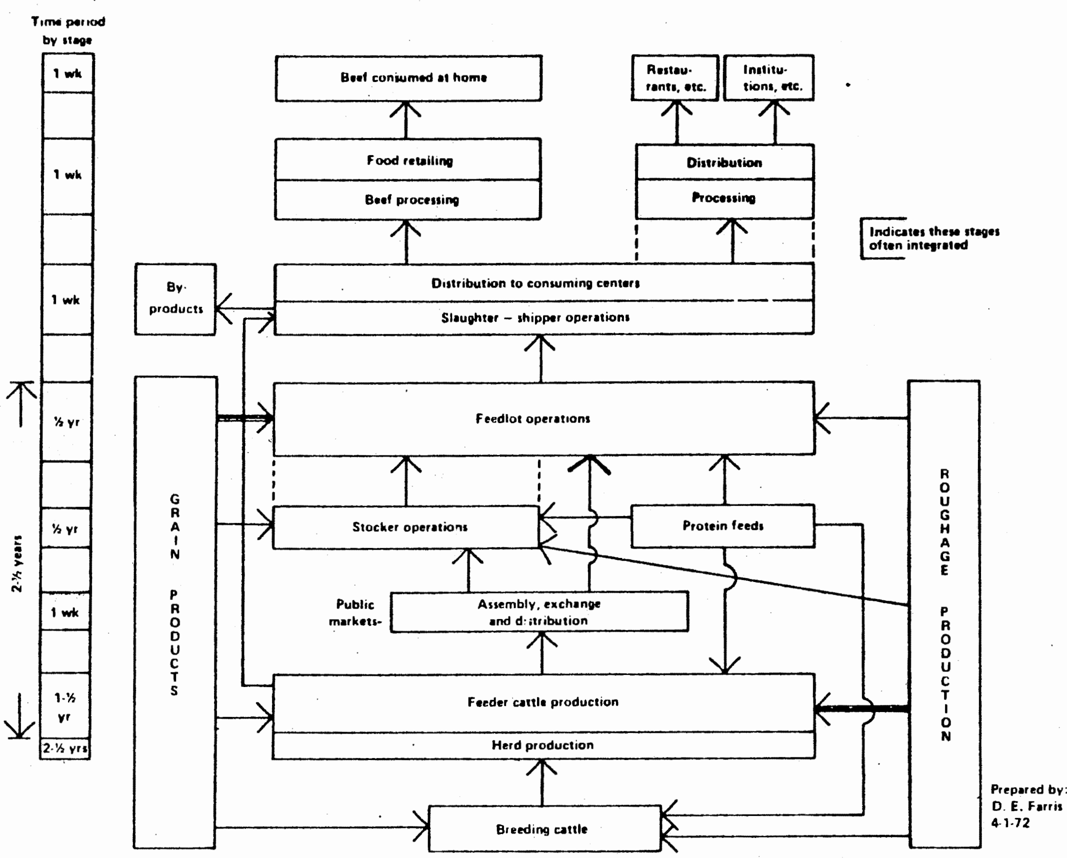
A View of the Fed Beef System

The incorporation of a descriptive narrative of the fed beef system would not necessarily enhance the clarity of the study. Nelson has already stated and identified additional sources of such narratives (44). The reproduction of Farris's illustration of the fed beef system in Figure 2 is helpful, as it provides both orientation and appreciation for the magnitude of the task involved in isolating, identifying, and measuring the major relationships in fed beef production and marketing (14).

Farris's sketch of the fed beef production and marketing system not only identifies the different endogenous and exogenous operating sectors which comprise the system, but also indicates the need for coordination of the system because of the 2½-year time lag between the initial production effort and ultimate consumption of lean meat. During that time span, there is a multitude and diversity of product transformation alternatives.

Some Applicable Economic Concepts

A serviceable concept of markets and marketing attuned to the objectives of this study is offered by McCoy (40). McCoy's definition of marketing as that area of economics concerned with the exchange and valuation of goods and services encompasses two distinct functions. The first is concerned with the technical issues surrounding the physical movement and transformation of the different products. The valuation function is concerned with the economic issue of pricing the products. The effectiveness and efficiency with which the second function is performed is of major analytical interest in this study because product pricing theoretically directs the organization of the whole system.



Source: Farris, D. E., and W. C. Couvillion. Vertical Coordination of Beef in the South -- Nature of Different Systems. Southern Cooperative Series Bulletin 192. College Station: Texas Agricultural Experiment Station, August, 1975, p. 14.

Figure 2. Simplified Diagram of Stages of Cattle-Beef Production and Marketing Systems

The Role of the Price Mechanism

The dominating characteristic of the fed beef system is that the activities of its production and marketing sectors are guided by sets of prices established from the interactions of derived demands and existing supplies. The advocates of an unfettered pricing system argue that the self-correcting features of the price system ensure optimum resource allocation and product distribution.

Too much documentation of evident ills in the fed beef system exists, however, to believe that the price mechanism provides for a fully efficient and effective coordinating system of fed beef production and marketing. This documentation necessitates an examination of the effectiveness of the price signal.

In the process of price establishment, there exists a natural and legitimate conflict between buyer and seller. In an efficient and effectively functioning system, the nature of that conflict ensures the optimum allocation of resources and distribution of products. When the conflict is neither natural nor legitimate, it results in barriers which impair the functioning of the system.

The logical conclusion from three Oklahoma State University studies of different sectors of the fed beef system is that barriers exist because buyers and sellers pursue goals largely independent of the value attributes of the products over which they are haggling (53)(12) (55). Theoretically, price establishment for a product makes certain implicit assumptions about the variables of value for that product. The failure to satisfy these implicit assumptions because of goal conflicts between producing and using sectors of the product leads to distorted price signals. Distorted price signals, in turn, prompt the search for alternative means of coordination so as to effect more nearly optimum resource allocation and product distribution.

Need and Justification for a Systems Analysis

McCoy notes that while major administrative organizations such as the USDA distinguish between production and marketing on the basis of when the product leaves the primary producer's hands, there is a direct relationship between the two as the quantity, quality, and timing dimensions of marketing products are influenced by production decisions. McCoy notes that a systems approach takes it name from the fact that production and marketing are considered as one integrated and coordinated system (40).

A systems approach to study of the fed beef system provides the means for investigating the hypothesis that distorted price signals lead to a search for alternative means of coordinating production and marketing activities within the system. As in nature, distortion of the price signal in the open market creates a vacuum in the form of economic incentives which are not necessarily consistent with economic or technical efficiency for the system or for sectors of the system. In the production and marketing environment for fed beef, such a vacuum will be filled by various degrees of coordinated structures which constitute departures from the open market system.

Alternative Forms of Market Coordinated Structures

It is possible to view the fed beef system as a coordinated system from Figure 2. Conceptually, however, it is easier to view the fed beef system as a coordinated system comprised of the four major sets of activities shown in Figure 3.

Carcass-Breaking

↑

Slaughtering

↑

Feeding

↑

Feeder Calf Producing

Figure 3. The Fed Beef Coordination System in Terms of Major Sets of Activities

Nelson provides descriptive statements outlining the relationships between the sectors performing the activities and the system in terms of input-output products and decisions functions (44). Nelson's particular diagram and accompanying description of the fed beef system may also prove instructive (44).

If the price mechanism fails to provide for effective and efficient coordination of the fed beef system, then the coordinating arrangements which emerge may fall between structures characterized by exchange processes and vertical integration. Coordination may be achieved through a network of contracts which specify product attributes at two or more points of ownership transfer. With vertical integration, a single ownership of all of the sectors ensures coordination of input-output relationships between the various stages or levels of economic activity. The possible combinations of vertically coordinated arrangements of the fed beef system are almost infinite.

Existing studies offer some insights into possible alternative vertically coordinated and vertically integrated organizational structures of the fed beef system. A recent study by Farris and Couvillion identifies some of the important considerations in an evaluation of such vertical arrangements (14).

In another study, Farris and Williams estimated that an integrated system offered savings of up to $10 per head over the open market system given the stated assumptions and prevailing prices (15). Johnson's study of ownership transfers through tele-type transmissions parallels the concept of a vertically coordinated system through contracts because price formation is based on explicit descriptions of the marketed product (31).

The basic conceptual ideas provided in these earlier works can be retained, extended, modified, and modeled in this study by using Mighell and Jones' basic framework of analysis (42). The key idea is that the initial product is transformed into intermediate and final products through processing by different sectors of the system. Processing entails costs which cumulate in discrete amounts as the product flows through the system. In this study, the term "sector" is used in lieu of "stage" in the earlier works. The referenced work (42) details the train of though from firm to stage, and finally to the consolidation of stages into vertically coordinated arrangements of production and marketing.

The illustrative extension and modification of the earlier works consists of defining the rectangular production grid more explicitly so that the horizontal axis represents the total supply of fed beef forthcoming during any given period of time. The vertical axis is, in turn, subdivided into equal parts to represent the major products of the four explicit sectors of the fed beef system defined in Figure 3. The result is Figure 4.

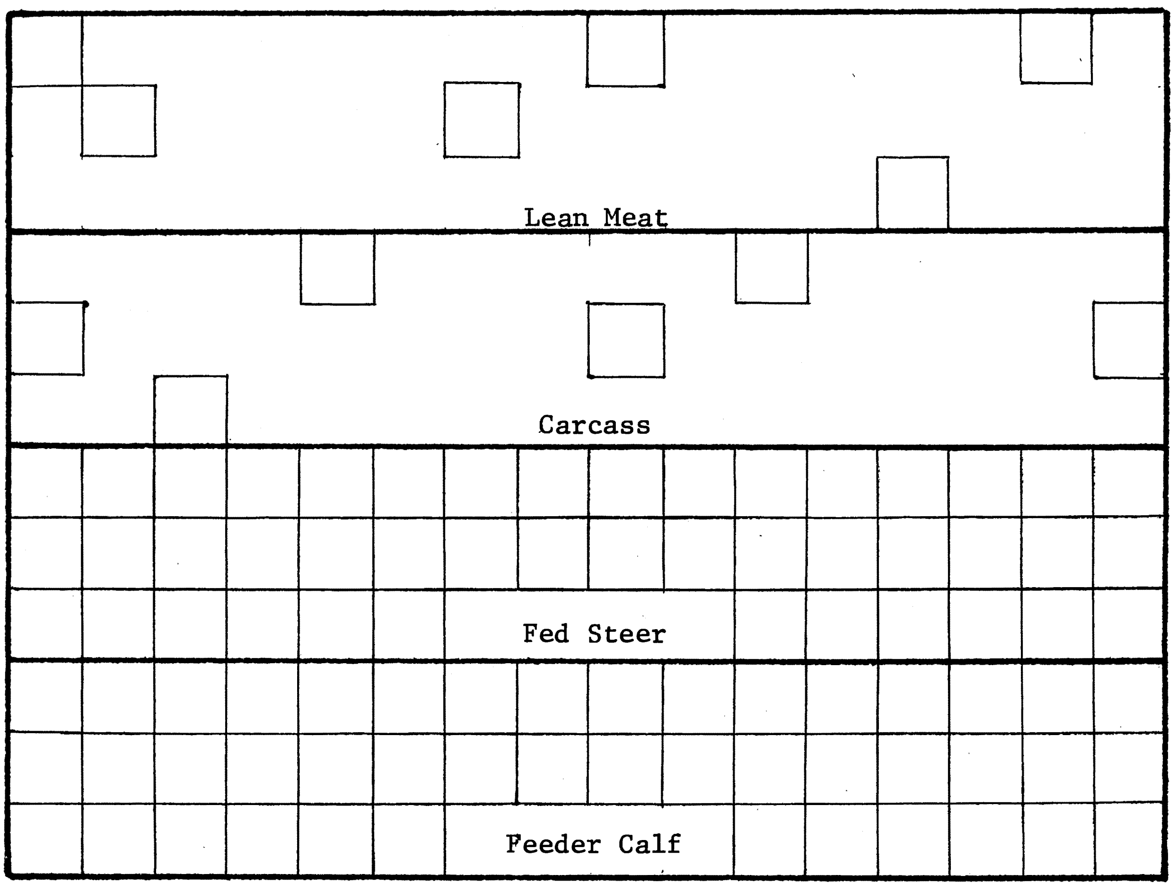


Figure 4. Initial, Intermediate, and Final Products Produced in a Coordinated Fed Beef System

The number of squares associated with every sector denotes the existence of perfect competition in the feeder calf producing and feeding sectors and the oligopolistic nature of competition in the packing and carcass-breaking sectors. The concept of the firm, stage, and coordinated stage developed by Mighell and Jones remains intact. Their work develops the theory surrounding the generation of average total cost curves between and among the sectors. This study addresses economic efficiency through coordination of the sectors so that the optional type, fed weight, slaughter, and associated weights of products flow between the sectors.

The principal impetus giving rise to alternative vertically coordinated structures is distorted price signals between the sectors. Distorted price signals fail to compensate adequately one or more sectors for their implicit specification output as measured by level of output and timing of product flow. An integrated sector theoretically controls the level of output and the timing of product flow at all points or sectors of production so that initial, intermediate, and final products are harmonized both as inputs and outputs.

The preceding discussions have sought to identify the most significant sources of economic and marketing theory underlying this study of the fed beef system. The theory, however, is sterile without consideration of the growth and nutritional relationships embodied in cattle feeding. It is also necessary to recognize that the body composition differs between types of steers at the same weight.

The relevant concepts of growth and nutrition include the growth curve, compensatory gain, and mature weight. Body composition concepts are essential because of their role in determining the value-related attributes of quality grade, yield grade, and dressing percent.

Concepts of Growth, Nutrition, Mature Weight, and Body Composition

The Growth Curve

The growth curve concept bridges the important relationships between the animal science postulates and the economic principles at work within the fed beef cattle system. It is well established that the growth curve is S or sigmoid shaped, and that it constitutes a relationship between live weight and time. It is a fundamental law that the growth curve is similar in all species (5). It is illustrated in Figure 5.

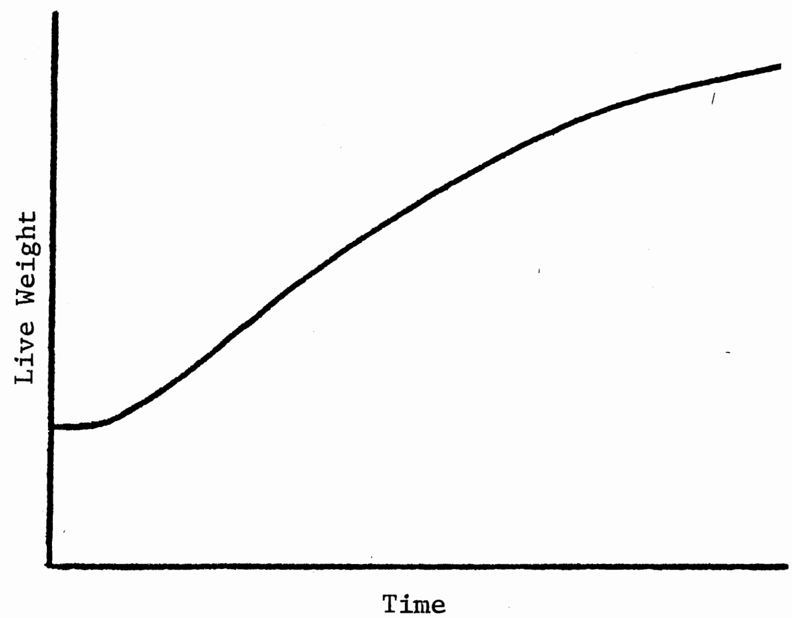


Figure 5. The Growth Curve

Brody divides growth into self-accelerating and self-inhibiting phases (5). The latter phase is affected principally by the environment, which is primarily the plane of nutrition. The principal effect of the self-inhibiting phase is to establish a maximum or mature limit to growth.

The growth curve may be the nucleus, but the order in which the various parts and tissues develop is important because it determines body composition. It is generally accepted that as fed weight increases, there is a general pattern to the development of the parts and tissues which shows a slowly decreasing percentage of bone, a more rapidly decreasing percentage of muscle or protein, a slowly increasing ratio of carcass weight to live weight, and an increasing percentage of fat.

Figure 6 provides a graphical view of these growth processes, and is based on work by Preston (50). Preston's work provides a useful synthesis of current knowledge with regard to growth processes.

The shape of the growth curve and the order of tissue growth and development is the same for all species (5)(41). The underlying thesis of this analysis, however, is that the magnitude (amplitude) of the growth curve is different within a specie due to the type of animal and its plane of nutrition. Within the beef cattle species, a different type means a different mature weight. It is the ratio of fed weight at slaughter to mature weight that eventually determines the magnitudes of the value attributes of the products. More detail will be provided on this and related concepts in Chapter III.

Body Composition and Determination of Economic Attributes by Type

Available literature has docomented the economics inherent in the relationships between heavier fed weights and increasing energy requirements for both maintenance and gain (20)(21). Nelson has established the significance of the order of tissue growth to the development of quality grade, yield grade, and dressing percent attributes in each type (44).

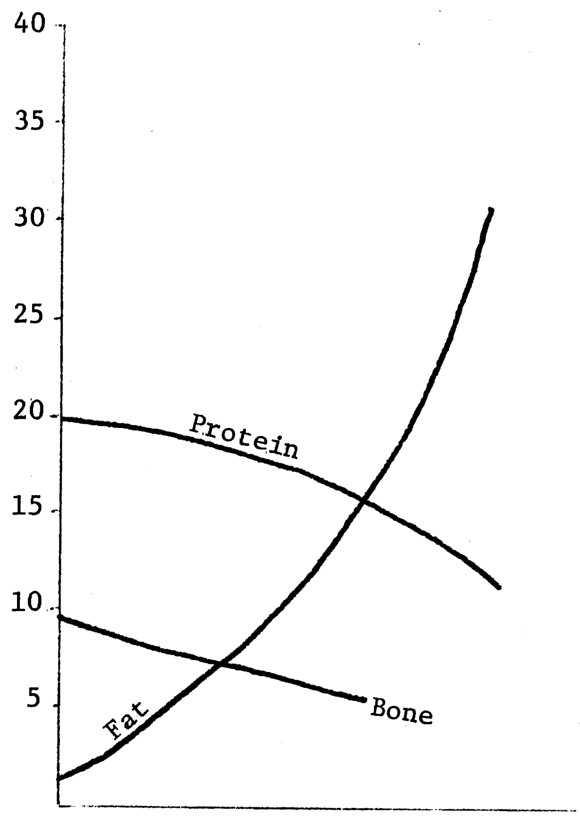


Figure 6. Live Weight Body Composition of Cattle

Source: Preston, R. L. "Effects Nutrition on on the Body Composition of Cattle and Sheep." (Paper presented to the Georgia Nutrition Conference, Feb. 18, 1971.) Wooster, Ohio: Ohio Research and Development Center, 1971.

The important variable in the determination of value attributes, however, is the ratio of the fed weight at slaughter to the mature weight, or to the percent of mature weight attained at slaughter. The emphasis on plane of nutrition stems from Nelson's note that comparable animals fed at different nutritional planes for the same length of time would be at different percentages of mature weights with predictable differences in results (44).

The summary point is that despite the plane of nutrition and for a given fed weight, there are distinct differences in value between types of fed cattle. The differences in value are due to differences in the magnitudes of the quality grade, yield grade, and dressing percent attributes of the intermediate and final products.

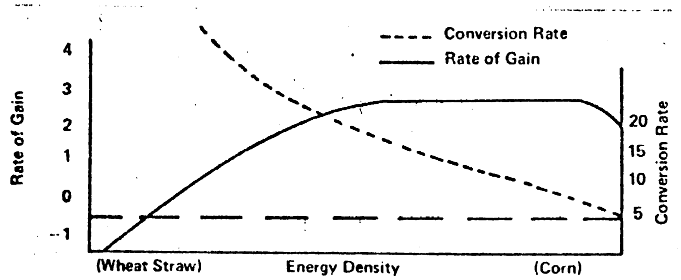
For any given type, the fixed and unalterable constant is the mature weight. The feeding sector, by exercising control over the feeding regime and the length of time on feed, can control the fed weight. Control over the fed weight then becomes the key to the profitability of not only the feeding sector, but also to all other sectors within the fed beef system. In addition to fed weight selection, the individual feeding sector needs to select the least-cost feeding regime.

Implicit assumptions regarding the quantity and quality of feed and non-feed inputs underlie the growth curve. The most significant of these inputs is the plane of nutrition as defined by the percent of grain and forage in the rations. An alternative expression for the plane of nutrition is the energy density of the various feedstuffs.

The Economic and Nutritional Relationships of Energy Density

Gill's illustration of the relationship between rate of gain, conversion rate, and energy density of feedstuffs is important because of its nutritional and economic content (21). Energy density refers to the NE_m and NE_g content of a feedstuff as measured by the net energy system.

Figure 7 illustrates the expected relationships between rate of gain, conversion rate, and energy density of feedstuffs. The rationale of Figure 7 is that the animals simply can't eat enough low energy density feeds to realize its full gain potential. The illustration shows that the rate of gain does increase with increases in the energy density. At very high energy densities, however, the rate of gain will decline as the ruminant animal requires a minimum amount of roughage for normal rumen functions. Since a high density ration fails to satisfy this minimum requirement, efficiency of gain declines (21).



Source: Donald R. Gill, Formulating Rations for Finishing Cattle. Great Plains Feeding Handbook, GPR-1600, 10-1972.

Figure 7. Effect of Energy Densities on Rate and Efficiency of Gain

Feed conversion is defined in terms of pounds of feed dry matter per pound of live weight gain. Balanced rations appear to offer the best compromise between conversion rate and rate of gain.

Since it may be assumed that the quality grade, yield grade, and dressing percent value attributes of the intermediate and final products are not affected by the energy density of the ration, the most profitable energy density in any given feeding program becomes a function of both feed and non-feed costs (24)(47)(50). Neither set of costs can be considered alone as the combination of rations affects the length of the feeding period which determines the magnitude of the non-feed costs.

Because feed costs make up such a large portion of the total costs of feeding, relative feed prices exert a tremendous influence on the feedstuffs used in the rations. Given that the animal's NE_m and NE_g requirements are satisfied, the optimum feeding program becomes a function of feed costs, non-feed costs, and fed cattle prices.

Given feed and non-feed prices, fed cattle prices determine the optimum fed weights for any given type in a given feeding program. At any point in time, fed cattle prices are a function of the derived demand for fed cattle and the existing supply of fed cattle. Fed cattle prices are generally expressed in terms of live weight for an estimated quality grade. The demand for fed cattle is derived from the demand for carcasses.

The Notion of Compensatory Gain

An important economic and nutritional phenomenon in cattle feeding is the notion of compensatory gain. Compensatory gain refers to the gain, often rapid and efficient in terms of conversion rates, which an animal realizes when placed on a high-energy ration after having been on a plane of energy sufficient for normal skeletal development, but not sufficient for gains consistent with its normal growth potential.

A recent paper concluded that the possibility of too little grass in certain years makes compensatory gain a real phenomenon in the fed beef industry (32). In this study, the closest proxy to a compensatory gain situation occurs under conditions of shrink due to changes in ownership and/or moving the animal from low-energy rations to high-energy rations. Separate analyses of the relative magnitudes of feeder grades assigned to the feeder calf under varying percentages of shrink may provide some appreciation for the significance of this phenomenon.

An economic analysis must necessarily consider the effects of compensatory gain on the economic variables of body composition, total feed consumption, and feed efficiency. The literature supports the assumption that the existence of compensatory gain does not alter body composition enough to affect the value determining attributes of quality grade, yield grade, and dressing percent materially (24)(47)(50). From both economic and nutritional considerations, it is necessary to recognize that an animal making compensatory gains consumes more feed during the period of weight gain. However, total feed consumption is no greater than that for the animal making normal gains, since feed conversion for the animal realizing compensatory gains is superior. The nutritional rationale supporting the superior feed conversion revolves around the capacity of the compensatory gain animal's body to realize greater efficiency in feed utilization.

Basic economic analysis permits comparative profitability analyses of feeding compensatory-gain versus non-compensatory gain animals. The most pertinent economic variables are the age of the animal, the length of time in the feedlot, and the composition of the ration (32). The more important economic question, however, has to do with how well the open market or price system recognizes the economic merits of feeding animals with compensatory gain. In a sense, the analyses of alternative feeding regimes seek answers to the basic question of how well the compensatory gain feeder calf fares economically relative to the non-compensatory gain feeder calf.

Linear Programming as the Basic Tool of Analysis

Linear programming is defined to be the maximization (or minimization) of a linear function subject to a constraint of linear inequalities (73). The linear inequalities constitute sets of input-output, cost-output, and price-output relations. The production of outputs entails the combination of processes which are fixed combinations of particular inputs. The maximization of profit or the minimization of cost constitutes the objective function which is subject to constraints. Out of several feasible solutions, there may be none, but no more than one optimum solution (73).

Linear Programming Assumptions not Limiting

The assumptions underlying linear programming are often cited as limitations of the usefulness of the tool. The unreasonableness of the assumptions is often used to advance the argument that the results of conventional marginal analysis are superior to the results stemming from a linear programming analysis.

The linearity assumption is an applicable case in point. Plaxico notes, however, that constant returns to scale is one of the basic assumptions of the conventional marginal theory, and that the curves in the modern textbooks are due to the law of variable proportions, not varying returns to scale (49). With regard to the basic argument, at least two applied studies in cattle feeding have demonstrated how linear programming can be made to approximate marginal analysis so that first and second order conditions for optimization of the production function can be satisfied without violation of the basic assumptions underlying either method of analysis (27)(33).

Applicability of Linear Programming in This Study

The nature of the problem under study could conceivably be analyzed with marginal tools of analysis, but at great time, expense, and loss of precision. The techniques of linear programming are best suited for this study for reasons which may best be cited by paraphrasing Dorfman (11):

> Once the feeding period for a given type of fed steer is terminated, the different intermediate products associated with that fed steer are rather inflexible with regard to magnitude and value attributes. Thus, upon slaughter of a given fed weight of a given type, several of the other variables in the production function for both the feeding and non-feeding sectors of the fed beef system have also been determined at the same time. This means that it is not possible to move freely from point to point on the production surfaces of either one or a combination of

sectors. This can be seen as follows: Although any particular feeding regime (process) is quite inflexible with regard to the magnitude and value attributes of the intermediate products, there are a number of alternative feeding regimes for producing a given fed weight for a given type. The consideration of different feeding regimes produces a wide variety of factor-input and product-output ratios for the sector or combination of sectors under analysis.

The type of decision which faces a sector or a combination of sectors which must work with alternative fed weights from alternative types of cattle makes for decisions which are essentially different from the decisions contemplated by marginal analysis. The feeding, non-feeding, or combination of activities of any sector makes for a decision center which may decide the extent to feed each of the types of cattle it owns at any time. In that case, any variation in the fed weight implies simultaneous variations in the weights and value attributes of the intermediate products associated with that fed weight. The feeding or non-feeding sector(s) may choose among a number (generally finite) of fed weights to which to feed or derivative intermediate products of a given fed weight. It also needs to select among a type of cattle to feed. All of these decisions differ in two respects from the kind of decision treated in the marginal analysis. First, they affect the weights and value attributes of distinct intermediate products simultaneously. Secondly, the range of fed weights for a given type in this study does not lie along a continuous scale, but involves selection among discrete alternatives.

The effects of such decisions are therefore not adequately expressed by the theoretical operation of partial differentiation with respect to the weights and value attributes of intermediate products associated with a given type's fed weight.

In this study, linear programming is used to construct alternative coordination models of the fed beef system by either permitting or denying the different sectors of the system access to given sets of activities. These activities are enumerated in Table XIX. The linear programming PARAMETRIC ROUTINE option is employed to infer the magnitude of premiums and discounts which given sectors can bargain over in order to realize optimum programs.

Model Construction

The alternative coordination models of the fed beef system as a communications system are actually subsets of different production activities made available to different sectors of the system. In fact, the sectors are delineated on the basis of which subsets of activities are made available to them. The decision processes open to a sector are facilitated through the judicious uses of 1's and -1's to provide for the creation, utilization, and disposal of complementary, supplementary, and competitive intermediate products as described in a standard reference (29).

The Role of Shadow Prices in the Analysis

A shadow price is the net marginal value product of forcing an activity not in solution into a program. It has been noted, however, that the shadow price in the Mathematical Program System Extended

(MPSX) output is not the marginal value prouct by the strict definition of marginal value product. This is because all activities except the one to which the MVP accrues cannot be held constant in MPSX as activities are defined in fixed ratios to one another. Despite this logical weakness in the technique, the concept of the shadow price as an estimate of the marginal value product of a non-basic activity is operationally useful and provides the means for satisfying the third objective, because it measures the magnitude of the premium available which could be offered by the optimized sector to another sector to encourage either production or use of the initial, one of the intermediate, or the final product (2).

Because of the normative nature of the analysis, shadow prices play a key role in interpretation and inference. The magnitude of the shadow price provides a base value for inducements between sectors of the system. The following paraphrase from Watson may serve to put the role of the shadow price in this analysis into perspective (73):

> The literature on linear programming mentions another way that calculated shadow prices can be used. The monitor of a combination of two or more sectors of the fed beef system faces the problem of getting the individual sectors to pull together in making profits. One sector might increase its profits at the expense of the profits of another sector by using a type of cattle or a fed weight common to both sectors. It is not enough to tell each sector to maximize its profits. There must be a mechanism to ensure that profits for each sector mesh into one grand maximum for the integrated subset of the fed beef system or for the whole fed beef system. For a subset of or for the whole

fed beef system, a linear programming solution (which would probably be attained only after overcoming the most formidable difficulties) for maximum profits would yield shadow prices for the particular types and fed weights common to the sectors. A sector would be directed to use a given type and fed weight only if it could "pay" for it.

The application of shadow price values is apparent. They can be used as the base for negotiating contracts between producing and using sectors of the initial (the feeder calf), intermediate (fed steer carcass), and final (lean meat) products of the fed beef system. Shadow prices provide the mechanism for comparing alternative forms of vertical coordination and vertical integration, since they incorporate all associated sets of non-feed and feed costs of ownership transfers.

Introduction of "Shocks" Into the System

A "shock" may be defined as any change in objective function value for an initial, intermediate, or final product, or non-generated system input. Shocks are introduced with the Parametric Routine option. The purpose of introducing shocks is to measure the effects upon profitability and infer the nature of change in type and fed weight due to changes in input prices of corn and corn silage.

A change in price alters the value of the objective function and the slope of the isoprofit line. It does not alter the feasible region. Therefore, depending on the magnitude, change in price may or may not change the point of tangency of the isoprice line to the boundary of the feasible region (1).

With a Parametric Routine analysis, differences in the objective function can be used to analyze the relative profitability of different forms of alternative vertically coordinated arrangements of the fed beef system given changes in input prices. This includes the independent micro sector, a combination of two or more micro sectors, the integrated sector (Y), or the entire fed beef system (A).

The basic linear programming analyses identify the magnitudes of profits and the set of activities which yield optimum programs for the micro sectors, including the integrated (Y) sector, and the fed beef system (A). Shadow prices indicate the cost to a sector and the fed beef system of deviating from use of the optimal type and fed weight. The Parametric Programming analysis assesses the direction and magnitude of change in profit as well as in type and fed weight for given changes in input prices, particularly feedstuffs.

CHAPTER III

DATA DEVELOPMENT

Introduction

The purpose of this chapter is to present the tools, document the pertinent data, and develop the remainder of the data used as coefficients in the general linear programming model to be presented in Chapter IV. The development of procedures outlining the techniques by which the tools and data are integrated will be presented either in the text or in appendices.

The data base reflecting costs for the cow-calf, stocker, feeder, packer, and boner micro sections, integrated sector (Y) and the fed beef system (A) were generated from secondary sources. In some instances, judgment was exercised with regard to data source, modification, and updating to the 1974 base study period. These judgments were based on consultations with knowledgeable Oklahoma State University researchers and extension specialists.

Several assumptions or constraints on the analysis were employed:

1) The analysis is always in terms of a one-steer unit. The cost-of-production coefficients assume certain economies of size explicitly but the basic coefficients are for one steer.

2) There is no difference in the technical efficiency between sectors in the performance of any particular activity.

3) The analysis is static. The only incorporation of time occurs through creation of different fed weights for analysis. The emphasis, however, is not on days on feed, but on fed weights.

4) Corn is used as a proxy for concentrates, and corn silage is used as a proxy for forages. This is a critical distinction, since the study constitutes a systems analysis of the economic merits of grain-fed versus forage-fed beef. However, there are many varieties of grain, and corn silage is not necessarily equivalent to other forages in terms of NE_m and NE_g content. In addition, all rations contain both corn and corn silage, but in different quantities.

5) The packer and boner are distinct entrepreneurs.

6) A pound of lean beef meat of a given quality is the same, regardless of type or breed of the cattle involved.

Order of Presentation

Production and revenue data were assembled for the functions of feeder calf production, feeding to alternative fed weights, killing the fed steer, and breaking the cold carcass. The independent micro sectors and the integrated sector are defined by the set of activities open to them. By assumption, each sector performs a given activity with the same level of technical efficiency. Organization of activities creates differences in economic efficiency. The output product and revenue associated with a given set of activities is homogeneous within the sectors.

In generating the needed data, the costs of production associated with a given function are developed first, and then the returns associated with resulting product are developed. Before developing coefficients for the feeding sector, it was necessary to present the technical information bearing on those coefficients. This included information about growth and nutritional relationships, derivation of value attributes, economic aspects of alternative fed weights, the net energy system, the influence of forages and concentrates, key ideas underlying employment of the Beef Gain Simulator, development of input parameters for the Beef Gain Simulator, and usage and development of the output parameters from the Beef Gain Simulator as coefficients for the general linear programming model. With the exception of the feedstuffs, all cost and revenue coefficients are in a form suitable for incorporation directly into the general linear programming model.

Feeder Calf Producing Sector Coefficients

The model permits only the cow-calf (C) sector and the integrated sector (Y) to produce a feeder calf. Once produced, the calf may be either sold through the auction or transferred into the feedlot for feeding by its producer.

Differences in feeder calf costs between types of cattle are due to differences in weaning weights, calf crop percentages, calving difficulty costs, effects upon subsequent parturitions of current calving difficulty, and cow-maintenance costs. The study employs only the Angus and Hereford types of dams, but employs Jersey, Hereford, and Charolais sires. The sire effects upon birth weight, calving difficulty costs and subsequent effects upon parturition are fairly well documented. The effects of cow-maintenance costs are not quantitatively incorporated into the analysis because there is no uniform consensus among researchers as to how to differentiate the maintenance cost of an

Angus from a Hereford cow (35). Therefore, it is assumed that there is no difference in maintenance costs between an Angus and a Hereford cow.

The basic approach will be to develop a representative cow-calf cost of production budget under the set of 1974 prices and costs. Using the final cost of production cited in the budget as a base figures, the explicit costs associated with every variable that affects feeder calf production costs for each of the three types of cattle will be developed and reflected as an adjustment to this base figure. The basis for development of these explicit costs is published research from the U. S. Meat Animal Research Center at Clay Center, Nebraska (38).

The Representative Feeder Calf Producing Sector Cost of Production Budget

The representative cow-calf cost of production budget for the set of 1974 prices and costs is presented in Table I. This is essentially the same budget that Nelson used in his study, except that it reflects 1974 costs instead of average 1968-1972 costs (44).

In formulating coefficients for the cow-calf sector, Nelson used base coefficients from a paper prepared by Brant (4). This study consolidates cow-calf and feeder costs of production for the North Central area of Oklahoma. Nelson chose to use the original budget from which Brant's paper was prepared, and elected to employ the Oklahoma State University Budget Generator to update the budget to reflect the average 1968-1972 period.

The Oklahoma State University Budget Generator's format provides information on units of measurement and rates per unit as well as providing for an identification of operating inputs (58). Explicit

TABLE I

BASIC FEEDER CALF COST OF PRODUCTION BUDGET FOR 1974 PRICES AND COSTS

Livestock Investment	Units	Price	Value
Beef Cow	1.0	$350.00	$350.00
Beef Bull	.03	750.00	22.50
Beef Heifer	.09	275.00	24.75
Horse	.01	200.00	2.00
Total			$399.25
Operating Inputs			
41% Prot. Supple.	403.2 lbs	$.1026/lb	$ 41.37
Grass Hay	815.36 lbs	.01/lb	8.15
Pasture	6.72 AUM	0.0	0
Salt & Minerals	26.88 lbs	.025 lb	.67
Vet. & Med.	1.0	-	2.86
Hauling & Mktg.	1.0	-	5.00
Personal Taxes	1.03	2.00	2.06
Livestock Supplies	1.0	-	3.25
Bulls	.01 Hd	750.00/hd	7.50
Native Pasture	4.14 AUM	0.0	0.0
Machinery Fuel & Lube			2.94
Mach. & Equip. Repair			3.68
Total			$ 77.48
Labor Costs			
Machinery Labor	4.38 hrs	$ 2.00/hr	$ 8.76
Equipment Labor	3.61 hrs	2.00/hr	7.22
Livestock Labor	3.61 hrs	2.00/hr	7.22
Total			$ 23.20
Ownership Costs (Depreciation, Taxes, Insurance			
Machinery			$ 2.85
Equipment			5.35
Livestock			.50
Total			$ 8.70
Capital Costs			
Annual Operating Cap.	$ 47.395	$.120/dol.	$ 5.69
Machinery Investment	17.294	.120/dol	2.08
Equipment Investment	44.400	.120/dol	5.33
Livestock Investment	399.250	.120/dol	47.91
Total			$ 61.01
Revenue From Sale of Cull Stock			$ 21.08

Source: Sharkey, Roy L. Jr., Crop and Livestock Budgets North Central Oklahoma. Budget Identification Number 112012184 321 1, Budget Record Number 335, Stillwater: Oklahoma State University, p. 93.

changes to maintain consistency throughout the study were made in investment costs to the beef cow, beef bull and beef heifer, and in the prices or costs of 41% protein supplement, interest, and revenue from sale of cull stock. The remainder of the budgetary costs are the same as those in the Oklahoma State University Budget Generator for the North Central region of Oklahoma under 1974 conditions.

Because of the inherent problems in assigning either opportunity costs or use-value costs to land, it was decided not to recognize a charge for land. While this has the effect of artificially inflating returns to the feeder calf producing sectors, it does not affect the analysis since the land charge is treated consistently for all three types of cattle. In addition, the original budget cites returns to land, overhead, risk, and management. Consolidation of costs less revenue from cull sales in Table II shows the representative cost of feeder calf production under the set of 1974 average prices and costs to be $149.31.

Variables Influencing Feeder Calf Cost of Production by Type

In earlier discussions, five variables affecting the feeder calf cost of production were identified. The dollar cost of each variable is computed and added to the representative cost of $149.31 by type of cattle.

Weaning Weight of the Calf. This variable is of interest because it is the principal attribute of the product of the cow-calf sector. Since cull sales were included in the representative budget, the weaning weight is the only determinant of the net production cost per pound for the feeder calf. The weaning weight is also one of the principal determinants of profits, since the product of weight and the difference between production costs and selling price determines the magnitude of profit or loss.

TABLE II

CONSOLIDATION OF BASIC FEEDER CALF COST OF PRODUCTION FOR 1974

Costs of Production	
Operating Inputs Cost	$ 77.48
Labor Costs	23.20
Ownership Costs	8.70
Capital Costs	61.01
Total	$170.39
Revenue	
Cull Cow Receipts	$ 21.08
Basic Cost of Production	$149.31

The weaning weights used in this study were obtained from the U. S. Meat Animal Research Center's 1970, 1971, and 1972 calf crops (71). The weights were adjusted for birth date, for sex, and for the mature age of the dam. The weaning weights by type are: Jersey-Angus (JRAN), 455 pounds, Hereford-Hereford (HEHE), 450 pounds, and Charolais-Hereford (CHHE), 493 pounds (4, Table 3). Dividing each of the respective weaning weights into the representative cost of \$149.31, yields per pound production costs of \$.3282 for the JRAN, \$.3318 for the HEHE, and \$.3029 for the CHHE.

Calf Crop Percentage. In this study, calf crop is defined as the percentage of calves that survive beyond 24 hours after birth. This variable is important because it affects fixed costs within the cow-calf sector.

There are any number of variables exogenous to the study which may affect the magnitude of the calf crop. Variables of interest in this study which do affect the calf crop are the respective sire and dam type. In addition to inherent reproductive characteristics, their physical sizes determine the size of the calf relative to the size of the cow which is a primary contributor to losses at calving time.

Data on calf crop percentages by type were taken from a U. S. Meat Animal Research Center publication (38). The data base included 5064 parturitions from 14 types over the period from 1967 to 1972. About 35% of the parturitions were from two-year-old cows, 24% were from three-year-old cows, and 41% were from four years old and older. The number of parturitions and the calf crop percentage for each type under analysis are listed in Table III.

In this study, the calf crop percentage parameter will be employed in a manner analogous to Nelson's employment of that parameter (44); that is, it will be used to determine the feeder calf producing sector's cost of producing one whole steer for each type. The effect of calving percentage is incorporated into feeder calf cost of production by dividing the calf crop percentage into the \$149.31 representative feeder calf cost of production. The resulting total and per pound costs of producing each type of weaned calf are listed in Table IV.

TABLE III

NUMBER OF PARTURITIONS AND CALF CROPS BY TYPE

Type	Number of Parturitions	Calf Crop Percentage
JRAN	181	94.5
HEHE	357	87.4
CHHE	198	87.4

Source: Laster, D. B., "Effects of Calving Difficulty on Calf Mortality and Postpartum Rebreeding." _U. S. Meat Animal Research Center 1973 Beef Cattle Research Progress Report_, May, 1973, p. 42.

TABLE IV

TOTAL AND PER WEANED POUND FEEDER CALF COST OF PRODUCTION BY TYPE

Type	Total Cost of Production	Weaned Weight	Per Weaned Pound Cost of Production
JRAN	$158.00	455	$.3473
HEHE	170.84	450	.3796
CHHE	170.84	493	.3465

Calving Difficulty Costs. Calving difficulty costs vary by type primarily because the type determines both the form and frequency of calving difficulty. The form of calving difficulty manifests itself by the need to either pull the calf, perform a Caesarian section, or conduct a posterior presentation. While the frequency of calving difficulty varies by type, it is more frequent in two-year-old cows than in older cows regardless of type (38).

To derive the cost of calving difficulty, it is necessary to establish the cost of calving difficulty by type and age category. This constitutes a weighted cost of calving difficulty. The pertinent information for these costs calculations is provided in Table V.

The data in Table V are drawn from published research studies of the U. S. Meat Animal Research Center (38)(71). For purposes of this study, the data in each column may be considered the weight assigned to each form of difficulty by type. The weights assigned by type of calving difficulty for two-year-old and for older cows are reflected as the percentage type of parturition in Tables 1 and 2 of reference (71). The weighted frequency of calving difficulty is drawn from Table 4 of reference (38).

The Oklahoma State University Veterinarian Hospital suggested a representative schedule of fees for each form of calving difficulty. This schedule cited a fee of \$12.50 for calf pulling, \$35.00 for a Caesarian section, and \$15.00 for a posterior presentation. Laster's article indicated that about 35% of the cows from which the parturition data were drawn were two-year-old cows. This means that the remaining 65% of the parturitions were from older cows (38). The costs shown in Table VI reflect the weighted differences in calving difficulty costs

TABLE V

CALVING DIFFICULTY BY FORM OF DIFFICULTY AND FREQUENCY OF DIFFICULTY BY TYPES

Type	Form of Calving Difficulty	Weighted Form of Calving Difficulty in: Two-year-old Cows (35%)	Weighted Form of Calving Difficulty in: Older Cows (65%)	Weighted Frequency of Calving Difficulty by Type	Assigned Cost by Type due to Calving Difficulty
JRAN	Calf Puller	13.2	0.0	6.6	$ .0544
	C-Section	1.3	0.0		
	Posterior Presentation	0.0	0.9		
HEHE	Calf Puller	52.2	3.1	30.1	$1.0465
	C-Section	4.5	0.0		
	Posterior Presentation	0.0	4.0		
CHHE	Calf Puller	54.1	24.4	39.4	$3.0002
	C-Section	21.6	0.0		
	Posterior Presentation	2.7	4.9		

Source: Laster, D. B., "Effects of Calving Difficulty on Calf Mortality and Postpartum Rebreeding." U. S. Meat Animal Research Center 1973 Beef Cattle Research Progress Report, May, 1973, pp. 41-46.

due to type and age.

TABLE VI

TOTAL AND PER WEANED POUND COST OF PRODUCTION BY TYPE FOLLOWING INCORPORATION OF CALVING DIFFICULTY COSTS

Type	Total Cost of Production	Per Weaned Pound Cost of Production
JRAN	$158.0544	$ .3474
HEHE	171.8865	.3820
CHHE	173.8402	.3526

The final variable to incorporate into feeder calf production cost is related directly to calving difficulty. Laster's study indicated there was a 15.9 percent greater reduction in total conception rate for cows experiencing calving difficulty as opposed to cows which have no calving difficulty (38).

Subsequent Parturition Costs Following Calving Difficulty. The cost of artificial insemination serves as a base for determining the cost of subsequent parturition cost following calving difficulty. An artificial insemination charge of $10.00 per cow was used based on interaction with those providing the service.

One measure of the subsequent parturition cost by type may be obtained by multiplying the weighted frequency of calving difficulty by type given in Table V times the basic artificial insemination charge of $10.00. The resulting product times the 15.9 percent reduction in total conception rate for cows experiencing calving difficulty yields a cost to the JRAN of $.1049, to the HEHE of $.4786, and to the CHHE of $.6265. The net result from incorporating these charges in the cost of feeder calf production by types is summarized in Table VII.

TABLE VII

TOTAL AND PER WEANED POUND COST OF PRODUCTION BY TYPE FOLLOWING THE INCORPORATION OF SUBSEQUENT PARTURITION COST FOLLOWING CALVING DIFFICULTY

Total	Total Cost of Production	Per Weaned Pound Cost of Production
JRAN	$158.1593	$.3476
HEHE	172.3651	.3830
CHHE	174.4667	.3539

The final feeder calf producing sector coefficient to derive is the magnitude of gross returns to each type. The feeder calf producing sector realizes a return only if the feeder calf is sold through the auction. If the feeder calf producing sector transfers the calf into its own feedlot, the computation of returns to the sector are deferred until ownership changes. Returns are not differentiated between returns for producing a feeder calf and returns from feeding.

The Computation of Gross Returns to the Feeder Calf Producing Sector

Three assumptions underlie the computations of gross returns to the feeder calf producing sectors. First, the weaned weight is the sell weight as the total cost of production provides a production weight that covers shrinkage from the ranch to the auction. Second, the auction marketing and transportation charges to the auction are incorporated into the feeder calf's cost of production, and thus are not deducted from gross returns. Finally, the study assumes no differential in selling price per pound by type of feeder calf for comparable weights.

The 1974 average price for a 400-500 pound choice feeder calf at Oklahoma City was $40.22 per hundred weight (67). Given the stated assumptions, the gross returns were calculated and summarized by type in Table VIII.

The formal presentation of coefficients for the feeder calf producing sector is now complete. The effect of transfer activities upon the cost of production for each type will be incorporated into the discussion of the cattle feeding sector coefficients. The net returns to each type can be derived by subtracting the total cost of production in Table VII from the gross returns in Table VIII.

Feeding Sector Coefficients

Individually, each of the sectors performs a unique role within the fed beef system (A). Although some activities are not affected, decisions by the feeding sector regarding types and fed weights, made within the tenets of technical growth considerations, affect the economic well being of all sectors. The development and use of coefficients associated with the feeding sector requires a basic understanding of the Beef Gain Simulator developed at Oklahoma State University (23). A prerequisite to understanding of the Beef Gain Simulator and its role in the analysis requires digressions into basic growth and nutritional relationships.

TABLE VIII

GROSS RETURNS BY TYPE TO THE FEEDER CALF PRODUCING SECTOR

Type	Weaned Weight	Returns per Hundredweight	Gross Returns
JRAN	455	$40.22	$183.0010
HEHE	450	40.22	180.9900
CHHE	493	40.22	198.2846

Growth and Nutritional Relationships of the Live Animal and Carcass Characteristics

The incorporation of basic growth and nutritional relationships into the analysis is important to the validity of the study. Detailed treatments and extensive bibliographies outlining these relationships are available from Nelson's companion study and contributors to the Animal Sciences literature (44)(18)(20)(21)(22)(24)(47)(50)(59)(60)(61). The major objective of the following digressions is to establish the rationale for the assumptions and procedures which underlie the development of the coefficients used in the general linear programming model.

The Growth Curve Approach. Nelson discussed the metabolic control approach and the growth curve approach as two alternative explanations of fed steer growth (44). Level of complexity, lack of data, and lack of consensus regarding its theoretical underpinnings led Nelson to reject the metabolic control approach.

The growth curve approach embodies basic tenets about physical growth and development that are important to any economic analysis of the fed beef system. The first tenet indicates that the growth in physical weight and in individual body components follow a characteristic sigmoid or S-shaped pattern. This means that growth cannot be explained or predicted with a linear function, and that a non-linear growth model is needed for live weight calculations.

Nelson references Brody's division of growth into self-accelerating and self-inhibiting phases (44). In the self-accelerating phase, the percentage growth rate is constant as each cell's reproduction unit in the body is generating new reproduction units. In the second phase, growth is limited by the environment, and a greater percentage of the available energy goes for body maintenance, leaving less for new growth. Eventually, a maximum or mature limit is reached.

The first phase does not offer much economic significance for this analysis. The self-inhibiting phase's increasing energy requirements for body maintenance necessitate economic analyses to determine trade-offs between the value of additional live weight and the increasing cost of the additional feed required to attain the heavier live weight. The idea that the fed steer has a mature weight unique to a particular breed or breed-type was vital to Nelson's efforts to develop quality grade, yield grade, and dressing percent prediction equations. These equations, in turn, were basic to the development of the coefficients for the general linear programming model.

Body composition has reference to the component parts of the fed steer's body, and may be discussed on either an absolute or percentage basis. On the basis of earlier writings, Nelson drew upon available references and concluded that the order of tissue growth and development follows an outward trend from the central nervous system to bone, muscle, intra-muscular fat, and subcutaneous fat (41)(48).

The majority of the economic value from both production and marketing standpoints of the fed steer rests in the value of the muscle. The value of the muscle is related to the amount of fat distributed and interspersed throughout the muscle. The relationships between muscle and fat distribution can be expressed in terms of quality grade, yield grade, and dressing percent.

The growth curve approach to fed steer growth offers one explanation of the fed steer's body composition. Two important issues bearing on this study and discussed in the animal sciences literature is whether or not the fed steer's diet and breed can affect its body composition. The pertinent aspects of those issues have been extracted from the writings of Nelson (44) and Owens (47).

Effect of Plane of Nutrition on Body Composition. In separate syntheses summarizing the findings of studies dealing with the effects of diet on the body composition of fed steers, both Nelson and Owens were careful to stress that the findings were to be interpreted on the basis of equal fed weights, and not equal times on feed. The consensus of their consolidated findings is that body composition is influenced by the fed weight, not by the plane of nutrition. Both studies define percent composition as the quotient of fed weight to mature weight.

The body composition of a steer exhibiting compensatory gain is important to this study. Study of the findings of Nelson and Owens leads to the conclusion that previous feed intake restriction has little or no influence upon the body composition of animals slaughtered at equal weights (44)(47). Topel concluded that level of energy consumption, when regulated by level of feed intake, has no major influence on dressing percentage, carcass quality, or upon the percentage of muscle, fat, and bone in the carcass when the cattle are slaughtered at an equal slaughter weight (61). An Iowa study comparing the effects of a high corn and a high corn silage ration upon body composition concluded that the concentration of energy in the ration has little or no influence upon body composition (17).

Both Nelson and Owens make reference to mature body size in their discussions of body composition. Owens notes that mature body size is largely a function of genetics or hormones and that animals of a species have reasonably similar body compositions at maturity (47). Nelson provides estimates of mature body weights for each of the three types of this study (44).

Effect of Breed on Body Composition. The effect of breed on composition is important to the analysis. A paper based on data from the U. S. Meat Animal Research Center concluded that sire breed had three to four times as much influence as did nutritional treatment (59).

A large difference in body composition was reported between the English and Charolais types, with the Charolais crosses exhibiting less fat and larger ribeye areas. The difference was explained in terms of the different mature weights between English and Charolais breeds. It was argued that for any given weight, the Charolais breed is not as "mature" as the English breed and therefore not as fat. It was reported that the Charolais would attain the choice grade but at considerably heavier weights than the English cattle. It was noted that the weights at which the Charolais would grade would be at a percent of the Charolais' mature body size that would be equal to the English breed's percent of mature body size for comparable grades.

Extracts from Owens' introduction and conclusion provide an appropriate summary for the discussions of the growth curve approach, its relationship to body composition, and to the influence of plane of nutrition and breed on body composition. Owens notes that animals follow a specific growth curve from conception to adulthood, with muscle and fat depositions occurring in the latter stages of life. Owens further notes that the carcass composition of steers is influenced primarily by weight within a breed or type. Nutritional factors including forage or concentrate level on restricted growth will influence the time to make grade, but not the weight to make grade. Exotic breed crosses appear to increase the mature size of an animal which makes it necessary to feed the exotic crosses to heavier weights in order to have them attain grades comparable to their straightbred counterparts (47).

Effect of Sex on Body Composition. This analysis assumes the feeding of steers only. Cost coefficients developed for the feeder calf producing sectors assume that both male and female calves would be dropped. The model is general enough to facilitate an analysis in which only heifers would be fed.

After reviewing the literature, Nelson concluded that differences in growth and composition by sex is due predominantly, if not entirely, to differences in mature size and rate of maturing (44). Thus, the same assumptions and procedures of analysis being used in this study for steers would be equally applicable for heifers.

The Derivation of Dressing Percent, Quality Grade, and Yield Grade Value Attributes

Three attributes merit attention because they are determinants of product value and are generated from prediction equations developed in Nelson's companion study (44). The use of Nelson's dressing percent, quality grade, and yield grade prediction equations is the first direct application of Nelson's work to an applied problem in the fed beef system. These equations also serve as a link between the two studies.

Dressing percent is defined as the percent of hot carcass weight to slaughter weight. The difference between slaughter weight and carcass weight is primarily offal, which is a much less valuable product on a per pound basis than either the slaughter steer or the carcass. In this analysis, gross returns to the feeding sectors are based on slaughter weight, while calculations of gross returns to the slaughtering sectors need to consider both offal value and carcass value.

Nelson derived separate dressing percent prediction equations for each of the three types of cattle. A dummy variable regression technique was used to derive these equations with the value for the HEHE type serving as the intercept. The only independent variable employed by Nelson was percent of fat in the empty body, BODFAT (%). The rationale behind its use may be found in the companion study (44). The equations required for its derivation are outlined in Appendix A.

The Omnitab programs in Appendix G calculate dressing percent, quality grade, and yield grade values for alternative weights and types. These values were used to calculate coefficients for the general linear programming model. The prediction equations developed by Nelson for dressing percent are given in Table IX; for quality grade in Table X, and for yield grade in Table XII.

TABLE IX

DRESSING PERCENT PREDICTION EQUATIONS BY TYPE

Type	Dressing Percent Prediction Equation
JRAN	57.054 - 1.26882 + .1341 [BODFAT (%)]
HEHE	57.054 + .1341 [BODFAT (%)]
CHHE	57.054 + .51274 + .1341 [BODFAT (%)]

Source: Nelson, Kenneth Ervin. "A System Analysis of Information and Communication in Beef Marketing." (Unpublished Ph.D. dissertation, Oklahoma State University, 1974), p. 98.

Quality grade serves as a palatability index. Palatability tends to be a subjective measure of the tenderness, juiciness, and flavor of the cooked lean meat. Quality grade determinations are based on the fed beef steer's degree of marbling, maturity, and conformation (20).

Marbling refers to the amount and distribution of small flecks of fat within the lean. Its definition draws upon the earlier discussion of body composition and quality grade. That discussion indicated that plane of nutrition had no effect on body composition, but that breed had an effect. Thus, type affects quality grade.

Maturity is a proxy for the age of the animal at slaughter. Since the analysis provides for the slaughter of the fed steer before it is 16 months of age, or mature, this variable is of no immediate interest in the analysis.

Conformation is defined as thickness in relation to length. Although conformation is a function of breed, it can be related only to breed while the animal is alive and the type can be identified. Since the quality grade prediction equations fail to provide for incorporation of this variable and the fed steer in the analysis is hypothetical, this variable also is of no immediate interest. The quality grade is known with certainty only after the fed steer is converted into a cold carcass. Estimates of quality grade, however, are incorporated into the determination of selling price.

Nelson incorporates probability distributions reflecting the ability of buyers to estimate quality and yield grades (44). Although this study does not use Nelson's probability distribution estimates, it does provide for a distribution of quality grades for the slaughter steer, carcass, and lean meat cuts associated with the discrete fed weights.

The quality grade prediction equations developed by Nelson for each type are presented in Table X.

TABLE X

QUALITY GRADE PREDICTION EQUATIONS BY TYPE

Type	Quality Grade Prediction Equations
JRAN	4.1932 + .29558 + .17646 [BODFAT (%)]
HEHE	4.1932 + .17646 [BODFAT (%)]
CHHE	4.1932 + .48188 + .17646 [BODFAT (%)]

Source: Nelson, Kenneth Ervin. "A System Analysis of Information and Communication in Beef Marketing." (Unpublished Ph.D. dissertation, Oklahoma State University, 1974), p. 98.

The numerical values calculated from the prediction equations for dressing percent are the dressing percents. The numerical values calculated for quality grade, however, are only indexes for one of three graduations of the Prime, Choice, and Good quality grades. Fractional parts of a calculated quality grade are dropped, and the quality grades recorded as shown in Table XI.

The yield grade serves as an index of the amount of trimmed retail cuts that can be obtained from a beef carcass (20). Yield grade determination is based on the following four variables: (1) backfat thickness, (2) square inches of rib-eye area, (3) percent of kidney, heart, and pelvic fat, and (4) pounds of carcass weight.

TABLE XI

NUMERICAL VALUE DESIGNATIONS FOR QUALITY GRADES

Numerical Value	Quality Grade
15	Prime +
14	Prime
13	Prime -
12	Choice +
11	Choice
10	Choice -
9	Good +
8	Good
7	Good -

The first three variables can be readily related to the earlier discussions of composition. Those discussions indicated that breed had an effect on body composition. Thus, type alone is important in yield grade determinations because of its effects on the quantity and distribution of fat and muscle. For a given plane of nutrition and length of time on feed, type affects carcass weight. Thus, type exerts an influence on yield grade through its effects on all four factors affecting yield grade determination.

As with quality grade, the yield grade is never known with certainty until the carcass is converted into pounds of lean meat. In this study, the yield grade distribution was not used to assign monetary value to the fed steer. The calculated yield grade, however, was used to establish value for the carcass and lean cuts. Nelson's set of yield grade prediction equations for each type are given in Table XII.

TABLE XII

YIELD GRADE PREDICTION EQUATIONS BY TYPE

Type	Yield Grade Predicted Equation
JRAN	.27859 + 0 + .09519 [BODFAT (%)]
HEHE	.27859 + .09519 [BODFAT (%)]
CHHE	.27859 - .40517 + .09519 [BODFAT (%)]

Source: Nelson, Kenneth Ervin. "A System Analysis of Information and Communication in Beef Marketing." (Unpublished Ph.D. dissertation, Oklahoma State University, 1976), p. 96.

In this analysis, calculated yield grade numerical values are adjusted to mid-range values. Thus, a calculated yield grade of 2.2 or 2.8 is read as yield grade 2.5. Following mid-range adjustment, the appropriate percentage factor to use to convert cold carcass weight into lean meat is given in Table XIII.

According to Table XIII, this study follows the USDA in using a

4.6 percent difference in trimmed retail cuts for the entire carcass between yield grades. Work at Oklahoma State University has questioned the accuracy of the 4.6 percent difference between yield grades using the argument that industry does not trim its fabricated lean cuts in accordance with the assumptions that underlie the terms in the USDA's yield grade formula (54). An interesting application of the model may entail an analysis of the effects upon the sectors of the fed beef system from modification of the USDA yield grade formula to make it conformable with the OSU study. Although the value of the slope coefficient for each attribute is the same for each type, the magnitude of the BODFAT (%) variable differs between types because of their different mature weights. As a result, the values for the attributes will differ between types for a given fed weight. For this reason, Nelson used BODFAT (%) and not fed weight as the independent variable in the prediction equations.

TABLE XIII

YIELD GRADES AND CORRESPONDING PERCENTS OF TRIMMED RETAIL CUTS IN THE CARCASS

Yield Grade	Percent of Trimmed Retail Cuts in Carcass
1.5	82.0
2.5	77.4
3.5	72.8
4.5	68.2
5.5	63.6

The Economic Complexity of Alternative Fed Weights

The earlier discussions of body composition indicated that the intramuscular and subcutaneous fat were the latest developing components of the body. Nelson's prediction equations account for this phenomenon of growth through incorporation of the percent of body fat as the independent variable in the dressing percent, yield grade, and quality grade prediction equations. The fat content of the body increases with increases in fed weights.

An increase in fed weight increases both the absolute and percentage quantities of fat in the body. According to Nelson's equations, increases in fed weight shifts the quality grade upward from the relatively low value Good grade to the relatively higher valued Choice and Prime grades. The same increases in fed weights, however, shift the yield grades from the relatively high cutability index value of 1 to the relatively low cutability index value of 5.

The third variable to consider is the dressing percent. Dressing percent increases as fed weight increases; but increases in fed weights require increasing amounts of feed for maintenance.

The economic question is whether the increase in revenue from improvement in the quality grade and dressing percent is sufficient to offset the lower return of a deteriorating yield grade and increased cost of gain associated with an increase in fed weight. The profit-maximizing answer varies among the alternative arrangements of the fed beef system.

Research findings support the assumption that the diet has no effect on the composition of the body, but that it does affect the rate of growth (24)(47)(50)(61). An understanding as to why and how the diet affects the rate of growth is available from a digression into the net energy system.

The Net Energy System for Feedstuffs

A minimum number of nutritional terms and concepts need to be examined because of their bearing on the development of coefficients for the general linear programming model. The contributions of Fox and Gill to the Great Plains Beef Cattle Feeding Handbook series provide adequate terms and concepts for this study (18)(21)(22). A physiologically-oriented study of the fed beef system would require a more supportive set of scientific references.

The energy value of feedstuffs may be discussed in terms of systems of gross energy, digestible energy, metabolizable energy, total digestible nutrients, or net energy. Although there is a definite relationship between these systems, the net energy system was chosen for this study primarily because rations inputed into the Beef Gain Simulator need to be expressed in terms of net energy values.

In addition, the net energy system is probably the best of all systems developed so far for evaluating the energy value of feedstuffs, because it adjusts for variations in heat loss as well as for other energy losses which makes net energy values more consistent between feeds. It also provides for the separation of feed energy value into net energy for maintenance, NE_m, and net energy for gain, NE_g. This separation tends to further minimize the variations in energy values from one feed to another.

The ability to separate feedstuffs into NE_m and NE_g values allows for a more accurate prediction of gains from a given combination of feedstuffs (18). This enhances the validity of the coefficients developed from the Beef Gain Simulator for use in the general linear programming model.

The NE_m and NE_g system of evaluation feedstuffs was developed by Drs. Lofgreen and Garrett, at the University of California. For purposes of this study, net energy may be defined as the energy remaining after digestive losses, gas losses, urinary losses, and work of digestion are deducted, or simply as the amount of energy left either for maintenance or gain (22).

The net energy required for maintenance, NE_m, is equal to the basal heat production of an animal, or the heat produced by the animal when it is not consuming feed (22). In terms of the feed itself, the net energy value of a feed for maintenance (NE_m) represents the energy in the feed per pound that is available for supporting the animal's maintenance functions such as beating of the heart and functioning of the other organs and muscular activity. The energy value of a feed for growth (NE_g) represents the energy in a feed per pound that is available for supporting growth of body tissue, and is actually deposited as protein and fat tissue gain in beef cattle (18). The procedures for determining the NE_m and NE_g in a feed are not relevant to the study, but may be found in the literature. The procedures for calculating the NE_m and NE_g in the rations fed by the MARC are outlined in Appendix B.

The net energy system provides for the incorporation of tenets surrounding feedstuffs and growing animals into the development of coefficients for this analysis. The net energy system recognizes that any feed used for maintenance has a higher energy value than the same feed used for gain (22).

The net energy system also recognizes that maintenance requirements increase in relation to surface area. For this reason, the computational formula for determining maintenance requirements uses metabolic weight instead of actual weight. The net energy for gain requirement increases as more fat and less protein and water are included in the gain. This tenet may be combined with the earlier note that fat deposition was the latest maturing component to support the conclusion that older animals have greater NE_m and NE_g requirements (22).

Maintenance requirements are the same for both steers and heifers. Gain requirements, however, differ with the sex of the animal and with the energy content of the produced gain. Separate equations have been developed for estimating the NE_m and NE_g requirements for both steers and heifers. The respective maintenance and gain requirement equations for steers are

$$NE_m = 0.77W^{0.75}, \text{ and}$$

$$NE_g = (0.05272g + 0.00684g^2)(W^{.75})$$

where W is animal weight in kilograms, $W^{.75}$ is metabolic weight in kilograms, and g is gain per day in kilograms. The NE_m and NE_g requirements are stated in meal per day.

The net energy system assumes that the ration is balanced in terms of protein, vitamins, minerals, and all other nutrients (22). The analysis assumes that the duplicated MARC low energy rations and the hypothetical high energy rations are balanced rations. This assumption is not crucial to the analysis because this study does not base its coefficients upon results obtained from the actual feeding of a steer, but from the hypothetical feeding of a steer. There are any number of factors from extrememes in weather and cattle to pen conditions and compensatory growth that will reduce the predictability of gains from any system designed to evaluate the net energy value of feedstuffs. The literature notes, however, that while no system adjusts for all variables, the net energy system appears to eliminate more variables than other systems (18).

The first characteristic of the system has implications for the extremes in types of cattle under study. The literature indicates that with small early maturing cattle, the published NE_g values for each increment of gain are probably too low when these cattle reach the 750 to 1000 pound and up range. With large breeds such as the Charolais, the requirements for gain may be slightly lower than those shown in the table, because these cattle do not lay down fat as rapidly as do the smaller breeds at the lower weights (22). Adjustment equations to correct the net energy system for early maturing and late maturing cattle have not yet been published (44).

Another characteristic of the net energy system that has implications for the validity of model coefficients is that its tables were developed using steers that had been either fed or implanted with stilbestrol. The current ban on use of growth promotants in feedstuffs means that gains will be down about 10 percent from those reported in the table (22). There was no attempt to adjust the tables, since there was no known adjustment technique. Since the tables were applied uniformly over the three types of cattle, the relative effects were assumed to be equal. The absolute effects, however, are more significant for the sectors permitted to feed.

Net energy tables express the net energy values of feeds on either a 90 or 100 percent dry matter basis (22). This study uses net energy tables published by the National Research Council (NRC). These tables use a 100 percent dry matter or absolute moisture basis. The important point is that the moisture content of the feed affects its net energy values on a per pound fed basis, but not on a standard dry matter basis of 90 or 100 percent. For this reason, the assumptions made regarding the moisture content of the feedstuffs must be considered by future users of this study because of the effects of moisture on net energy values and feedstuff costs.

Feed preparation techniques affect net energy values. The roughage-concentrate ratio and the total balance of nutrients probably interact with feed processing techniques to affect net energy values (22). This study assumes that these are neutral variables, since the feeding function is hypothetical.

Three major determinants of the nutrient requirements of animals are related to basic assumptions and procedures underlying the analysis (21). The first determinant of nutrient requirements is the sex and size (weight) of the animal. Steers were used in this study because they constitute the majority of all fed animals. It is sufficient to note that the Beef Gain Simulator automatically provides for the provision and subsequent accounting of nutrients as weight changes throughout the feeding period.

A second determinant of nutrient requirements is the level of production or daily gain. One of the explicit procedures requires the Beef Gain Simulator to duplicate applicable segments of either one or both of the MARC growth curves as the basis for analysis. The results determine the level of daily gains and the associated set of feed requirements and non-feed costs. These are subsequently recorded by the Beef Gain Simulator and are extracted as coefficients for incorporation into the general linear programming model.

The third determinant of nutrient requirements is the nutrient intake quantity. The duplication of applicable segments of one or both MARC growth curves is achieved through manipulation of the Beef Gain Simulator's feeder grade. The feeder grade controls the nutrient intake.

The last topic to be considered under basic growth relationships is the respective influences of forages and concentrates upon the assumptions and procedures used in developing model coefficients. While both the economic and nutritional dimensions need to be considered in assessing the influence of these two general classes of feedstuffs, only the nutritional dimension will be considered at this time. The economics surrounding the use of forages and concentrates as alternative feedstuffs was discussed in Chapter II.

The Nutritional Influence of Forages and Concentrates Upon Coefficients

Documentation was provided earlier to support the assumption that for equal fed weights within a type, the plane of nutrition does not affect the composition of the fed steer's body. By extension, it was inferred that since the plane of nutrition does not affect the composition of the body, it also does not affect the value determining attributes of quality grade, yield grade, and dressing percent.

In this study, the plane of nutrition is a function of the respective forage and concentrate compositions of the four rations fed in conjunction with a defined feeding regime. Although arbitrary, any feeding regime in which three of the four rations contain more than 40 percent forage or concentrate may be considered low energy or high energy, respectively.

The plane of nutrition affects the rate of growth. Nutritional facts accounting for differences in rate of growth between feedstuffs have been summarized from the writings of animal nutritionists (18)(21)(22).

There is considerable variation among feeds in NE_m and NE_g values. All feeds have higher net energy values for maintenance than for growth. Roughages are lower in both NE_m and NE_g than are concentrates, for two reasons.

First, the relatively greater fiber content of roughages results in less digestible energy and greater feces losses. Secondly, the process of transforming energy in the feed into a form usable by the animal yields metabolizable energy losses which are proportionately higher in roughages than in grains (22). As a result of various digestive and metabolic processes, it has been estimated that about 60 percent of the total combustible energy in grains and about 80 percent of the total combustible energy in roughages is lost as feces, urine, gases, and heat.

In addition to the fact that the NE_m and NE_g of roughages is lower than concentrates, the rate of growth is slower with roughages than with grains because the animal can eat only between 22 and 26 pounds of dry matter per day (21). The animal will eat more total pounds of roughages than grains, but the roughages have a much higher moisture content, so that on an equivalent dry matter content basis more concentrates are consumed daily. Thus, concentrates provide more NE_m and NE_g than roughages, which means a more rapid rate of growth.

Review of the literature on forages and concentrates indicates that it is possible to switch rather rapidly from a grain to a forage ration, but not from a forage to a grain ration (18). The compensatory gain feeding regimes discussed in the general model do not make provision directly for the gradual introduction of grain into the ration. The compensatory gain feeding regime is created through the Beef Gain Simulator via feeder grade adjustments. The adjustments in the feeder grade parallel relatively greater increases in NE_m and NE_g values due to heavier concentrate rations.

Additional general observations regarding concentrates and forages support implicit assumptions embodied in the study. The first observation is that the fed steer's NE_m and NE_g requirements do not vary for different concentrate-forage rations. A second observation is that the net energy system can account for any combination of concentrate-forage rations (22).

These observations plus the fact that the Beef Gain Simulator simply works on the basis of inputed NE_m and NE_g values negates the need for undue concern over the composition of the ration from a nutritional standpoint. The economics of ration composition, however, cannot be and is not ignored as it is central to the analysis. The observation that the ruminant animal requires a minimum amount of roughage for normal rumen functions is noted and is assumed to be satisfied by all rations used in the study (21).

Because of its central role in the creation of non-feed cost and feed consumption coefficients for the general linear programming model, there is a need for establishment of the historical and philosophical rationale which supports employment of the Beef Gain Simulator in this study. The discussion of this topic is followed by treatment of the rationale underlying development of the Beef Gain Simulator's input parameters.

Key Ideas Underlying Employment of the Beef Gain Simulator

The MARC initiated a cattle germ plasm evaluation program beginning with the 1969 breeding season and continuing into the present. From that program, production data on growth, feed efficiency, reproduction, maternal ability, and carcass and meat traits for fourteen types of cattle have been made available to the public (71). The production data on reproduction and maternal ability has already been incorporated with economic data to generate costs of production coefficients for the feeder calf-producing sectors by type.

Three of the fourteen types were selected for this analysis. The criteria used to select the three types was their overall representation of the range in physical sizes to 1974 cow herds. In terms of physical size from smallest to largest and with breed of the sire given first, the types selected for analysis include Jersey-Angus (JRAN), Hereford-Hereford (HEHE), and Charolais-Hereford (CHHE).

The U. S. Meat Animal Research Center fed a total of 81 JRAN steers, 69 HEHE steers, and 78 CHHE steers drawn from its 1970-71-72 calf crops (4, Table 5). A total of four rations was fed to these steers and the adjusted final weights attained on these rations after an average of 212, 247, and 279 days on feed became part of the production data report (71). Additional data regarding actual consumption level by kind of feedstuff were not available. Fed weights at other intermediate points also were not available for analysis.

The MARC rations were found to be relatively high in corn silage. Subsequent net energy evaluations of the rations showed them to be relatively low in net energy for maintenance, NE_m, and net energy for gain, NE_g. Because of their low net energy levels, these rations produced low energy growth curve of analysis.

The OSU Beef Gain Simulator provided an opportunity to create a live weight feeding cost data base for analysis based on the four low energy Clay Center rations and the reported growth of the fed steer. In addition, it provided an opportunity to increase the energy concentration of the rations through the substitution of corn for corn silage and thus to create a data base based on a high energy plane of nutrition. The procedures followed in calculating the composition of the rations, NE_m, NE_g, feedstuff prices, and magnitudes of the non-feed cost components are presented in Appendix B. The applicable parameters resulting from those calculations become inputs into the Beef Gain Simulator.

The feeding regimes are created through manipulation of the Beef Gain Simulator input parameters. The purchase weight and rate of shrinkage become proxies for previous plane of nutrition, source of acquisition, and number of ownership changes. The inputed ration cost, NE_m, and NE_g define the plane of nutrition. Given these input parameters, the growth curve defined by the feeding regime is "tracked" through manipulations of the feeder grade. Manipulation of the feeder grade creates a relatively superior or inferior feeder calf automatically. The analysis, however, is based on the production and economic data of different feeding regimes which "track" common growth curves. There is no known publication documenting the relative superiority of the feeder calf on the basis of the magnitude of the feeder grade. Therefore, the analysis assumes that the feeder calf possesses the requisite feeder grade needed to satisfy the requirements of the feeding regime.

The Beef Gain Simulator and Its Input and Output Parameters

The Beef Gain Simulator is described as a computer program for predicting feed consumption and live weight gains of average feedlot cattle under average weather conditions and the assumptions embodied in the input parameters (23). The Beef Gain Simulator was constructed from the historical performance of average cattle and the net energy system for evaluating both feedstuffs and the requirements of feedlot cattle.

The Beef Gain Simulator creates alternative feeding regimes through duplications of applicable segments of either the historical low energy MARC growth curve, or the generated high energy curve. A computer printout reflects total feed consumption and feeding costs by fed weight and feeding regime. Feed consumption data by feedstuff and non-feed cost data, associated with a given fed weight and feeding regime, are extracted from the computer printout manually for use as model coefficients.

Beef Gain Simulator input parameters associated with each feeding regime and type of cattle are recorded in Tables LXII, LXIII, and LXIV of Appendix C. The nutritional and physiological rationale underlying the development of these parameters has already been presented. Justification for the use of specific costs and returns values will be provided in the discussion.

<u>Sex</u>. Since the analysis is in terms of steers, the number 1 is inputed into the Beef Gain Simulator's control program.

<u>Purchase Weight</u>. The feeder calf's weaning weight becomes the input parameter for purchase weight. An equal purchase weight is inputed regardless of whether the calf enters the feedlot by way of auction sale or through direct transfer from the cow herd. The purchase weights by type are JRAN, 455 pounds, HEHE, 450 pounds, and CHHE, 493 pounds.

<u>Purchase Cost/cwt</u>. It is assumed that the feeder calf is sold on the basis of weight only, and that there is no price discrimination on the basis of type for comparable weights. There is a need to distinguish between the purchase cost/cwt of transferred feeder calves and auction acquired feeder calves, because of the effects this variable has on death loss cost and interest cost.

The purchase cost of a transferred feeder calf is its per pound cost of production adjusted for hauling and marketing charges. Since the feeder calf can be transferred only by its producer, there are no marketing charges. The hauling charge is a specific input charge into the Beef Gain Simulator. Double-counting needs to be avoided by either incorporating the hauling charge into the purchase price/cwt and inserting a 0 freight charge into the Beef Gain Simulator, or by isolating the hauling charge from the computations of the purchase price/cwt and inserting a hauling charge into the Beef Gain Simulator. The latter alternative was chosen because it provides for greater uniformity of cost computations between all feeding regimes. It also ensures greater uniformity in non-feed cost computations between the transferred and auction acquired feeder calf. In addition, it assigns hauling costs on the basis of weight. Computations of total purchase cost and identification of purchase cost components by types at alternative feeder calf weights are provided in Tables LXV, LXVI, and LXVII, of Appendix D.

Starting Factor. The starting factor is defined to be the percent (to the nearest 10 percent) of normal consumption that the animal will eat in the first ten days (23). There is no basis for varying the magnitude of this parameter between types or feeding regimes. Thus, it is inputed at 0.8.

Feeder Grade. The authors of the Beef Gain Simulator define feeder grade to be the animal's "gain ability" (23). It is the principal mechanism used to create feeding regimes through duplication or "tracking" of applicable segments of the low and high energy growth curves. The feeding regime and type of cattle determine the magnitudes of the feeder grades. Since feeder grades are inputed with rations, the creation of a given feeding regime may require the assignment of up to four different feeder grades.

Medical Cost/Head. A uniform medical charge of $3.00 was levied against the animal at every change in ownership under the assumption that a new owner chooses to vaccinate rather than take the risk of feeding an unvaccinated steer.

Shrinkage Percent. The magnitude of the shrinkage percent is used to distinguish the auction acquired feeder calf from the transferred feeder calf. In this study, the procedure for assigning shrink against the feeder calf varies with whether the calf has just been weaned, or whether it has been on feed.

Regardless of type, a 9.5 percent shrink is inputed in the Beef Gain Simulator against a freshly weaned auction acquired calf. The magnitudes of the assessed shrink are based on reported research findings and the judgment of OSU extension personnel (56). A greater shrink is levied against the auction acquired feeder calf, since the auction method of transferring ownership entails more physical movement and greater exposure to stress and disease.

Shrink was not explicitly assigned in the Beef Gain Simulator against the feeder calf which had been on feed for 77 or 133 days prior to auction sale. The purchase weight inputed into the Beef Gain Simulator, however, is only 94 percent of the live weight. Thus, the heavier stocker is shrunk six percent to the seller, but 0 percent to the buyer.

Selling Weight. The model necessitates the consideration of two broad categories of selling weights. The first entails the sale of the stocker while the second entails the sale of the fed steer. The model provides for the cow-calf, stocker, or integrated sectors to sell the stocker after either 77 or 133 days on the low energy plane of nutrition. The sell weight is 94 percent of the live weight, as there is a six percent shrinkage associated with stockers. The live weight after 77 or 133 days on the low energy plane of nutrition is a function of whether the stocker was acquired from the auction or transferred from the cowherd.

The maximum low energy and high energy weights permitted by the model are attained after the animal has been on feed for 279 days. The fed steer may be sold at fed weights lighter than the maximum low energy and high energy weights.

Sale of the fed steer, unlike sale of the stocker, is governed by the fed weight and not by the number of days on feed. Recall that the model permits the steer to be fed for a maximum period of 279 days.

Regardless of the feeding regime, there is but one maximum fed weight associated with the low energy growth curve and one maximum fed weight associated with the higher energy growth curve. The maximum fed weights, however, vary between types of cattle. The maximum fed weights for the low energy growth curve by type are JRAN, 1030 pounds, HEHE, 1090 pounds, and CHHE, 1189 pounds. The maximum fed weights for the high energy growth curve by type are JRAN, 1100 pounds, HEHE, 1162 pounds, and CHHE, 1261 pounds.

Regardless of type, the sell weight of the fed steer is 96 percent of its fed weight. The difference represents a four-percent shrink due to transportation from the feedlot to the packing plant. The four-percent shrink follows USDA calculations of costs and returns to a hypothetical Panhandle steer (65).

The model provides for the sale of the fed steer in discrete 25-pound live weight increments. The lightest fed weights of sales correspond to the lightest slaughter weights reported by the MARC (71). Since the MARC slaughtered its first batch of test animals after 212 days on feed, fed steer sales were permitted when fed weights equalled those of the MARC types after they had been on feed for 212 days. The lowest fed weights by type of cattle are JRAN, 929 pounds, HEHE, 955 pounds, and CHHE, 1074 pounds.

The alternative selling weights for each type were determined by weights for both the low energy and high energy planes of nutrition until the remainder equalled the 212 day low energy fed weight. This procedure resulted in uniform sets of selling weights regardless of feeding regime for each type. These weights are reported in numerous tables, but consolidated sets by type are presented later in Tables XVI, XVII, and XVIII.

Selling Price/cwt. The selling price per hundredweight is a function of both the fed weight and the quality grade distribution associated with the fed weight. The quality grade associated with a given fed weight from a particular type is determined in accordance with Nelson's quality grade prediction equation (44). A distribution of quality grades around a particular fed weight results from the assumption of a 150-pound weight range in pens of fed cattle.

Since the standard error is 25 pounds and the weight range is 150 pounds, a standard normal Z-distribution can be used to determine the quality grade distribution. The distribution is then multiplied by the 1974 fed steer price for that quality grade to yield a weighted 1974 price. That price is unique to a particular sell weight and type. The set of 1974 average fed cattle prices for the Omaha market used in deriving the selling prices is as follows: Choice, 900-1100 pound, \$41.96; Choice, 1100-1300 pound, \$41.81; Good, 900-1100 pound, \$38.76, and Good, 1100-1300, \$38.48 (67).

Equity/Head. This parameter identifies the dollars of equity in the feeder on which interest will not be charged (23). In order to achieve the greatest consistency between feeding regimes, a value of 0 was inputed for this parameter.

Interest Rate Percent. Informed judgment suggested that a representative non-real estate interest rate for 1974 would be 12 percent.

Overhead/Head/Day. On the basis of an OSU extension economist's judgment and the writings of one of one of the Beef Gain Simulator's creators, the daily overhead charge for 1974 was inputed at \$.15 per head per day (21).

FRT + Comm/Head. Although inputed as a single value, the freight and commission charges were calculated separately since the freight cost was assumed to be a function of weight. The freight charge was based on the USDA formula of \$.20 per hundredweight per 100 miles (65). Both the feeder calf and fed steer were assumed to be hauled 150 miles. A fixed buying commission of \$1.50 was added to the freight cost and the sum inputed into the Beef Gain Simulator.

In Date. This information is used to indicate the date (month, day, and year) on which feeding begins and could be important to analyses which attempt to account for the influence of weather. The inputed value has no special significance for this study.

Death 1. By itself, this parameter is meaningless. Together with the Day 1 parameter, it becomes a determinant of death loss cost. The magnitude of the Death 1 parameter depends upon whether the feeder calf is freshly weaned or whether it has been on feed, and whether it was acquired through an auction or transferred by a producer.

A freshly weaned auction acquired feeder calf is assumed to experience a 1.5 percent death loss in the first 25 days after being placed in the feedlot. A freshly weaned transferred calf is assumed to experience only a one percent death loss in the first 25 days.

Regardless of the prior method of acquisition, a calf that has been on feed is assumed to suffer only a one percent death loss in the first 25 days. The rationale is that such a calf is larger and more hardy than the freshly weaned calf, and therefore has a smaller death rate.

Day 1. Informed judgment suggested a value of 25. Thus, the Beef Gain Simulator will compute death loss charges on the assumption that the inputed Death 1 percent of animals placed on feed will die within the first 25 days. Both the daily and accumulated death loss costs are available from the Beef Gain Simulator.

Death 2. The Death 1 discussion applies equally to Death 2. Informed judgment suggested a value of one percent.

Day 2. This value indicates the number of days on feed after the first 25 for which the one percent value cited in Death 2 is applicable.

Print Increment. This particular study required a print increment of 1. This parameter, however, has no real significance for the analysis.

Ration Data. A summary of the ration data inputed into the Beef Gain Simulator is presented in Table XIV. The procedures used in deriving the values reported in Table XIV are outlined in Appendix B.

TABLE XIV

LOW ENERGY AND HIGH ENERGY RATION DATA AS INPUTED INTO THE BEEF GAIN SIMULATOR

Ration Number	Number of Days Fed	Absolute Cost per cwt	Absolute NE_m	Absolute NE_g
		Low Energy Rations		
1	28	$4.19	78	48
2	49	4.45	81	51
3	56	4.96	85	54
4	$\leq$146	5.09	88	56
		High Energy Rations		
1	28	$4.90	85	54
2	49	5.35	89	57
3	56	5.70	93	60
4	$\leq$146	5.98	96	63

Procedures for assimilating input and output parameters of the Beef Gain Simulator into model coefficients for the feeding sectors need to be considered. Input parameters need to be distinguished from the output parameters.

Feeding Sector Coefficients

The output parameters of the Beef Gain Simulator which provide the non-feed cost and feed consumption coefficients for alternative fed weights in the general linear programming model were consolidated by feeding regimes and type. One of the 54 working sheets containing model coefficients is presented in table LXVIII of Appendix E. Two categories of costs applicable to the feeding sectors are feeder calf acquisition and feeding costs. The cost components within each category of cost are important both methodlogically and analytically.

Costs of Feeder Calf Acquisition

The four components of feeder calf acquisition costs are purchase price, medical, trucking, and buying commission. Trucking and buying commission costs are summed and inputed into the Frt + Comm/Head parameter as a single figure.

Feeder Calf Purchase Price. The model provides for the cow-calf and integrated sectors to either sell or transfer the feeder calf from the cowherd into the feedlot. In order to provide for the calculations of the non-feed interest and death loss costs, it was necessary to input a purchase price/cwt into the Beef Gain Simulator for the transferred feeder calf. The procedure for computing the purchase cost/cwt on the transferred calf was outlined earlier. Calculations of purchase prices of alternative types and weights of feeder calves acquired through the auction are detailed in Tables LXV, LXVI, and LXVII of Appendix D.

In order to distinguish consistently between the cost of producing the transferred feeder calf from the feeder calf sold at the auction, the total cost of production cited in Table VII is inputed into the general linear programming model under the calf cost of production activities. The transferred activities are credited with the difference between the hauling charge and the $5.00 hauling and marketing charge in the basic feeder calf cost of production budget.

The model provides for the stocker, feeder, and integrated sectors to purchase the feeder calf at weaning, after 77 days on the low energy plane of nutrition or after 133 days on the low energy plane of nutrition. The set of 1974 choice feeder calf prices used to calculate the purchases costs for alternative weights at the feeder calf is 400-500 pounds, $40.22; 500-600 pounds, $37.87; 600-700 pounds, $36.36, and 700-800 pounds, $35.54 (67).

The model provides for sale and purchase of the feeder calf at three different weights. The alternative weights at which the feeder calf may be purchased and placed on feed is one dimension to the definition of feeding regime.

The purchase cost of the calf is a function of its weight. Weaning weights were taken from the MARC report (71). Weights after 77 and 133 days on the low energy plane of nutrition are a function of whether the calf was transferred into the feedlot or acquired from the auction. Alternative weights at which the feeder calf may be bought and the acquisition costs associated with those weights by type are identified in Tables LXV, LXVI, and LXVII of Appendix D.

Medical Cost Per Head. A charge of \$3.00 for medication is levied against the feeder calf every time it undergoes a change in ownership through the auction. Since the basic feeder calf production budget, Table I, provides for medication, the transferred calf is assumed to have been vaccinated and is, therefore, not charged for medication. The \$3.00 medical charge appears in every table of Appendix D. The presence or absence of a \$3.00 medical charge within tables of Appendix C identify feeding regimes by distinguishing between auction acquired and transferred feeder calves.

Trucking. The trucking charge is calculated on the basis of \$.20 per hundredweight per hundred miles (65). Since both the auction acquired and transferred feeder calf are assumed to be hauled 150 miles, the freight charge is computed by multiplying the weight by \$.003. The exact trucking charge for a given weight of feeder calf may be found in the appropriate table of Appendix D.

Buying Commission. A fixed cost of \$1.50 was levied against the animal at every change in ownership regardless of weight. The magnitude of the buying commission was based on earlier research dealing with marketing methods (31) and telephone conversations with livestock commission firm personnel. The charge applies only to the auction acquired feeder calf. Its presence within the tables of Appendix C also identifies feeding regimes by distinguishing between the auction acquired and transferred feeder calf.

Cost of Feeding

Feeding costs consist of non-feed costs and feed costs. The Beef

Gain Simulator is used to determine non-feed costs and quantities of feedstuffs consumed over serial fed weight increments. Feed costs are calculated internally through execution of the MPSX program. This feature of the model permits analyses of alternative feedstuff prices.

Non-feed Costs. Non-feed costs include overhead, death, and interest. The non-feed cost coefficients in Table LXVIII of Appendix E are serial cost contributions between fed weight increments. These coefficients differ between types and feeding regimes. The coefficients from 54 tables similar to Table LXVIII were needed to model the feeding activities.

The coefficients in these tables were extracted manually from the output of 54 Beef Gain Simulator runs. To determine the non-feed cost of producing a given fed weight from Table LXVIII, sum the entries in the cost component's row up to and including the column giving the fed weight of interest. Next, sum the totals overhead, interest, and death loss cost components.

Feed Costs. A single value denoting feed cost for any fed weight is part of the Beef Gain Simulator's output. It, however, is not the coefficient inputed into the general linear programming model. Instead, the pounds of each feedstuff consumed between fed weight increments are inserted as coefficients.

The absolute per pound cost of each feed is entered as another set of coefficients into the general linear programming mode. Transfer row manipulations then provide for the interest computations of feed costs for a given weight.

The purpose behind this feature of the model's construction is to provide the model with the flexibility of evaluating alternative sets of feedstuff prices. This feature of the model is basic to the satisfaction of the general objective of the study.

The pounds of each feedstuff consumed are not part of the Beef Gain Simulator's output. These coefficients must be extracted from the consumption data which is part of the Beef Gain Simulator's output. Since the absolute percentage composition of each feedstuff in each ration is known from the tables of Appendix B, the absolute pounds of each feedstuff consumed can be derived through multiplication. The absolute pounds of corn silage, corn, supplement, and soybean meal become fixed coefficients for each serial increment of fed weight. In this model, only the absolute prices are subject to change.

The final step in the development of coefficients for the feeding sector is the determination of gross returns. The gross return is the product of sell weight and selling price.

Gross Returns to the Feeding Sectors

The fed steer is inputed directly into the integrated (Y) sector's packing plant. Its costs of production are carried forward with gross returns being deferred until the final product, lean meat, is sold.

It is assumed, however, that the stocker and feeder micro sectors sell the fed steer directly to the packer and incur no direct marketing costs. Thus, their returns are solely a function of the fed steer's selling weight and selling price. Both of these variables, however, are functions of other variables.

Selling Weight. The packer pays on the basis of the delivered weight, which is alternatively referred to as sell weight or slaughter weight. The sell weight is assumed to be 96 percent of the fed weight. The remaining four percent is assumed to be lost in transit in the form of shrink. The alternative sell weights by type considered in the model are listed in Tables XVI, XVII, and XVIII.

Selling Price. The selling price associated with a given fed weight for a particular type is a function of the quality grade distribution around that fed weight. The general procedure followed in determining the quality grade weighted price was discussed under the selling price/cwt input parameter. Appendix F further illustrates the procedure.

Procedures for the development of coefficients for the feeding sectors have now been outlined. Attention now turns to the development of coefficients for the sectors engaged in packing and carcass-breaking. Earlier background materials will be drawn upon implicitly or explicitly in the development of these coefficients.

Slaughter Sector Coefficients

The model permits only the packer and integrated sectors to slaughter the fed steer. There are two major sources of costs and two major sources of revenue. In this model, offal revenue offsets the cost of slaughter rather than contributing directly to revenue.

Slaughter Sector Cost Components

Two major categories of slaughter cost are fed steer acquisition cost and slaughter cost. Each category contains distinct elements.

<u>Fed Steer Acquisition Cost</u>. The fed steer acquisition cost coefficient is inputed into the general linear programming model. It is the total of fed steer purchase, trucking from the feedlot to the packing plant, and buying commission costs. Each element of cost and their total is identified by type and fed weight in Table LXXXIV, LXXXV, and LXXXVI of Appendix K.

Purchase cost is the product of sell weight and the weighted quality grade purchase price. It constitutes gross returns to the feeding sectors and appears in column 8 of Appendix H tables, and in Tables LXXIV, LXXXV, and LXXXVI of Appendix K.

Under the assumption of direct fed steer sale, the slaughtering sector pays the trucking charge from the feedlot to the packing plant. Given USDA rate of \$.20 per hundredweight per 100 miles and a distance of 150 miles, the trucking cost is obtained by multiplying the fed weight by .003 (65).

Under direct sale, the packer sector's buying cost is \$1.50 per head. This element of cost is an adjustment to a 1974 base of an earlier estimate of the direct buying (31). The integrated sector does not experience a buying cost.

<u>Slaughter Cost</u>. The elements of slaughter cost include the cost of killing, carcass chilling and storage, and carcass transportation to the breaking sectors. The cost of killing the fed steer is a fixed cost to the slaughtering sector, whereas carcass chilling and storage and carcass transportation costs vary with weight. The elements of costs and the gross slaughter cost by type and fed weights are summarized in Tables LXXVIII, LXXIX, and LXXX of Appendix I.

The cost coefficient for slaughtering activities inputed into the linear programming model is the net slaughter cost which is the difference between the value of offal and gross slaughter cost. Since offal is a revenue component, the procedures for determining its value will be explained later. Now it is time to outline the procedures followed in deriving values for gross slaughter cost components.

The 1974 fixed cost of killing the steer was calculated to be $13.61. The calculations entailed the use of USDA published index numbers on different items of slaughter plant costs to update Logan's 1965 estimates of slaughter plant costs to a 1974 period (69). Data and procedures are developed in Appendix L.

Slaughter produces a carcass whose hot weight is a function of the associated dressing percent. The carcass is assumed to be chilled and stored by the slaughtering sector for a period of at least twenty-four hours. The costs of chilling and storage were consolidated into one cost component, since both are calculated on a common weight basis. The carcass chilling and storage cost is treated as a variable cost because it is calculated on a per pound basis (13).

Litchy's costs were based on 1970 data (13). The rentals and services index on a 1967 base in 1970 was equal to 120. In 1974, the index was 157. Litchy's 1970 per pound carcass chilling and storage costs were $.009 and $.004, respectively. Adjustments of these costs to 1974 produces a per pound carcass cost of $.0118 and $.0052 for chilling and storage, respectively. Summed, the 1974 chilling and storage carcass cost equals $.017. This cost, by type and fed weight, is identified under column 16 in Tables LXXVIII, LXXIX, and LXXX of Appendix I.

In this model, the slaughtering sector transports the carcass to the carcass breaking sector. Litchy's 1970 per pound cost estimate for carcass transportation was $.010 (13). The transportation cost index on a 1967 base in 1970 was 117. In 1974, it was 162 (69). Adjustment to 1974 produces a per pound transportation cost of $.0138. The carcass transportation cost for a given type and fed weight is identified under column 15 of Tables LXXVIII, LXXIX, and LXXX in Appendix I.

The summed costs of killing the steer, chilling and storing the carcass, and transporting the carcass to the carcass breaking sector's plant are called gross slaughter cost. Given type and fed weight, the gross slaughter cost is identified under column 18 of Tables LXXVIII, LXXIX, or LXXX.

The Sources of Revenue to the Slaughtering Sectors

The two sources of revenue to the slaughtering sectors consist of the sales of offal and cold carcass. Model construction requires that the revenue coefficient be a summed value. Each source of revenue is computed in a slightly different manner.

Offal Revenue. In this study, offal includes all byproducts of slaughter including the hide. The value of offal is the product of sell weight and the average 1974 value of offal.

The sell weight has been previously defined as 96 percent of the fed weight. The 1974 average value of offal was calculated to be $3.82 per hundredweight (67). The weekly, monthly, and computed annual average offal values are presented in Table LXXXVIII of Appendix M.

As a model coefficient, the value of offal is subtracted from the gross slaughter cost and the difference recorded as the net cost of slaughter. These three values are given by type and fed weight in columns 19, 18, and 20, respectively, of Tables LXXVIII, LXXIX, and LXXX in Appendix I.

Sale of Cold Carcass. The revenue derived from the sale of the cold carcass is a function of the cold carcass weight, the quality grade weighted price of the cold carcass, and the yield grade. The magnitude of each determinant is derived either directly or indirectly from the fed weight.

Cold carcass weight is 98.5 percent of the hot carcass weight. The 1.5 percent difference is cooler shrink. Hot carcass weight is a function of dressing percent. The dressing percent is calculated from Nelson's dressing percent prediction equation (44).

The procedures for calculating the quality grade weighted price of the carcass are exactly the same as the procedures for calculating the quality grade weighted price of the fed steer. These procedures are outlined in Appendix F. The quality grade weighted carcass price associated with a given type and fed weight is identified under column 12 of Tables LXXV, LXXVI, and LXXVII of Appendix H.

The product of cold carcass weight and the quality grade weighted carcass price yields a base value for the cold carcass. The base value applies to a carcass with a yield grade of 3.5. A cold carcass with a smaller (superior) yield grade commands a premium, whereas a carcass with a higher yield grade sells at a discount.

The magnitude of the premium or discount applied to the base carcass value is a function of the additional pounds of lean in the carcass and the packer's per pound share of that lean value. The additional pounds of lean in the carcass is a function of the yield grade. According to USDA standards, the lean in the carcass changes 4.6 percent per yield grade. The additional pounds of lean in the carcass of different types and fed weights are identified under column 11 of Tables LXXVIII, LXXLX, and LXXX in Appendix I.

The slaughtering sector's per pound share of the additional lean is a function of its bargaining power and the wholesale price for the particular quality grade of lean. Determination of the slaughter sector's bargaining power was beyond the scope of the study, so it was assumed equal to the breaking sector's bargaining power. Hence, it was assigned a value of .5.

The wholesale price for the particular quality grade of the lean is the quality grade weighted price determined in accordance with procedures outlined in Appendix F. The derivation of the base wholesale lean meat price is developed in Appendix O.

Once established, the quality grade weighted price is multiplied by the bargaining strength value of .5 and the product recorded as the packer's per pound share of the additional pounds of lean in the carcass. Subsequent multiplication of that product times the additional pounds of lean in the carcass yields the magnitude of the premium (discount) accruing to the packer from the sale of a carcass with a yield grade less (greater) than 3.5.

The sum of the premium or discount and the base value of the carcass is defined as gross carcass returns. Its value is recorded under column 14 in the tables of Appendix I. The net slaughter cost is subtracted from the gross carcass returns and the remainder is entitled Gross Total Returns. Gross total returns realized by the slaughtering sectors by type and fed weight are identified in column 21 of Tables LXXVIII, LXXIX, and LXXX of Appendix I. Gross total returns coefficients are inputed into the general linear programming model.

Carcass-Breaking Sector Coefficients

The model permits only the breaker-boner and integrated sectors to break the carcass. The boner sector purchases its carcass from the packer, while the integrated sector obtains its carcass from its slaughtering activities.

Carcass Breaking Sectors Cost Components

Cost components associated with carcass breaking include carcass acquisition cost, fixed costs of carcass transformation, and variable costs of carcass transformation. The carcass acquisition cost and the variable cost of carcass transformation are functions of carcass weight. By definition, the fixed cost of carcass transformation occurs regardless of carcass weight. All carcass transformation costs were updated to 1974 from an earlier study using 1970 costs (13).

Carcass Acquisition Cost. Since the model assumes that the slaughtering sector delivers the cold carcass to the carcass breaking sector, the carcass acquisition cost is the purchase cost. For any given carcass, the carcass purchase cost to the carcass breaking sectors is the same as the gross carcass return to the slaughtering sectors. The gross carcass return to the packer is the sum of the base cold carcass value plus the carcass premium or discount. The applicable value associated with a given type and fed weight appears in column 14 of Tables LXXVIII, LXXIX, and LXXX in Appendix I, and again in column 7 of Tables LXXXI, LXXXII, and LXXXIII of Appendix J.

Fixed Carcass Transformation Costs. The components of fixed carcass transformation costs are primal breaking labor, retail breaking labor, and grinding beef labor. According to Litchy, the sum of these costs in 1970 on a per head basis was $20.018 (27). On a 1967 base, the USDA's meat processing labor index in 1970 was 120.5, and in 1974 it was 162. Adjustment to 1974 results in a 1974 fixed carcass transformation cost of $26.91.

Variable Carcass Transformation Costs. Components of variable carcass transformation cost include storage of the carcass, wrapping and labeling of retail cuts, storage of retail cuts, and transportation of retail cuts. The carcass storage costs need to be calculated separately from component costs associated with retail cuts because of differences in either weight bases and/or adjustment index numbers. The procedures for derivation and the magnitudes of the 1974 per pound variable carcass transformation costs are outlined in Appendix N.

Given the type and fed weight, the carcass and lean cut weights are established using Nelson's dressing percent and yield grade prediction equations. Multiplications of the respective weights and per pound costs yield individual component variable costs. Summed, they produce the carcass-breaking sector's variable cost of carcass transformation. The sum of the fixed and variable carcass transformation costs becomes the input coefficient into the general linear programming model for carcass breaking. The fixed variable and total costs of carcass transformation appear in columns 8, 9, 11, and 12, respectively, of Tables LXXXI, LXXXII, and LXXXIII of Appendix J.

The final coefficient to develop for input into the general linear programming model is the magnitude of returns derived from the sale of lean cuts. The development of these coefficients given alternative types and fed weights may be traced through the columns of Tables LXXXI, LXXXII, and LXXXIII of Appendix J.

Carcass Breaking Sector Revenue

The only source of revenue to the carcass breaking sectors is sale of lean meat. The only two determinants of revenue, therefore, are pounds of lean meat sold and quality grade weighted price of the lean.

Pounds of Lean Meat. Given type and fed weight, the pounds of lean meat are the product of the associated yield grade percentage given in Table XIII and the cold carcass weight. Procedures for deriving both of these parameters were developed earlier.

Quality Grade Weighted Wholesale Lean Meat Price. The procedure for determining the quality grade weighted price is outlined in Appendix F. The procedure for derivation of the wholesale lean meat price according to quality grade is outlined in Appendix O. The resulting set of wholesale price for lean cuts is Prime, $1.273, Choice, $1.243, and Good, $1.193.

The procedures necessary for development of cost and revenue coefficients for the carcass breaking sector have now been outlined. The values derived in accordance with those procedures by type and fed weight may be found in Tables LXXI, LXXXII, and LXXXIII of Appendix J.

Summary

The summary serves as a key to the development of the coefficients throughout the text and appendices. Three tables with identical formats often appear together. Each table contains data for one of the three types of cattle under analysis.

Because of its ability to create uniform sets of alternative fed weights for each type under alternative feeding regimes, a logical starting point for data assembly is the input parameters of the Beef Gain Simulator. These parameters and their assigned values are presented in Tables LXII, LXIII, and LXIV of Appendix C. The row entries in the tables of Appendix C provide information on all variables associated with feeder calf acquisition, feeding, and fed steer sale. The cost and revenues of those activities as influenced by the alternative feeding weights were developed in the text and appendices.

The cost of producing a fed steer is influenced by the source of feeder calf acquisition. Source of the feeder calf determines the per hundredweight cost of production which is inputed as purchase price/cwt into the Beef Gain Simulator. The basic 1974 feeder calf cost of production is presented in Table I. Depending upon type, the feeder calf purchase cost to input into the Beef Gain Simulator may be found in Table LXV, LXVI, or LXVII of Appendix D.

Execution of the Beef Gain Simulator produces uniform sets of fed weights within a type for alternative feeding regimes. A total of 54 final Beef Gain Simulation runs were required for this study. The non-feed costs and feed consumption data associated with the output of each run required manual extraction. An illustrative set of extracted non-feed costs and feed consumption data for the first run is presented in Table LXVIII of Appendix E.

The value-determining attributes of quality grade, yield grade, and dressing percent for the intermediate and final products of fed steer, carcass, and lean meat were derived from Nelson's prediction equations (44). In Nelson's equations, the relationship between the fed weight and the mature weight of each cattle type is of central importance because it determines the value of the only independent variable in those equations, namely BODFAT (%). Consolidated sets of quality grade, yield grade, and dressing percent values by type and fed weight are presented in Tables XVI, XVII, and XVIII. They were derived with the OMNITAB programs in Tables LXXII, LXXIII, and LXXIV of Appendix G.

The weights of the intermediate and final products are the single most important determinants of value. The weights of the various intermediate and the final product are related by rates of shrink and applicable dressing percent and yield grade values.

For example, the sell weight is 96 percent of the fed weight. The hot carcass weight is a function of the dressing percent and sell weight. The cold carcass weight is 98.5 percent of the hot carcass weight. The pounds of lean meat are a function of the yield grade. The analysis must account for the fact that, between types, the weights vary for a common fed weight.

It is assumed that there is a 150-pound weight range in any given pen of fed cattle. Since the value of the independent variable in Nelson's prediction equations is a function of the fed weight variable, it became necessary to derive a price series for the intermediate and final products on the basis of a normal distribution around a given type's fed weight. The procedures for deriving this distribution and using it to determine quality grade weighted prices for alternative fed weights are discussed in Appendix F. The resulting quality grade weighted price series for fed cattle may be found in Tables LXXV, LXXVI, and LXXVII of Appendix H.

The cost of slaughter is separated into fed steer acquisition costs and slaughter cost. Fed steer acquisition costs are developed from data in Appendices E and H and are summarized in Appendix K. Slaughter costs are developed from data in Appendices L and M, and are summarized in Appendix I.

The costs of carcass breaking include carcass acquisition, fixed carcass transformation, and varialbe carcass transformation. Although the data are given in Appendix J, procedures for development of fixed and variable carcass transformation costs are presented in Appendix N.

The absence of a price series for wholesale lean meat necessitated its derivation. The procedures underlying its derivation are outlined in Appendix O.

CHAPTER IV

THE GENERAL MODEL

The purpose of this chapter is to describe the general model in terms of the component parts of the linear programming tableau. Description synthesizes the relationships between the assumptions, auxiliary tools and the coefficients of the model. In this model, the linear programming tableau ties the sectors and the activities associated with fed beef production and marketing together for analysis.

Model Description and Construction

The model is classified both as a profit-maximizing and comparatively static model since it does not incorporate the effects of time explicitly. The birth weights and low energy growth data are grounded in feeding experiments conducted by the MARC (71). The high energy growth curve was generated from the low energy growth curve. Cost and revenue data were drawn from the USDA and agricultural experiment station sources.

Each sector of the model is defined by the set of activities open to it. The model identifies the optimum programs for each of these sectors. The optimum program for a given sector, given cost and revenue relationships, represents the best combination of type, function, plane of nutrition, fed, slaughter, carcass, and lean meat weights, and feeding regimes. These variables are coded and illustrated with the Hereford, HEHE, type in Table XV.

The core of any linear programming tableau is its activities, constraints, and right-hand sides. The activities are columns, while the constraints are rows. In this model, there is one objective function row, N, for each sector for a total of seven. One equality row, E, establishes the analysis in terms of one steer. Four less than rows, L, provide for feed purchase activities. The remaining L rows provide for the production, exchange, and consumption of the initial and intermediate products. The columns complement the rows.

The tableau is not illustrated because of its size. The names for both columns and rows were created using the codes identified in Table XV. A discussion of the coding scheme for naming rows and column enhances the clarity of the results chapter, and serves to document the logic and construction of the model.

MPSX (Mathematical Programming System - Extended) permits use of a maximum field of only eight characters for identifying columns and rows. Both alphabetic and numerical characters are used in this model. The characters used and their meanings are presented in Table XV. Each column in Table XV is denoted by a single character. Generally, the column number designates the character's position number within the MPSX field of eight. There are exceptions as the notational format was built to facilitate identification of the feeding activities. The non-feeding activities were identified with less than eight characters. The reason for this is that a given fed weight from any sector and any feeding regime produces a common slaughter weight among sectors and feeding regimes. The packer and breaker-boner sectors neither know nor care about the fed steer's background. Their interest is only on

TABLE XV

IDENTIFICATION OF ROWS AND COLUMNS

(1) TYPE	(2) ACTIVITY		(3) PLANE OF NUTRITION	(4) FEEDER CALF OR FED WEIGHT			(5) SECTOR	(6) FEEDING REGIME	(7) SOURCE	(8) NO. OF OWNERSHIP CHANGES	(9) INTERMEDIATE AND FINAL PRODUCT
H Hereford	CCOP	Calf Cost of Production	L Low	L	1	604 A 616 T	C Cow-Calf	1 Total High Energy	T Transfer	1 One	G Slaughter Steer
C Charolais Hereford	CSPUR	Corn Silage Purchase	H High		2	759 A 768 T	S Stocker	2 CG-771	A Auction	2 Two	X Carcass
J Jersey Ang.	CORN PUR	Corn Purchase			3	955	F Feeder	3 CG-133I			M Lean Meat
	SUP PUR	Supplement Purchase			4	989	Y System	4 CG-77E			
	SBOM PUR	Soybean Oil Meal Purchase			5	1014A 1015T	P Packer	5 CG-133E			
	D	Feed			6	1040	B Boner	6 CG-133I-1			
	L	Sell			7	1064					
	B	Buy			8	1090	T Retailer	7 Low "All-the-way"			
	G	Slaughter						8 77-E			
	K	Break Carcass		H	1	809 A 817 T		9 133-E			
					2	962 T 963 A					
					3	986 A 987 T					
					4	1010A 1011T					
					5	1036A 1037T					
					6	1061					
					7	1087					
					8	1110A 1111T					
					9	1137					
					10	1162T 1163A					

fed weight, since it affects the quality grade, yield grade, and dressing percent value attributes. Feeding activities, however, must incorporate the feeder calf's background because of its effects on growth and the costs of feeding.

The degree of identification dictates the number of characters which must be combined. For example, the determination of the pounds of any intermediate or final product requires the combination of three characters denoting type, plane of nutrition, and fed weight. The characters contained within the columns of Table XV code type, activities, plane of nutrition, feeder calf or fed weight, sector, feeding regime, source of feeder calf acquisition, and number of ownership changes. Although the MPSX program limits names to eight characters, Table XV contains nine columns. The role of the ninth column is to code characters representing intermediate or final products. These characters are used within the field of eight in conjunction with an activity.

In selecting the alphabetic codes, an attempt was made to select letters and activities easily understood. As a result, three instances exist in which the same letter represents two different pieces of information. In the first instance, the letter H represents both the Hereford type of cattle and the high energy plane of nutrition. In the second instance, the letter G represents both the slaughter activity and the slaughter steer intermediate product. In the third instance, T represents both the transfer source and the retail sector.

The model does not incorporate the retail sector of the economy except as the recipient of the final product, lean meat. Row and column names are distinguished from each other by the interchange of the first and second characters denoting type and activity, respectively. If the type character appears first, reference is to a row (constraint). If the activity character appears first, reference is to a column (activity).

The following discussion attempts to conceptualize the fed beef cattle system through descriptions of the columns in Table XV. The arrangement of the columns identifies the activity of interest. Comparable activities are grouped together so that the model may be viewed conveniently in terms of blocked activities.

In discussing any given column, reference is first made to the position of the column's character within the field of eight characters permitted by MPSX. This is followed by a description of the column which attempts to establish its position both functionally within the tableau and conceptually within the fed beef system.

The Columns of Table XV

Column 1: Type

The first column, TYPE, is coded by the first of the eight characters. Type is basically a proxy for size and characterizes a unique variety of basic attributes with economic content. These attributes include fertility levels as reflected in calf crop percentages, live birth rates, cow maintenance requirements, feedlot gaining ability, and unique quality grade, yield grade, and dressing percent combinations for any given fed weight.

In order of smallest to largest, the three breed types used in this study include Jersey-Angus (JRAN), Herefore-Hereford (HEHE), and

Charolais-Hereford (CHHE). The type of the sire precedes that of the dam.

Column 2: Activity

The second column, ACTIVITY, is coded by the second of the eight characters. In this model, an activity is a transformation process in which an initial product is converted into an intermediate product. The intermediate product, in turn, is either converted into a more highly processed intermediate product or into a heavier product. Transformation activities dominate because the exchange process of the fed beef system is the thrust of analysis.

Because outputs of one sector are inputs for a second sector, it is necessary to identify the initial, intermediate, and final products of the fed beef system. The initial product is the feeder calf, while the intermediate products are either a fed steer with a unique quality grade, yield grade, and dressing percentage combination, or a carcass with a unique quality grade and yield grade combination. The final product is lean meat with a unique distribution of good and choice quality grades. The intermediate byproducts of offal, fat, and bone are not identified explicitly, but are accounted for in the objective function values of the slaughtering sectors.

The feed purchase activities are crucial activities because they provide the mechanism by which changes in feed prices are introduced into the model for subsequent analysis. These activities reflect differing feed requirements between feeding regimes via the magnitudes of their entries.

Column 3: Plane of Nutrition

The third column, PLANE OF NUTRITION, is defined by the combination of low energy and high energy rations in the diet. It is coded by the third character. It may be either low or high. A complete low or high energy plane of nutrition is four low or high energy rations of progressively greater net energy for maintenance, NE_m, and net energy for gain, NE_g, content.

The model permits the entrepeneur in the cow-calf, stocker, feeder, or integrated sectors to follow an all-low, all-high, or combination low and high feeding regime. The model distinguishes between the stocker and feeder sectors by requiring the stocker to adhere to the low energy plane of nutrition for the first 77 days. Any sector eligible to feed can go only from a low energy plane of nutrition to a high energy plane of nutrition. Once the high energy plane of nutrition is initiated, it must be followed for the remainder of the feeding period.

The model assumes that regardless of the plane of nutrition, the steer consumes the first of the four rations during the first 28 days following weaning, the second ration between 29-77 days on feed, the third ration between 78-133 days on feed, and the fourth ration for the remainder of time on feed. While the steer may be placed on the high energy plane of nutrition immediately following weaning, the model requires that any switch from the low to high plane of nutrition transpire at either 77 or 133 days on feed or after weaning. Given the stated assumption, this means that any steer exhibiting compensatory gain after 77 days on feed was fed the first two low energy rations for the first 77 days on feed, the third high energy ration between 78-133 days on feed, and the fourth high energy ration for the remainder of time on feed.

The low energy plane of nutrition is the diet in the MARC reports (71). Because of its high corn silage content, a steer on the low energy plane of nutrition is considered to be representative of a forage-fed steer.

Although corn, sorghum grain, and wheat were mixed and used as the concentrate in the MARC studies, only corn was considered as the concentrate in this study. On the basis of the reported ingredients in each of the four MARC low energy rations, the NE_m and NE_g for each of the respective rations were calculated. These values were then used as parameters in the Beef Gain Simulator to generate the growth curve of an average or typical steer. The growth curve is defined in terms of live weights given periods of time on feed. These two growth curves appear repeatedly in Table XX.

With the use of the Beef Gain Simulator, the live weight reported by the MARC for the steer on the low plane of nutrition after 279 days on feed was duplicated. Employment of the Beef Gain Simulator required specification of basic input parameters. Among these parameters were the NE_m and NE_g for each of the four rations which constitute the low energy plane of nutrition.

The high energy plane of nutrition was specified arbitrarily in terms of percent concentrate in each of its four rations. The balance of the ration consisted of corn silage and supplement. Given the ingredients, the NE_m and NE_g for the high energy ration were calculated and employed in the Beef Gain Simulator to generate the high energy weight after 279 days on feed.

Column 4: Feeder Calf or Fed Weight

The fourth column, FEEDER CALF OR FED WEIGHT, facilitates the assembly of a variety of information. Meaningful interpretation of column four requires information coded in other columns of Table XV. The degree of identification determines the number of other columns to use. At a minimum, the alphabetic characters in columns one, two, and three need to be combined with the numerical character in column four in order to determine type and whether reference is to a live animal, carcass, or lean meat.

With regard to the feeder calf and the first high energy weight, the alphabetic character coding source from column seven and the numeric character coding number of ownership changes from column eight must be combined to determine the weight of interest. Within the model, these early weights reflect the influence of the first 133 days on feed and reflect the first three rations. These weights reflect the period of time during which decisions are made regarding plane of nutrition and the sale of the calf as a stocker by either the cow-calf, stocker, or integrated sectors.

Information conveyed by columns seven and eight may be ignored in discussions of fed weights as source and ownership changes entail only one pound weight increment differences. These differences are probably caused by internal "rounding off" within the BEEF GAIN SIMULATOR program. That same information, however, is vital to the identification of feeding regimes.

The live fed weights corresponding to the numeric codes in column four of Table XV for Herefords are listed and are followed by either an

A, denoting auction, or a T, denoting transfer. A single weight denotes a common weight for both auction and transfer. A listing of fed weights, however, is not sufficient because Table XV codes activities engaged in by the Packer (P) and Boner (B) sectors as well as by the cow-calf (C), stocker (S), feeder (F), and integrated (Y) sectors. Therefore, Table XV requires the augmentation of Tables XVI, XVII, and XVIII.

Tables XVI, XVII, and XVIII key the carcass and lean meat weights to the live fed weights for the HEHE, JRAN, and CHHE types, respectively. For any fed weight, these tables identify the slaughter weight, the unique combination of quality grade, yield grade, and dressing percent, and the associated pounds of carcass and lean meat.

The numerical codes for the slaughter steer, carcass, and lean meat weights are also given in Tables XVI, XVII, and XVIII. The numerical difference between the fed weight and the corresponding transformed weight of interest in Tables XVI, XVII, and XVIII is two for the low energy weight and one for the high energy weight. Thus, an L4 fed steer represents an L2 slaughter steer, an L2 carcass, and L2 pounds of lean meat, while an H4 fed steer represents an H3 slaughter steer, an H3 carcass, and H3 pounds of lean meat.

Column 5: Sector

The fifth column, SECTOR, provides the basic tool for answering the question of whether the existing fed beef system can be made more economically efficient through coordination of its sectors. The model consists of one macro sector, the fed beef system (A), and six micro sectors. The micro sectors include cow-calf (C), stocker (S), feeder

TABLE XVI

ACTIVITY WEIGHTS OF INTEREST AND THEIR ASSOCIATED QUALITY GRADE, YIELD GRADE, AND DRESSING PERCENT ATTRIBUTES FOR HEHE

Energy Level & Fed.Weight Code No.		Live Fed. Weight A T		Slaughter Weight	QG Composition % (Good,Choice)	YG	DP %	Cold Carcass Wt.	Additional Pounds of Lean In Carcass YG:3.5=0	Pounds Lean in Carcass
Low										
	1	604 616	Non-slaughter	568 579						
	2	759 768	Non-slaughter	713 722						
	3	955	1	917	(100,0)	2.7/2.5	60.28	544.48	25.05	421.43
	4	989	2	949	(100,0)	2.8/2.5	60.43	564.88	25.98	437.22
	5	1015	3	974	(100,0)	2.9/2.5	60.55	580.91	26.72	449.62
	6	1040	4	998	(100,0)	3.0/3.5	60.67	596.40	-0-	434.18
	7	1064	5	1021	(99,1)	3.1/3.5	60.79	611.36	-0-	445.07
	8	1090	6	1046	(93,7)	3.2/3.5	60.94	627.87	-0-	457.09
High										
	1	809 817								
	2	963	1	924	(100,0)	2.7/2.5	60.32	549.00	25.25	424.93
	3	987	2	948	(100,0)	2.8/2.5	60.42	564.19	25.95	436.68
	4	1011	3	971	(100,0)	2.9/2.5	60.53	578.93	26.26	448.09
	5	1037	4	996	(100,0)	3.0/3.5	60.66	595.11	-0-	433.24
	6	1061	5	1019	(99,1)	3.1/3.5	60.78	610.06	-0-	444.12
	7	1087	6	1044	(94,6)	3.2/3.5	60.93	626.57	-0-	456.14
	8	1111	7	1067	(72,28)	3.3/3.5	61.07	641.84	-0-	467.26
	9	1137	8	1092	(33,67)	3.5/3.5	61.23	658.60	-0-	479.46
	10	1163	9	1116	(7,93)	3.6/3.5	61.39	674.84	-0-	491.28

TABLE XVII

ACTIVITY WEIGHTS OF INTEREST AND THEIR ASSOCIATED QUALITY GRADE, YIELD GRADE, AND DRESSING PERCENT ATTRIBUTES FOR JRAN

Energy Level & Fed.Weight Code No.		Live Fed. Weight A T		Slaughter Weight	QG Composition % (Good,Choice)	YG	DP %	Cold Carcass Wt.	Additional Pounds of Lean In Carcass YG:3.5=0	Pounds Lean in Carcass
Low										
		586		551						
	1	599		563						
		727		683						
	2	736		692						
	3	929	1	882	(100,0)	2.9/2.5	59.28	520.85	23.96	403.14
	4	955	2	917	(96,4)	3.0/3.5	59.66	538.88	0	392.30
	5	980	3	941	(79,21)	3.1/3.5	59.82	554.46	0	403.65
	6	1004	4	964	(50,50)	3.3/3.5	60.00	569.72	0	414.76
	7	1030	5	989	(46,54)	3.4/3.5	60.20	586.45	0	426.94
High		733								
	1	782								
	2	929	1	892	(100,0)	2.9/2.5	59.28	520.85	23.96	403.14
	3	949	2	911	(98,2)	3.0/3.5	59.39	532.93	0	387.97
	4	975	3	936	(84,16)	3.1/3.5	59.54	548.93	0	399.62
	5	1000	4	960	(50,50)	3.2/3.5	59.69	564.43	0	410.91
	6	1024	5	983	(48,52)	3.4/3.5	59.85	579.50	0	421.88
	7	1050	6	1008	(34,66)	3.5/3.5	60.03	596.03	0	433.91
	8	1075	7	1032	(0,100)	3.7/3.5	60.21	612.05	0	445.57
	9	1100	8	1056	(0,100)	3.8/3.5	60.41	628.36	0	457.45

TABLE XVIII

ACTIVITY WEIGHTS OF INTEREST AND THEIR ASSOCIATED QUALITY GRADE, YIELD GRADE, AND DRESSING PERCENT ATTRIBUTES FOR CHHE

Energy Level & Fed.Weight Code No.		Live Fed. Weight A T	Slaughter Weight		QG Composition % (Good,Choice)	YG	DP %	Cold Carcass Wt.	Additional Pounds of Lean In Carcass YG:3.5=0	Pounds Lean in Carcass
Low										
		669		629						
	1	682		641						
		839		789						
	2	849		798						
	3	1073	1	1030	(100,0)	2.1/2.5	60.56	614.41	28.26	475.55
	4	1090	2	1046	(100,0)	2.1/2.5	60.61	624.47	28.73	483.34
	5	1113	3	1068	(100,0)	2.2/2.5	60.68	638.34	29.36	494.08
	6	1139	4	1093	(100,0)	2.3/2.5	60.77	654.25	30.10	506.39
	7	1164	5	1117	(100,0)	2.3/2.5	60.86	669.61	30.80	518.28
	8	1189	6	1141	(100,0)	2.4/2.5	60.95	685.01	31.51	530.20
High		890								
	1	899								
	2	1074	1	1031	(100,0)	2.1/2.5	60.57	615.11	28.30	476.10
	3	1087	2	1044	(100,0)	2.1/2.5	60.61	623.28	28.67	482.42
	4	1112	3	1068	(100,0)	2.2/2.5	60.68	638.34	29.36	494.08
	5	1136	4	1091	(100,0)	2.3/2.5	60.76	652.95	30.04	505.38
	6	1161	5	1115	(100,0)	2.3/2.5	60.85	668.30	30.74	517.26
	7	1187	6	1140	(100,0)	2.4/2.5	60.94	684.30	31.48	529.65
	8	1212	7	1164	(100,0)	2.5/2.5	61.04	699.85	32.19	541.68
	9	1235	8	1186	(98,2)	2.6/2.5	61.13	714.13	32.85	552.74
	10	1261	9	1211	(85,15)	2.6/2.5	61.24	730.49	33.60	565.40

(F), integrated (Y), packer (P), and breaker-boner (B). The fed beef, system (A), by definition, embraces all six micro sectors. Its role, within the confines of the model, is to identify the sets of activities by performing sectors which would maximize returns to the entire fed beef system.

The function of each micro sector is to maximize profit to a defined set of activities. The model differentiates between the micro sectors by opening or closing activities to them. The sets of activities open and closed to each sector are given in Table XIX.

Table XIX and its legend indicates that the solid areas designate closed activities, while the checked (✓) areas designate open activities to the sector. Table XIX shows all activities open to the fed beef system (A).

Although the model permits the cow-calf sector to feed the feeder calf on any energy plane, it requires that the calf be from the sector's own herd. According to Table XIX, the stocker (S) and feeder (S) sectors can feed only calves obtained from the auction. The integrated (Y) sector can either feed the calf it produces or it may purchase its feeder calf from the auction. The cow-calf (C), stocker (S) and integrated (Y) sectors are further differentiated from the feeder (F) sector by the stipulation that the feeder cannot sell at weights less than H2 or L3.

The model allows the integrated (Y) sector to participate in all but three activities. These include the purchase of fed steers for slaughter, the sale of carcasses, and the purchase of carcasses. The packer (P) and boner (B) sectors are excluded from all activities except those associated with slaughtering and carcass-breaking,

TABLE XIX

ACTIVITIES OPEN AND CLOSED TO EACH SECTOR

ACTIVITY	A	C	S	F	Y	P	B
Produce Calves	✓	✓			✓		
Sell Feeder Calves	✓	✓			✓		
Secure Feeder Calves							
Transfer	✓	✓			✓		
Auction	✓		✓	✓	✓		
Buy Feed	✓	✓	✓	✓	✓		
Feed-Energy Levels							
Low Energy Initially	✓	✓	▨	✓	✓		
Low Energy	✓	✓	✓	✓	✓		
High Energy	✓	✓	✓	✓	✓		
Combination Low and High Energy	✓	✓	✓	✓	✓		
Sell Fed Steers	✓	✓	✓	✓	✓		
Buy Fed Steers	✓					✓	
Slaughter Steers	✓				✓	✓	
Sell Carcasses	✓					✓	
Buy Carcasses	✓						✓
Break Carcasses	✓				✓		✓
Sell Lean	✓				✓		✓
Buy Lean	✓						

☐ Model closes activity to sector.

▨ Sector must employ this activity.

respectively.

A number of assumptions underlie Table XIX. Although all were addressed in the chapter on Data Development, the most important is that no one sector is any more or less technically efficient than another in the performance of activities.

Column 6: Feeding Regime

A meaningful discussion of the sixth column, FEEDING REGIME, requires a review of the role of the BEEF GAIN SIMULATOR in the model. A thorough discussion of the BEEF GAIN SIMULATOR was presented in the chapter on Data Development.

The purpose of the BEEF GAIN SIMULATOR is to duplicate applicable segments of either the reported low energy MARC growth curve or to duplicate applicable segments of the generated high energy growth curve. An applicable segment may be the entire curve or a combination of both curves.

The basic mechanism used to manipulate the BEEF GAIN SIMULATOR into duplicating the desired segments of the MARC growth curves is the feeder grade. The feeder grade is simply an adjustment mechanism built into the BEEF GAIN SIMULATOR which enables one to manipulate the growth of a feeder calf.

Taken alone, the feeder grade has no economic content. Manipulations of the feeder grade, however, are expressible in terms of feed consumption, days on feed, interest and death loss costs. These variables have economic implications for the feeding sectors of the model.

The core of analysis is based on the idea that historic low energy growth curves and generated high energy growth curves for three breed types can be duplicated under varying sets of variables. These variables include sources of acquisition, rates of shrink, and feeding regimes. These variables are interrelated.

The feeding regime is a function of the plane of nutrition, the source, and the number of ownership changes. The source and number of ownership changes determine the weight at which the animal enters the feedlot.

A modified version of the compensatory gain phenomenon is incorporated into this study. Compensatory gain refers to the ability of an animal which, after experiencing a level of nutrition that was sufficient to satisfy only maintenance requirements, can realize gains sufficient to "track" the live weight of an animal that had sufficient nutrition to make normal gains. In this study, any change from the low energy plane of nutrition to the high energy plane of nutrition is termed "compensatory gain."

This study introduces different compensatory gain situations for analysis. These situations are coded by the numerals 2 through 6 in column 6 of Table XV. The compensatory gain situations are identified by both the number of days on the low energy plane of nutrition prior to the switch to the high energy plane of nutrition, and by transfer or auction sources of acquisition.

Definitions and illustrations of all possible feeding regimes using the HEHE type are provided in Table XX. Interpretation of the figures in Table XX should begin at the live weight intercept. Because the weaning weight regardless of source is common to the planes of nutrition, both major planes of nutrition share a common intercept. Any markings beginning at the original intercept indicate that the

TABLE XX

IDENTIFICATION OF FEEDING REGIMES USING HEHE

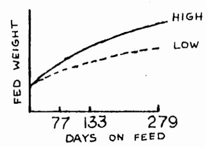
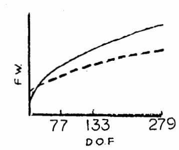
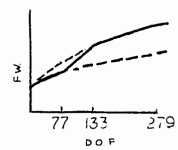
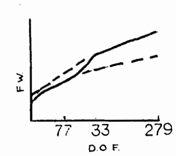
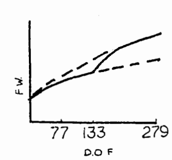
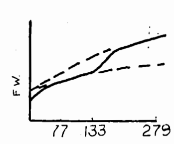
MPSX Field Position and Feeding Regime Identification Code	Short Title	Descriptive Statement	Figure
1 2 3 4 5 6 7 8			
1 T	Complete High Energy: Transfer	Following the weaning at 450 pounds, the feeder calf was transferred into its original owner's feedlot. The steer was subject to a six percent shrink so that it went on high energy feed for the remainder of the feeding period at a weight of 423 pounds	
1 A	Complete High Energy: Auction	Following weaning at 450 pounds, the feeder calf was sold via auction and placed into its second owner's feedlot. The feeder calf was subject to a nine and one-half percent shrink so that it went on high energy feed for the remainder of the feeding period at a weight of 407 pounds.	
2 T	CG-771: Transfer	Following weaning at 450 pounds, the feeder calf was transferred into its original owner's feedlot. The steer was subject to a six percent shrink so that it weighed 423 pounds when placed on low energy feed. It was kept on the low energy plane of nutrition for 77 days or until it weighed 616 pounds and was then placed on the high energy ration for the remainder of the feeding period.	
2 A	CG-771: Auction	Following weaning at 450 pounds, the feeder calf was sold via auction and placed into its second owner's feedlot. The calf was subject to a nine and one-half percent shrink so that it weighed 407 pounds when placed on the low energy plane of nutrition. It was fed on the low energy plane of nutrition for 77 days or until it weighed 604 pounds and was then fed on the high energy plane of nutrition for the remainder of the feeding period.	
3 T	CG-133I: Transfer	Following weaning at 450 pounds, the feeder calf was transferred into its original owner's feedlot. The calf was subject to a six percent shrink so that its weight when placed on the low energy plane of nutrition was 423 pounds. It was fed on the low energy plane of nutrition for 133 days or until it weighed 768 pounds and was then fed on the high energy plance of nutrition for the remainder of the feeding period.	
3 A	CG-133I: Auction	Following weaning at 450 pounds, the feeder calf was sold via auction and placed into its second owner's feedlot. The calf was subject to a nine and one-half percent shrink so that it weighed 407 pounds when placed on the low energy plane of nutrition for 133 days or until it weighed 759 pounds and was then fed on the high energy plane of nutrition for the remainder of the feeding period.	

TABLE XX (Continued)

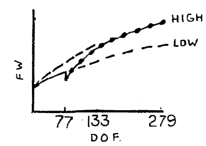
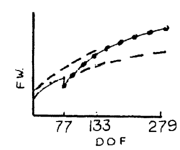
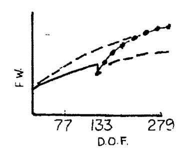
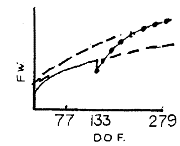
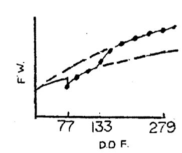
MPSX Field Position and Feeding Regime Identification Code	Short Title	Descriptive Statement	Figure
1 2 3 4 5 6 7 8			
4 T	CG-77E: Transfer	The acquired feeder's initial owner had transferred it as a feeder calf from the cow herd into the feedlot where it was placed on a low energy plane of nutrition for 77 days. Because it had been a previously transferred calf, its live weight at its first change in ownership is 616 pounds. Because of a six percent shrink, its weight into a feedlot for the second time is 579 pounds. It is placed on the high energy plane of nutrition for the remainder of the feeding period.	
4 A	CG-77E: Auction	The acquired stocker's second owner had purchased it as a feeder calf from an auction and placed it on the low energy plane of nutrition for 77 days. Because its second owner had acquired it from an auction, its live weight at this second change in ownership was 604 pounds. Because of a six percent shrink, its weight into the feedlot for the second time is 568 pounds. It is immediately placed on the high energy plane of nutrition for the remainder of the feeding period.	
5 T	CG-133E: Transfer	The acquired stocker's initial owner had transferred it as a feeder calf from the cow herd into the feedlot where it was placed on a low energy ration for 133 days. Because it had been a previously transferred calf, its live weight at its first change in ownership is 768 pounds. Due to a six percent shrink, its weight into the feedlot under its second owner is 722 pounds. It is placed on the high energy plane of nutrition for the remainder of the feeding period.	
5 A	CG-133E: Auction	The acquired stocker's second owner had purchased it as a feeder calf from the auction and had placed it on the low energy plane of nutrition for 133 days. Because its second owner had acquired it from an auction, its live weight at this second change in ownership is 759 pounds. Due to a six percent shrink, its weight into the feedlot under its third owner is 713 pounds. The stocker is immediately placed on the high energy plane of nutrition for the remainder of the feeding period.	
6 T	CG-133I-1: Transfer	The acquired stocker's initial owner had transferred it out of the cow herd and into the feedlot where it was placed on the low energy plane of nutrition for 77 days. Because it had only one previous owner, its live weight at the second change in ownership was 616 pounds. Because of a six percent shrink, its weight going into the feedlot for the second time was 579 pounds. Its second owner places it on the low energy plane of nutrition for an additional 56 days so that it accumulates a total of 133 days on the low energy plane of nutrition before being placed on the high energy plane of nutrition for the remainder of the feeding period.	

TABLE XX (Continued)

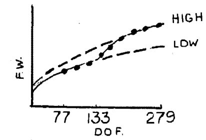
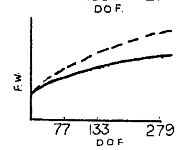
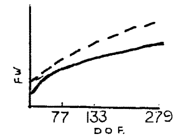
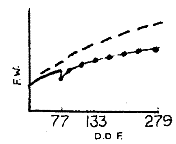
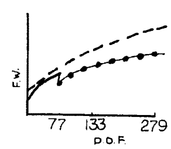
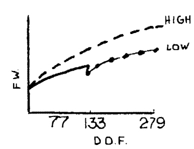
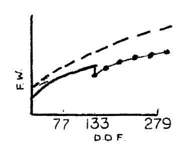
MPSX Field Position and Feeding Regime Identification Code	Short Title	Descriptive Statement	Figure
1 2 3 4 5 6 7 8 6 A	CG-1331-1: Auction	The acquired stocker's second owner had purchased it as a feeder calf from an auction and placed it on the low energy plane of nutrition for 77 days prior to selling it to the sector of interest. Because its second owner had acquired it from an auction, its live weight at this second change of ownership is 604 pounds. Because of a six percent shrink, its weight into the feedlot for the second time is 568 pounds. Its third owner places it on the low energy plane of nutrition for an additional 56 days so that it accumulates a total of 133 days on the low energy plane of nutrition before being placed on the high energy plane of nutrition for the remainder of the period.	
7 T	Complete Low Energy: Transfer	Following weaning at 450 pounds, the feeder calf is transferred into its original owner's feedlot. The transfer activity entails a six percent shrink so the calf weights 423 pounds when it is placed on the low energy plane of nutrition for the remainder of the feeding period.	
7 A	Complete Low Energy: Auction	Following weaning at 450 pounds, the feeder calf is sold via auction and placed into its second owner's feedlot. The calf is suject to a nine and one-half percent shrink so it goes on the low energy ration for the remainder of the feeding period at a weight of 407 pounds.	
8 T	77-E: Transfer	The acquired stocker's previous owner had transferred it as a feeder calf from the cow herd into the feedlot where it was placed on the low energy plane of nutrition for 77 days prior to sale. Because it had been a previously transferred calf, its live weight at this first change in ownership is 616 pounds. Because of a six percent shrink, its weight into a feedlot under its second owner is 579 pounds. It is placed on the low energy plane of nutrition for the remainder of the feeding period.	
8 A	77-E: Auction	The acquired stocker's second owner had purchased it as a feeder calf from an auction and placed it on the low energy plane of nutrition for 77 days prior to sale. Because its second owner acquired it from an auction, its live weight at this second change in ownership is 604 pounds. Because of the auction associated six percent shrink, its weight into the feedlot for the second time or under its third owner is 568 pounds. The stocker is placed upon the low energy plane of nutrition for the remainder of the feeding period.	

TABLE XX (Continued)

MPSX Field Position and Feeding Regime Identification Code	Short Title	Descriptive Statement	Figure
1 2 3 4 5 6 7 8 9 T	133-E: Transfer	The acquired stocker's initial owner had transferred it as a feeder calf from the cow herd into the feedlot where it was placed on a low energy ration for 133 days. Because it had been previously transferred, its live weight at this first change in ownership is 768 pounds. Due to a six percent shrink, its weight into the feedlot for the second time is 722 pounds. It is placed on the low energy plane of nutrition for the remainder of the feeding period.	
9 A	133-E: Auction	The acquired stocker's second owner had purchased it as a feeder calf from the auction and had placed it on the low energy plane of nutrition for 133 days. Because its second owner had acquired it from an auction, its live weight at this second change in ownership is 759 pounds. Due to a six percent shrink, its weight into the feedlot for the second time is 713 pounds. Its third owner places it upon the low energy plane of nutrition for the remainder of the feeding period.	

feeder calf was transferred into the feedlot. Markings denoting an auction acquired feeder calf begin below the original intercept because of the greater shrinkage associated with auction acquired calves.

Because of differences in shrink, transferred calves and auction acquired calves differ in weight through the first 133 days on feed. Figure markings alone are unable to reflect this weight difference.

Weights after 77 or 133 days on feed for both transferred and auction acquired calves are available from Tables XVI, XVII, and XVIII. The one pound fed weight difference between the two sources is so negligible that all fed weights are considered equal regardless of source of acquisition. The level of curvature of the markings in relation to the original lines and to the days on feed on the horizontal axis indicate the duration of time that the animal was maintained on each plane of nutrition. With this information and the appropriate Appendix table, the rations fed can be readily determined. Markings which fall below the low energy plane of nutrition and away from the vertical axis indicate a change in ownership achieved through the auction.

Common rations establish relationships between feeding regimes. Feeding regimes 2T and 4T are related in that the calf has been on the low energy plane of nutrition for 77 days prior to being placed on the high energy plane of nutrition. The significant difference is that under 2T, there is no change in ownership after 77 days on feed and the animal under 4T weighs .94 of what 2T weights because it was acquired from an auction at a weight equivalent to 77 days on the low energy plane of nutrition.

Feeding regimes 4T and 8T are related in that both experience ownership changes after 77 days on the low energy plane of nutrition.

The significant difference between these two regimes, however, is that under 4T the animal goes on the high energy plane of nutrition, whereas the 8T animal continues on the low energy plane of nutrition. Similar relationships exist between 2A and 4A, 4A and 8A, 3T and 5T, 5T and 9T, 3A and 5A, and 5A and 9A.

Feeding regimes are important in this model because they combine alternative planes of nutrition with varying backgrounds of feeder calves. The character in column three determines the plane of nutrition. The character in column six determines the particular combination of planes of nutrition. The characters in columns seven and eight establish the background of the feeder calf. Together, these four characters describe the feeding regimes completely. In Table XV, the single numeral in the sixth column describes the feeding regime. A meaningful interpretation of the sixth column in Table XV, however, requires the descriptive information in Table XX.

Only the two characters necessary to identify the feeding regime of interest are listed under the Regime ID Number column of Table XX. Any activity of interest may be identified by inserting appropriate characters into appropriate positions within the MPSX field of eight.

Although Table XX is self-explanatory, summary observations regarding the numerals 1 through 9 found in column 6 of the MPSX row or column name may prove useful. The numeral 1 denotes that the animal has been fed on the high energy plane of nutrition throughout the entire feeding period. Numerals 2 through 6 all denote compensatory gain feeding regimes. Numeral 7 denotes that the animal has been fed on a low energy plane of nutrition throughout its lifetime. Numberals 8 and 9 identify animals which were obtained at post-weaning days of age and weights and fed on the low energy plane of nutrition. In this study, these animals were introduced into the appropriate sectors at the auction shrunk weights of animals which had been on the low energy plane of nutrition for either 77 or 133 days since weaning.

Column 7: Source

The seventh column, SOURCE, constitutes part of the definition of feeding regime. The source of acquisition determines shrinkage. Feeder calves transferred into feedlots shrink six percent, whereas those acquired from auctions shrink nine and one-half percent.

Because the rations changed after 77 and 133 days on feed, analyses are made at these post-weaning days on feed. Because of the greater shrink assigned against auction acquired feeders, they fail to weigh as much as transferred feeders during the first 133 days on feed.

Through the first 133 post-weaning days on feed, live weight is a function of both plane of nutrition and source of feeder calf acquisition. Beyond the first 133 post-weaning days on feed, live weight is a function only of the plane of nutrition. Beyond 133 days on feed, the emphasis in analysis is on fed weight, and not on the number of days on feed.

Column 8: Number of Ownership Changes

The eighth column, NUMBER OF OWNERSHIP CHANGES, applies to the feeder calf and stocker. Its influence in the model is greatest during the first 133 days of the feeding period. It influences shrinkage because every change in ownership requires the assignment of auction based shrinkages.

As noted in the discussion of SECTOR, only the cow-calf (C), stocker (S) and integrated (Y) sectors can sell stockers that have been on feed less than 133 days. The model permits the sale of stockers at only two points in time. The first is at 77 days on feed, and the second is at 133 days on feed. The heavier calves moved via auction are assumed to shrink only six percent as opposed to the freshly weaned calves which shrink nine and one-half percent.

Beyond 133 days on feed, the steer is considered to be a fed animal and the model permits all four sectors engaged in feeding to sell fed animals at minimum H2 or L3 live weights less a uniform four percent shrink. Once sold, the fed steer is slaughtered and converted into carcass and lean meat. The associated weights and quality grade composition of the intermediate and final products are determined in accordance with the procedures outlined earlier.

Within the set of feeding activities, the magnitude of the numerical character in the eighth position indicates the number of times the steer changed ownership and still remained within the fed beef system. The absence of the numeral in the eighth position means that the animal is being fed by its original owner.

The nature of the problem posed by the necessity to identify feeding regime and number of changes in ownership resulted in the creation of two interpretations of the numeral in the eighth MPSX field position. The interpretations, however, are consistent between sources. Thus, the magnitude of the numerical value in the eighth position for transfer source indicates the number of owners that the animal had prior to slaughter. The same numeral for the auction source indicates the number of ownership changes. Because it requires two entities to effect a change in ownership, the numbers of owners is actually one greater than the number of ownership changes. Thus, a T1 means one owner and no changes in ownership, while an A1 means two owners and one change in ownership.

CHAPTER V

RESULTS

Chapter V is divided into five major sections. The first section identifies, defines, and establishes the relationships between key variables. The findings of the study are reported in the last four sections. First to be considered is the optimal program for each sector under the set of 1974 prices and costs. The minimum premiums and discounts required to effect changes in the optimal program are also presented. The optimal program for the integrated (Y) sector is then presented for each of the three types of cattle. The effects of varying corn and corn silage prices on the optimal programs for the feeder (F), cow-calf (C), and integrated (Y) sectors are then analyzed. An explanation for the absence of a total low energy feeding program is offered in the last section.

Key Variables and Feeding Decision Criterion Tables

Table XXI defines acronyms and establishes relationships between key variables. Table XXII states the economic criteria for feeding.

Optimum Sector Programs for 1974 Prices and Costs

Table XXIII records the profits which accrue to each sector when the objective function for that particular sector is optimized. Also

TABLE XXI

A SELECTED GLOSSARY OF ACRONYMS, DEFINITIONS, AND EQUALITIES UNDERLYING CATTLE FEEDING DECISION-MAKING CRITERIA

Acronym	Definition[a]	Equality[b]
FCW	Feeder calf weight: weaning, L1, L2	
FCCOP	Feeder calf cost of production	
FCSP	Feeder calf selling price	
FCAC	Feeder calf acquisition cost	FCAC = [(FCW)(FCSP + trucking)] + buying + medical
POG	Pounds of live weight gain added to input weight	
POF	Pounds of feed	
RC	Ration cost	
TFC	Total feeding cost	TFC = FC + NFC
FC	Feed cost	FC = (RC)(POF)
NFC	Nonfeed cost includes interest, death loss, and overhead	
COG	Cost of gain	COG = TFC/POG
COG:FC	Cost of gain due to feed only	COG:FC = FC/POG
COF	Cost of feeding	COF = [TFC + FCAC] /FSSW
FSSP	Fed steer selling price	
FSSW	Fed steer selling weight	FSSW = (.96)(fed wt)
DFC	Discount applied against FCAC	DFC = (COG - FCAC)> 0
DFS	Discount applied against FSSP	DFS = (COG - FSSP)> 0
PFC	Premium applied to FCAC	PFC = (COG - FCAC)<0
PFS	Premium applied to FSSP	PFS = (COG - FSSP)<0

[a]On a per hundredweight basis.

[b]A blank entry denotes that the variable is fixed or not readily subject to expression.

TABLE XXII

GENERAL CRITERIA EMPLOYED BY CATTLE FEEDING SECTORS BOTH BEFORE AND AFTER FEEDING COMMENCES

Criteria Before Feeding

Criteria Number	If	Then
(1)	FSSP $\geq$ COF	feed
(2)	FSSP = COG	feed only if FCAC $\leq$ FSSP
(3)	FSSP < COG	feed only if $\lvert$FCW (FCAC - DFC)$\rvert \geq \lvert$(FSSW) (COG - FSSP)$\rvert$
(4)	FSSP > COG	feed if FSSP < (FCAC + PFC) $\leq$ (FSSP - COG)
(5)	FSSP > FCAC	feed if (FSSW)(COG - FSSP) $\leq$ (FCW)(FSSP - FCAC)

Criteria After Feeding Commences

	If	Then	Expect
(6)	FSSP $\uparrow$ ($\downarrow$)	$\uparrow$ ($\downarrow$) POF until FSSP = COF	$\uparrow$($\downarrow$) FSSW
(7)	RC $\uparrow$ ($\downarrow$)	$\downarrow$ ($\uparrow$) POF until FSSP = COG	$\downarrow$($\uparrow$) FSSW

TABLE XXIII

LEVEL AND DISTRIBUTION OF PROFITS WHEN OPTIMIZING RETURNS TO EACH SECTOR AND TO THE FED BEEF SYSTEM FOR 1974 PRICES AND COSTS ACROSS ALL BREED TYPES

Returns by Sector	Sector Being Optimized[a]						
	A	C	S	F	Y	P	B
A	$95.99	$-164.02	$-170.95	$-170.95	$95.99	$-90.31	$73.15
C		$24.84					
S			0				
F				0			
Y					$95.99		
P						$11.26	
B							$131.14

[a]The sectors are coded as follows: A, fed beef system; C, cow-calf sector; S, stocker sector; F, feeder sector; Y, integrated sector; P, packer sector, and B, breaker-boner sector.

shown is the profit which accrues to A or the composite of all individual sectors.

The MPSX program optimizes only one objective function at a time. Since all activities are open to the A "sector," optimizing to A generates the array of programs across the individual sectors which maximizes total profit. This form of model construction ensures satisfaction of the one unit constraint on product utilization and disposal. It also provides a basis for comparisons between the individual (C, S, F, P. B) sectors; the integrated Y sector, and the fed beef system (A).

A comparison of the activities associated with the optimal program for a particular sector and the set of activities associated with the optimal program for (A) suggests the realignment in terms of breed types, feeding regimes, and fed weights that the entire fed beef system (A) must undergo to accommodate the optimization of a given sector. The returns to the optimum program for each individual sector are valid measures. However, the accompanying returns to A, the fed beef system, are artificial. They fail to reflect the disposal possibilities of alternative products open to the fed beef system. The exception occurs when optimizing to the breaker-boner (B) sector, since it involves usage of the final product.

The set of activities associated with each sector's optimum program is enumerated in Table XXIV. Table XV aids in the interpretation of Table XXIV. The illustrative figures in Table XX can be used to supplement Tables XXIII and XXIV in identifying the optimum feeding program for each sector in terms of type, feeding regime, and fed weight.

The Optimum Fed Beef (A) Program

Under the set of 1974 returns and costs, the optimum fed beef system (A) program requires that the integrated sector (Y) perform all activities associated with fed beef production from calf production through sale of lean meat. Under this program, the returns to both the fed beef system (A) and the integrated sector (Y) are $95.99.

Table XXIV shows that the optimum programs for both the fed beef system (A) and the integrated sector (Y) entail feeder calf production, transfer, feeding, slaughtering, and breaking by (Y) of a CHHE at the fed weight of 1074 pounds. The optimum programs for the other sectors

TABLE XXIV

OPTIMUM OPERATIONAL STRATEGY BY SECTOR FOR THE SET OF 1974 PRICES AND COSTS ACROSS ALL BREED TYPES

A	C	S	F	Y	P	B
CSPUR (1530	JCCOPC	CCCOPY	CCCOPY	CSPUR (1530)	CSPUR (1804)	CSPUR (1723)
CORNPUR (1915)	JL455XA	CT493YY	CT493YY	CORNPUR (1915)	CORNPUR (3331)	CORNPUR (3230)
SUPPUR (58)				SUPPUR (58)	SUPPUR (84)	SUPPUR (82
SBOMPUR (342)				SBOMPUR (342)	SBOMPUR (469)	SBOMPUR (450)
CCCOPY				CCCOPY	CCCOPY	CCCOPY
CT493YY				CT493YY	CL493YA	CT493YY
DCL1Y7T1				DCL1Y7T1	BC493SA	DCL1Y7T1
DCL2Y7T1				DCL2Y7T1	DCL1S7A1	DCL2Y7T1
DCH2Y3T1				DCH2Y3T1	LCL1S7A1	DCH2Y3T1
GCH1Y3T1				GCH1Y3T1	BCL1YSA1	DCH3Y3T1
KCXH1Y				KCXH1Y	DCL2Y8A2	DCH4Y3T1
LCMH1YT				LCMH1YT	DCH2Y6A2	DCH5Y3T1
					DCH3Y6A2	DCH6Y3T1
					DCH4Y6A2	DCH7Y3T1
					DCH5Y6A2	DCH8Y3T1
					DCH6Y6A2	DCH9Y3T1
					DCH7Y6A2	DCHOY3T1
					DCH8Y6A2	LCGH9Y3T
					DCH9Y6A2	BCGH9P
					DCHOY6A2	GCH9P
					LCGH9Y6A	LCXH9PB
					BCGH9P	BCXH9B
					GCH9P	KCXH9B
					LCXH9PB	LCMH9BT

permitted to feed (C, S, F) entail no feeding at all.

As a result, the cow-calf sector (C) optimizes by calving and selling a weaned 455 pound JRAN feeder calf through the auction. The stocker (S) and feeder (F) sectors minimize their losses by simply not feeding. These findings suggest feeder calf production was profitable, but cattle feeding was unprofitable under the 1974 set of prices and costs. The packer (P) and breaker (B) sectors optimize by slaughtering and breaking carcass of a 1211 pound CHHE slaughter steer. Thus, all activities except feeding were profitable under 1974 conditions.

Inferences permeate Table XXIV. Since both the packer and breaker sectors optimize using the heaviest possible slaughter steer and carcass, it may be inferred that both would maximize profits with the heaviest fed steer available within any type under 1974 conditions. These results suggest that the major costs of killing and breaking tend to be fixed on a per head or per carcass basis.

A key observation is that there are discrepancies in optimum types and fed weights between those sectors permitted to feed (C, S, F, Y) and those sectors using the fed steer or its carcass as an input (P, B). Further examination of the findings provides measures of the implications of those discrepancies. Among these measures are the minimum premiums that the feeder calf producer would have to be offered to produce the type of calves which would be preferred at the packer and breaker levels. Also included would be the minimum premium that the feeding sector would have to be offered to feed each type to the weight that optimizes returns to the packer and breaker sectors. Providing comparable information would be the maximum price that the feeding sector can pay for feeder calves and the minimum selling price they could receive for fed steers.

The magnitudes of the premiums and discounts differ between the sectors, across the types and fed weights under consideration, and across the prices and feedstuffs. In effect, the shadow prices from which these premiums and discounts are derived incorporate the economic dimensions of opportunity costs created by subsets of activities being either open or closed to a given sector. These premiums and discounts will be identified where MPSX output permits, as discussion of each of the individual sectors is completed in more detail.

The Optimum Cow-Calf (C) Sector Program

For the set of 1974 prices and costs, the optimum program for the cow-calf (C) sector consists of calving, raising, and selling a 455 pound weaned JRAN calf through the auction. According to Table XXIII, optimization of the cow-calf (C) sector yields returns of $24.84 to the cow-calf sector, but costs the fed beef system (A) a loss of $164.02. As indicated earlier, however, the $164.02 loss to the fed beef system is an artificial loss. The fed beef system still has a valuable asset in the form of a 455 pound JRAN calf.

An analysis of the most economical disposition of the fixed cost to the fed beef system represented by this calf is not part of the MPSX output. Hand calculations of a program in which the calf would be bought, fed to its first high energy slaughter weight of 892 pounds, slaughtered, the carcass broken, and the lean sold by the integrated (Y) sector yields returns to the (Y) sector of $56.97. Combined with the cow-calf (C) sector returns of $24.84, the returns to the fed beef system, due to the cow-calf sector's production of a JRAN feeder calf instead of a CHHE calf with all other activities performed by the integrated (Y) sector, would be \$14.18 (\$95.99 - \$81.81).

The cow-calf (C) sector optimized with a JRAN calf because the cost of production was lowest for the JRAN (Table VII), and a uniform calf price was applied against all types (Table VIII). Returns to the (C) sector from producing and selling a HEHE calf instead of a JRAN calf would have been \$16.22 less, or \$8.62. Returns from the CHHE calf would have been \$1.03 less, or \$23.81.

The cow-calf (C) sector had the option of feeding its own feeder calf instead of selling it through the auction. Because the cost of gain per hundredweight (COG) exceeded fed steer returns per hundredweight (FSSP), the cow-calf (C) sector optimized by producing and selling a feeder calf in accordance with criteria number 3 of Table XXII.

According to Table XXIV, both the packer (P) and breaker (B) sectors optimize with the heaviest possible slaughter steer available under the set of 1974 prices and costs. In the MPSX output, shadow prices provide an indication of how much the packer (P) or breaker (B) would have to pay each of the micro feeding sectors (C, S, F, Y) in order to have that particular feeding sector feed each type to its maximum fed weight.

A shadow price is a measure of the magnitude by which costs need to be reduced or revenues increased in order to effect a realignment of activities so as to bring an activity not in the optimal solution into the optimal solution. In this case, the activity is the sale by the feeding sector of a particular type and weight of fed steer fed according to some feeding regime.

Shadow prices exist only for activities not in the basis. An activity in the basis at a positive level of 1, with the exception of feedstuff purchases, constitutes part of the optimal (most profitable) solution. An activity in the basis at a level of zero could be a part of any number of feasible solutions, but not the optimal solution.

By definition, an activity in the basis does not have a shadow price. This creates an indeterminancy as to whether a minimum premium is necessary to bring an activity in the basis at a zero level into the optimal solution at a positive level of one. The various tables noting premiums and discounts indicate these indeterminancies. While indeterminancy limits any analysis, it does not subtract from the relative relationships between types or across feeding regimes for which there are premiums and discounts.

The purpose of Table XXV for the cow-calf (C) sector and comparable tables for the other feeding sectors (S, F, Y) is to identify the magnitude of the minimum premiums that the packer (P) sector has to offer the feeding sector to motivate the feeding of each type under alternative feeding regimes to its maximum fed weight. The sets of activities, enumerated in Table XIX, opened and closed to each of the feeding sectors create alternative opportunity costs between the sectors as reflected by differences in their shadow prices for the same activity.

The fed steer prices quoted in Table XXV are quality grade weighted prices. Quality grade itself is a function of type and the type's fed weight. The base price is highest for the JRAN type because its maximum fed weight of 1100 pounds produces a 100 percent Choice fed steer. The maximum fed weights for HEHE and CHHE produce different combinations of Good and Choice fed steers.

Table XXV records the minimum fed steer prices required by the cow-calf (C) sector to realign its optimum program from JRAN feeder calf production and sales at weaning to include feeding of each type to maximum fed weight under alternative feeding regimes. The larger the differences between the base price and the price associated with the feeding regime, the less profitable is that type.

TABLE XXV

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS FOR ALTERNATIVE FEEDING REGIMES BY TYPE FROM THE COW-CALF (C) SECTOR FOR 1974 BASE CORN AND CORN SILAGE PRICES

Level of Returns	Corn Price ($/bu)	Corn Silage Price ($/ton)	Base Price Feeding Regimes	Minimum Fed Steer Price by Type[a]		
				HEHE	JRAN	CHHE
$24.84	$2.92	$21.41	Base	$41.60	$41.96	$39.40
			1T	$45.48	BS	$43.02
			2T	BS	$42.99	$41.05
			3T	$41.95	BS	$42.12

[a] BS indicates indeterminancy since the referenced activity is in solution, but at a zero level.

The cow calf (C) sector requires a smaller premium to feed the CHHE than the HEHE to its maximum weight under the total high energy (1T) feeding regime. Thus, the CHHE is more profitable than the HEHE to the cow-calf (C) sector under feeding regime 1T. The profitability of the JRAN relative to the CHHE and HEHE for the cow-calf (C) sector is indeterminate for feeding regime 1T.

Under feeding regime 2T, the JRAN is more profitable than the CHHE to the cow-calf (C) sector because it requires a smaller premium to maintain returns at $24.84. HEHE is indeterminate. Under feeding regime 3T, HEHE is more profitable than CHHE, and JRAN is indeterminate. An indeterminate situation in each feeding regime and the lack of consistent profitability rankings between types over feeding regimes bars clear-cut determination of the most desirable types for maximum weight feeding by the cow-calf (C) sector.

The descending order of feeder calf profitability for the cow-calf (C) sector is JRAN, CHHE, and HEHE. Table XXIV indicates that neither one of the two strictly feeding sectors, stocker (S), and feeder (F), fed cattle. This indicates that the cost of feeding was greater than fed steer returns in 1974. Since profitable feeder calf production implies that FCSP>FCCOP, the lack of feeding by the cow-calf (C) sector serves as another indicator that the COG>FSSP under the set of 1974 prices and costs.

Table XXV shows no feasible feeding regimes for CHHE within the cow-calf (C) sector, since the ranges between COG and FSSP produce losses or shadow prices. Feeding regime 2T is feasible for HEHE, but not feasible for JRAN. Feeding regimes 1T and 3T are feasible, but not profitable, for JRAN.

The Optimum Stocker (S) Sector Program

Only feeding activities were available to the stocker sector. Because the COF>FSSP inequality prevails for every type over all feeding regimes, the stocker (S) sector optimizes by simply not feeding. Consequently, Table XXIII shows returns to the stocker (S) sector to be zero while artificial returns to the fed beef system (A) are -$170.95.

Because the model requires utilization of one animal and the stocker (S) sector is not permitted to produce a feeder calf, the optimum set of activities associated with the stocker (S) sector in Table XXIV entails production and transfer by the integrated (Y) sector of a CHHE feeder calf. The cow-calf (C) sector could also have been selected to produce the feeder calf for the stocker (S). However, the selection of the integrated (Y) sector to produce the feeder calf that the stocker (S) declines to feed is consistent with model logic and earlier findings regarding optimization of the fed beef system (A).

Since the fed beef system (A) optimized by letting the integrated (Y) sector perform all activities, the fed beef system does not realize any loss from optimization of the stocker (S) sector. The integrated (Y) sector feeds the calf, resulting in the same program that optimized returns for the fed beef system (A).

In Table XXVI, the difference between the base price and the quoted price for a given type and feeder calf weight is the minimum discount necessary to enlist the stocker (S) sector in a feeding program that will maintain returns at zero under the set of 1974 prices and costs. Even if granted, the discounts do not reflect the fed weights to which the stocker (S) sector will feed. Alternatively, the quoted price may be viewed as the maximum "laid-in" cost that the stocker (S) sector could pay to maintain a zero loss from feeding the reference type and weight of feeder calf.

Unfortunately, discounts associated with the lightest two of the five feeder calf weights in Table XXVI are indeterminate for HEHE and JRAN. Over comparable weights and types of feeder calves, there is an inverse relationship in the discounts commanded by the HEHE and JRAN as compared to the CHHE. The pattern is one in which the lighter and earlier maturing HEHE and JRAN calves face small discounts at light feeder calf weights and large discounts at heavy feeder calf weights. An opposite relationship between the magnitude of discount and feeder calf weights prevails for the CHHE.

TABLE XXVI

A COMPARISON OF BASE 1974 AND MAXIMUM FEEDER CALF "LAID-IN" COSTS BETWEEN TYPES THAT WOULD AFFECT FEEDING BY THE STOCKER (S) SECTOR FOR BASE 1974 FEED PRICES

Level of Returns	Feeder Calf Weight[a]		Base 1974 and Maximum "Laid-in" Costs by Type[b]					
			HEHE		JRAN		CHHE	
			Base	Maximum	Base	Maximum	Base	Maximum
$0	weaning		$41.52	BS	$41.50	BS	$41.43	$30.88
	L1	T	$38.97	BS	$38.99	BS	$37.38	$33.18
		A	$38.98	$38.40	$39.01	$36.57	$37.39	$32.96
	L2	T	$36.48	$26.23	$37.33	$26.62	$36.42	$34.48
		A	$36.49	$26.58	$37.34	$23.41	$36.43	$34.44

[a]The weaning weights by breed type are: HEHE, 450 pounds; JRAN, 455 pounds; CHHE, 493 pounds. The other weights are available from Table II.

[b]BS means that the activity is in solution, but at zero level.

The stocker (S) sector has the option of obtaining its feeder calf either at weaning; after 77 days on the low energy plane of nutrition which produces the set of L1 weights; or after 133 days on the low energy plane of nutrition which produces the set of L2 weights. The actual feeder calf weights for each type may be found in Tables LXV, LXVI, and LXVII. The relationships between those weights and the alternative feeding règimes are stated in Table XX. Table XXVII keys the relationship between feeder calf weights and feeding regimes.

TABLE XXVII

A KEY FOR ASSOCIATING FEEDING REGIMES AND FEEDER CALF WEIGHTS

Feeder Calf Weights		Associated Feeding Regimes
Weaning		1T, 1A, 2T, 2A, 3T, 3A, 7T, 7A
L1	T	4T, 6T, 8T
	A	4A, 6A, 8A
L2	T	5T, 9T
	A	5A, 9A

Although the pattern of growth and development is similar among types, these are differences in marginal weight gains over the defined time periods of growth which are of technical and economic significance. Of the three types under analysis, the JRAN is the earliest maturing and achieves the greatest percentage of compositional maturity for any defined time period of growth in the study. The CHHE is the latest maturing, and its percentage of compositional maturity is least for a defined time period of growth.

The purpose, format, and interpretation of Table XXVIII follows the discussion outlined for Table XXV. According to TAble XXVIII, the stocker (S) sector finds the HEHE type to be feasible, although not profitable, for more feeding regimes than any other type. Its solid column of shadow prices indicates that no feeding regime is feasible for the CHHE type under 1974 cost and price relationships.

TABLE XXVIII

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS[a] FOR ALTERNATIVE FEEDING REGIMES BY TYPE FROM THE STOCKER (S) SECTOR FOR BASE 1974 FEED PRICES

Level of Returns	Corn Price ($/bu)	Corn Silage Price ($/ton)	Base Price Feeding Regime	Minimum Fed Steer Price by Type[b]		
				HEHE	JRAN	CHHE
0	$2.92	$21.41	Base	$41.60	$41.96	$39.40
			2A	BS	$42.84	$42.55
			3A	BS	BS	$42.97
			4T	BS	BS	$42.59
			4A	BS	$42.84	$43.23
			5T	BS	$42.83	$43.32
			5A	BS	$42.84	$43.05
			6T	$41.77	$43.39	$43.44
			6A	$41.72	BS	$41.22

[a]The maximum fed weights are: HEHE, 1163 pounds; JRAN, 1100 pounds, CHHE, 1261 pounds. Payments and calculations of minimum fed steer prices are based on sell weights which are 96 percent of fed weights.

[b]The base fed steer prices are quality grade weighted prices. A "BS" entry means that the inputed price is in solution, but at zero level.

Unwillingness of the stocker (S) sector to feed is caused by the conditions producing the inequality, COF>FSSP. Comparisons of base "laid-in" FCAC at weaning in Table XXVI and FSSP in column 6 of Tables LXXV, LXXVI, and LXXVII in Appendix H indicate that FCAC>FSSP except at the upper stratum of fed steer weights. The cow calf (C) sector analysis showed that COG>FSSP. Thus, the stocker (S) sector incurs losses from both feeder calf acquisition and feeding a calf acquired at weaning.

The acquisition of the feeder calf at its L1 or L2 weight creates a situation in which FCAC<FSSP. Thus, the stocker realizes a margin of profit from the acquisition of the heavier feeder calf. The inequality COG>FSSP is so great, however, that gains realized from feeder calf acquisition are offset by feeding losses and total losses occur over all types. As a result, discounts of the magnitude inherent in Table XXVI are required so that the gains realized from the inequality FSSP>FCAC negate the losses from the inequality COG>FSSP.

Over the two lightest sets of feeder calf weights, weaning and L1, the CHHE is the only type requiring discounts. At the heaviest feeder calf weight, L2, CHHE reflects the smallest discount, which suggests that it is the most profitable type for the stocker (S) sector to feed under feeding regimes 5T, 5A, 9T, or 9A.

Since the CHHE percentage of compositional maturity is least and its potential for gain is greater than the JRAN and HEHE at the L2 feeder calf weight, the range in the inequality COF>FSSP times the weight gain results in maximum CHHE losses from feeding relative to JRAN and HEHE. The range between FSSP>FCAC is greatest for CHHE, however, which maximizes its gains from feeder calf acquisition relative to JRAN and HEHE. In summary, a COF>FSSP inequality existed and produced losses over all types. The inequality, however, was greatest for the CHHE. It is not clear whether it is least for JRAN or HEHE.

It is important to note that the implicit premiums in Table XXVIII for the stocker and comparable tables of analysis for the other feeding sectors (C, F, Y) are for maximum fed weights. At those weights, the attained percentages of compositional maturities are: JRAN, 96.6%, HEHE, 93.4%, and CHHE, 84.4%. A high percentage of compositional maturity means relatively small additional fed weight gain potential and a larger percentage of feedstuff consumption for body maintenance. At equal percents of attained compositional maturities, the smallest breed types will have smaller marginal weight gains because the trajectories of their growth curves are not as high as the trajectories of the larger types.

The denial of the total high energy feeding regime, 1A, to the stocker (S) sector may have biased its sets of premiums needed on the fed steer and discounts required on the feeder calf relative to the other feeding sectors. For certain combinations of types, fed weights, and price relationships, feeding regime 1A may be the most profitable.

The Optimum Feeder (F) Sector Program

Because the set of 1974 prices and costs produced a situation where COF>FSSP, the feeder (F) sector optimized by not feeding. Thus, the feeder (F) sector realized net returns of zero, while the apparent loss to the fed beef system (A) from optimization of the feeder sector was -$170.95. Comparisons of base weaning feeder calf prices in Table XXIX against the sets of fed steer prices in Tables LXXV, LXXVI, and LXXVII of Appendix H indicate that the feeding of the weaned calf would be unprofitable unless the COG<FSSP because the FCAC>FSSP across all types. The magnitudes of the discounts, however, suggest that losses would be minimized by feeding the CHHE. Similar reasoning suggests that JRAN would be the most unprofitable to feed as a weaned calf. The weights to which these calves would be fed given the discounts cannot be determined from Table XXIX.

TABLE XXIX

A COMPARISON OF BASE 1974 AND MAXIMUM FEEDER CALF "LAID-IN" COSTS BETWEEN BREED TYPES THAT WOULD INDUCE FEEDING BY THE FEEDER (F) SECTOR FOR A CORN PRICE OF $2.92 PER BUSHEL AND A CORN SILAGE PRICE OF $21.41 PER TON

Level of Returns	Feeder Calf Weights[a]		Base 1974 and Maximum "Laid-in" Costs by Type					
			HEHE		JRAN		CHHE	
			Base	Maximum	Base	Maximum	Base	Maximum
0	weaning		$41.52	$30.81	$41.50	$29.90	$41.43	$36.09
	L1	T	38.97	27.64	38.99	32.31	37.38	25.80
		A	38.98	27.01	39.01	33.20	37.39	26.03
	L2	T	36.48	23.90	37.33	28.32	36.42	22.41
		A	36.49	24.22	27.34	28.74	36.43	22.39

[a]Weaning weights by breed type are: HEHE, 450 pounds; JRAN, 455 pounds, and CHHE, 493 pounds. The other weights are available from Tables LXV, LXVI, and LXVII of Appendix D.

From Table XXIX, the L1 and L2 feeder calf weights across all types suggest profitable feeding opportunities to the heavier weights, provided the COG<FSSP because the FCAC<FSSP at those weights. According to the magnitudes of the minimum discounts, the JRAN appear to be the most

profitable to feed, while the CHHE is the least profitable type.

The magnitudes of the minimum premiums inherent in Table XXX required to have the feeder (F) sector feed each type to its maximum fed weight also offers clues as to the most and least profitable types to feed under the set of 1974 prices and costs. The large number of indeterminate situations for HEHE and JRAN prohibit meaningful comparisons across types. The presence of premiums for the CHHE type, however, suggests that it was not a profitable type to feed.

TABLE XXX

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS[a] FOR ALTERNATIVE FEEDING REGIMES BY TYPE FROM THE FEEDER (F) SECTOR FOR BASE 1974 FEED PRICES

Level of Returns	Corn Price ($/bu)	Corn Silage Price ($/ton)	Base Price Feeding Regime	Minimum Fed Steer Price by Type[b] HEHE	JRAN	CHHE
0	$2.92	$21.41	Base	$41.60	$41.96	$39.40
			1A	BS	BS	$43.09
			2A	BS	BS	$43.65
			3A	BS	BS	$43.30
			4T	BS	BS	$43.86
			4A	BS	BS	BS
			5T	BS	BS	$43.08
			5A	BS	$43.44	$43.11
			6T	$41.63	$43.39	$43.45
			6A	$43.40	$42.84	$43.15

[a]Maximum fed weights by breed type are: HEHE, 1163 lbs; JRAN, 1100 lbs; CHHE, 1261 lbs. Payments and calculations of fed steer prices are made on the basis of sell weights, which are 96% of fed weights.

[b]Fed steer prices are quality grade weighted prices. A "BS" entry indicates that the activity is in solution, but at a level of zero.

More specifically, the magnitudes of the premiums for the CHHE required for feeding regimes 1A, 2A, and 3A indicate that the relatively small discount required on it as a weaned feeder calf cannot be interpreted to mean that it would be the most profitable type to feed to maximum weight. The discounts required for the CHHE as an L1 and L2 feeder calf and the premiums required to feed it to its maximum fed weight under other feeding regimes provide a consistent interpretation of the CHHE as the least profitable to feed under 1974 prices and costs.

The BS and minimum fed steer price entries in Table XXX are consistent with analyses of the cow calf (C) and stocker (S) sectors in which it was determined that COF>FSSP. The feeding of the weaned calf is unprofitable because both FCAC>FSSP and COG>FSSP. The feeding of the L1 and L2 feeder calf is unprofitable because the negative profit margin associated with the COG>FSSP inequality is greater than the positive profit margin created by the FCAC>FSSP inequality.

The Optimum Integrated (Y) Sector Program

The optimum program for the integrated (Y) sector entails the performance of all functions from feeder calf production through sale of lean meat by the integrated (Y) sector. According to Table XXIV, the integrated (Y) sector produces its own CHHE feeder calf, feeds it according to feeding regime 3T until it attains a slaughter weight of 1074 pounds, slaughters, breaks the resulting 615 pound carcass with a yield grade of 2.5, and sells 476 pounds of 100 percent Good lean meat to the retail outlet. Since this also constitutes the optimum program for the fed beef system (A), the integrated (Y) sector return of $95.99 constitutes no loss to the fed beef system.

Tables XXIII and XXIV and the earlier analyses have shown that all activities, except feeding, were profitable under the set of 1974 prices and costs. Although the integrated (Y) sector fed, it fed only up to the first high energy slaughter weight, and not to the maximum slaughter weight.

The FCCOP<FCSP<FCAC inequalities prompt the integrated (Y) sector to produce and transfer a CHHE weaned calf into its feedlot. According to Table XXXI, the FCCOP for the HEHE calf would have had to decrease from $38.30 to at least $34.19 per hundredweight for HEHE to have come into solution. The minimum discount necessary to force the JRAN into the optimal solution is indeterminate.

The integrated (Y) sector had the option of selling a feeder calf instead of performing all intermediate activities incidental to and including the sale of CHHE lean meat. Since the same 1974 price and cost parameters and technical efficiencies prevailed for the integrated (Y) sector and cattle were fed, the slaughtering and breaking activities must have been profitable enough to cover the loss from feeding to yield returns of $95.99 to the system.

One index of the profitability of the slaughtering and breaking activities is the price premium that other feeding sectors would have had to offer the integrated (Y) sector to acquire its feeder calf or that a packer would have had to offer for its fed steer. The selling prices and associated premiums that other feeding sectors would have had to offer the integrated (Y) sector are available in Table XXXII. Similarly, the minimum fed steer prices required by the integrated (Y) sector to produce the maximum weight fed steer of each type are given in Table XXXIII.

TABLE XXXI

BASE 1974 AND MAXIMUM FEEDER CALF PRODUCTION COSTS NEEDED BY THE INTEGRATED (Y) SECTOR TO MAINTAIN RETURNS BETWEEN TYPES UNDER THE SET OF 1974 PRICES AND COSTS

Level of Returns	Feeder Calf Weight	Base 1974 and Maximum Difference in Feeder Calf Costs of Production: HEHE Base	HEHE Maximum	JRAN Base	JRAN Maximum	CHHE Base	CHHE Maximum
$95.99	weaning	$38.30	$34.19	$34.76	BS[a]	$35.39	BS*
	L1 T	38.12	BS[a]	36.07	BS	35.99	BS*
	L2 T	38.61	BS	37.09	BS	37.08	BS*

BS means that the activity is in the basic solution, but at an activity level of zero.

BS* means that the activity is in the optimal solution.

The integrated (Y) sector had the option of purchasing instead of producing its feeder calf. Although this activity would not have been as profitable since FCCOP<FCSP<FCAC, it would have been profitable. With the exception of HEHE at weaning, the maximum FCAC that the integrated (Y) sector would be willing to pay according to Table XXXIV are indeterminate.

According to Table XXIII, slaughtering and breaking were profitable under the set of 1974 prices and costs. The premiums required by the integrated (Y) sector for its feeder calf and/or fed steer measure the opportunity cost of denial of these functions to the integrated (Y) sector.

The integrated (Y) sector optimized with a CHHE at its minimum or H1 slaughter weight. The lean meat prices required to have the system

TABLE XXXII

BASE 1974 AND MINIMUM FEEDER CALF SELLING PRICES REQUIRED BY THE INTEGRATED (Y) SECTOR TO MAINTAIN RETURNS OVER ALL TYPES FOR THE SET OF 1974 PRICES AND COSTS

Level of Returns ($)	Feeder Calf Weights		Base 1974, Minimum, and Their Absolute Difference in Feeder Calf Selling Price								
			HEHE			JRAN			CHHE		
			Base ($)	Minimum ($)	Difference ($)	Base ($)	Minimum ($)	Difference ($)	Base ($)	Minimum ($)	Difference ($)
95.99	Weaning		40.22	BS	NA	40.11	46.45	6.23	40.22	43.58	3.36
	L1	T	37.87	40.64	2.77	37.87	44.91	7.04	36.36	39.06	2.70
		A	37.87	BS	NA	37.87	40.45	2.58	36.36	39.06	2.55
	L2	T1	35.54	38.68	3.14	36.36	42.74	6.38	35.54	37.66	2.12
		A1	35.54	38.69	3.15	36.36	BS	NA	35.54	38.41	2.87
		T2	35.54	38.61	3.07	36.36	39.23	2.87	35.54	37.72	2.18
		A2	35.54	40.74	5.20	36.86	BS	NA	35.54	38.46	2.92

TABLE XXXIII

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS[a] FOR ALTERNATIVE FEEDING REGIMES BY TYPE FROM THE INTEGRATED (Y) SECTOR FOR BASE 1974 FEED PRICES

Level of Returns ($)	Corn Price ($/bu)	Corn Silage Price ($/ton)	Base Price / Feeding Regime	Minimum Fed Steer Price by Type[b] HEHE	JRAN	CHHE
95.99	2.92	21.41	Base	$41.60	$41.96	$39.40
			1T	52.38	51.34	52.09
			1A	52.38	51.34	52.09
			2T	52.38	51.34	52.09
			2A	52.38	51.34	52.09
			3T	52.38	51.34	52.09
			3A	52.38	51.34	52.09
			4T	52.38	51.34	52.09
			4A	52.38	51.34	52.09
			5T	52.38	51.34	52.09
			5A	52.38	51.34	52.09
			6T	52.38	51.34	52.09
			6A	52.38	51.34	52.09

[a]Maximum fed weights are: HEHE, 1163 lbs; JRAN, 1100 lbs; CHHE, 1261 lbs. Payments and fed weight calculations are based on sell weights which are 96 percent of fed weights.

[b]Base fed steer prices are quality grade weighted prices.

TABLE XXXIV

A COMPARISON OF BASE 1974 AND MAXIMUM FEEDER CALF "LAID-IN" COSTS BETWEEN TYPES REQUIRED BY THE INTEGRATED (Y) SECTOR TO MAINTAIN RETURNS FOR THE SET OF 1974 PRICES AND COSTS

Level of Returns ($)	Feeder Calf Weight		Base 1974, Maximum and Absolute Differences in "Laid-in" Costs								
			HEHE			JRAN			CHHE		
			Base ($)	Maximum ($)	Difference ($)	Base ($)	Maximum ($)	Difference ($)	Base ($)	Maximum ($)	Difference ($)
95.99	Weaning		41.52	38.29	3.23	41.51	BS	NA	41.43	BS	NA
	L1	T	38.97	BS	NA	38.99	BS	NA	37.38	BS	NA
		A	38.98	BS	NA	39.01	BS	NA	37.39	BS	NA
	L2	T	36.48	BS	NA	37.33	BS	NA	36.42	BS	NA
		A	36.49	BS	NA	37.34	BS	NA	36.43	BS	NA

produce alternative slaughter weight steers are given in Table XXXV. Although many of these prices are indeterminate, the range is smallest at approximately $.01 per pound for CHHE and largest at approximately $.06 per pound for HEHE.

Summarized Findings for the Feeding Sectors

The preceding analyses of the feeding sectors (C, S, Y) under the set of 1974 prices and costs failed to identify any one particular type as being either the most or least profitable. Rather, the analyses indicated that the most or least profitable type was as much a function of the activities open and closed to each individual feeding sector as it was a function of the set of 1974 prices and costs.

Two basic approaches were used in an attempt to determine the most or least profitable type by feeding sector. In the first approach, an attempt was made to determine which type as a feeder calf was most or least profitable to a given feeding sector. The type commanding the least (greatest) minimum discount was considered the most (least) profitable for that feeding sector. Judgments were suspended on an indeterminate activities.

Under the second approach, an attempt was made to determine the most profitable type of fed steer by each feeding sector if the steer were fed to its maximum allowable weight. The most (least) profitable type commanded the least (greatest) minimum premium. Judgment was suspended on types lacking shadow prices.

The results from applications of these criteria to determine the most profitable type as a feeder calf and then as a maximum weight fed steer by feeding sector are summarized in Tables XXXVI and XXXVII,

TABLE XXXV

A COMPARISON OF BASE 1974 AND MINIMUM LEAN MEAT PRICES REQUIRED TO MAINTAIN RETURNS FOR VARYING QUANTITIES BY TYPE FROM THE INTEGRATED (Y) SECTOR FOR BASE 1974 PRICES

Levels of Returns ($)	Corn Price ($/bu)	Corn Silage Price ($/ton)	Lean Meat Weights	HEHE Base ($)	HEHE Minimum ($)	JRAN Base ($)	JRAN Minimum ($)	CHHE Base ($)	CHHE Minimum ($)
95.99	2.92	21.41	H1	1.193	1.2019	1.193	BS	1.193	BS*
			H2	1.193	BS	1.194	BS	1.193	1.1939
			H3	1.193	BS	1.2010	BS	1.193	BS
			H4	1.193	BS	1.2180	BS	1.193	BS
			H5	1.1935	BS	1.2190	BS	1.193	BS
			H6	1.1960	BS	1.2260	BS	1.193	1.2057
			H7	1.2070	BS	1.2430	BS	1.193	BS
			H8	1.2265	BS	1.2430	1.2941	1.194	1.2013
			H9	1.2395	1.2933			1.2004	1.2109

TABLE XXXVI

IDENTIFICATION OF THE MOST (AND LEAST) OR INDETERMINATE PROFITABLE FEEDER CALF FOR ALTERNATIVE WEIGHTS AT ACQUISITION BY FEEDING SECTORS FOR THE SET OF 1974 PRICES AND COSTS

Feeding Sector	Weaning	Weights at Acquisition			
		L1		L2	
		T	A	T	A
Cow-calf[1]	JRAN* H	H,J,C		H,J,C	
Cow-calf[3]	JRAN* C	CHHE (JRAN)		H,J,C	
Stocker[2]	CHHE H,J	CHHE H,J	HEHE (CHHE)	CHHE (JRAN)	CHHE (JRAN)
Feeder[2]	CHHE (JRAN)	JRAN (CHHE)	JRAN (HEHE)	JRAN (CHHE)	JRAN (CHHE)
Ingegrated (Y)[1]	CHHE* J	CHHE* H,J	H,J,C	CHHE* H,J	H,J,C
Integrated (Y)[2]	HEHE J,C	H,J,C	H,J,C	H,J,C	H,J,C
Integrated (Y)[3]	JRAN H	JRAN (CHHE)	JRAN H	JRAN (CHHE)	HEHE J
				HEHE (CHHE)	HEHE J

*indicates that the associated activity was part of the optimal solution.

[1]The calf is selected for a sector as a producer of feeder calves that has vertical integration options. The calf with the smallest premium is the most profitable.

[2]The calf is selected for a sector that buys the feeder calf for the feedlot. The calf with the smallest discount is the most profitable.

[3]The calf is selected for a sector that sells the calf despite the vertical integration opportunities available. The calf with the highest premium is the most profitable.

TABLE XXXVII

IDENTIFICATION OF THE MOST (AND LEAST) PROFITABLE TYPES FOR MAXIMUM FED WEIGHT BY FEEDING SECTORS OVER FEEDING REGIMES

	Feeding Regime											
Feeding Sector	1T	1A	2T	2A	3T	3A	4T	4A	5T	5A	6T	6A
Cow-calf (C)	CHHE J	*	JRAN H	*	HEHE J	*	*	*	*	*	*	*
Stocker (S)	*	*	*	JRAN H	*	CHHE H,J	CHHE H,J	JRAN H	JRAN H	JRAN H	HEHE (CHHE)	HEHE J
Feeder (F)	*	CHHE H,J	*	CHHE H,J	*	CHHE H,J	CHHE H,J	H,J,C	CHHE H,J	JRAN H	HEHE (CHHE)	JRAN (CHHE)
Integrated (Y)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)	JRAN (CHHE)

*indicates denial of the feeding regime to the sector.

respectively. In both tables, the fully abbreviated type occupying the top position is the most profitable. The fully abbreviated type enclosed in parentheses is the least profitable. The presence of a single letter for a type indicates indeterminancy. Blocks with two or more single letters signal the need for additional analysis.

The Optimum Packer (P) Program

The model permits only the packer (P) to buy and slaughter a fed steer and to sell the cold carcass to the breaker (B). The value of offal is incorporated into the packer's net coefficient for slaughter costs, According to Table XXIV, the packer (P) sector achieves optimization under 1974 conditions from the purchase and slaughter of a 1211 pound CHHE slaughter steer and the subsequent sale of 85 percent Good, 15 percent Choice, 730-pound cold carcass to the breaker.

According to Table XXIII, optimization of the packer (P) sector results in positive net returns of $11.26 to the packer sector, but an artificial loss of $90.31 to the fed beef system (A). Since the value of offal was greater than the cost of slaughter by $10.15, the net return from sale of the carcass itself was only $1.11. This not only indicates the significance of offal to the packer's profit in 1974, but it suggests that the packer would be unable to grant the necessary premiums to any one of the feeding sectors (C, S, F, Y) in order to obtain a 1261 pound CHHE fed steer. It also indicates that a $.93 per hundredweight increase in FSSP with all other prices and costs held constant would result in a loss to the packer (P) sector.

The Optimum Breaker (B) Program

The model permits the breaker (B) to purchase the cold carcass only from the packer, break the carcass, and sell the lean meat. Under the set of 1974 prices and costs, optimization to the breaker requires the purchase of a 730-pound cold carcass from the packer sector and the sale of 565 pounds of lean meat which is 85 percent Good and 15 percent Choice. According to Table XXIII, optimization results in net returns to the breaker of $131.14 at a cost of $22.84 ($95.99 - $73.15) to the fed beef system (A).

Under the set of 1974 prices and costs, the breaker's optimum program complements the packer (P) sector's optimum program. Thus, there are no premiums or discounts to be considered between the packer and the breaker. The relatively small net return that the packer sector realizes from the sale of the 730 pound carcass, $1.11, suggests that the breaker (B) would have to provide premiums to the packer (P) for small increases in the cost of the slaughter steer, for small decreases in offal value, or for decreases in carcass selling price. The quotient of breaker returns and 1211 pounds of CHHE sell weight indicates that the minimum premiums required by all feeding sectors except the integrated (Y) sector could be paid and the breaker (B) still retain positive returns.

Although the fed beef system (A) bears some costs from optimization of the breaker (B) sector, the artificial level of returns to the fed beef system remains positive. This is unique as optimization of the other micro sectors resulted in negative artificial returns to the fed beef system (A).

Carcass breaking activities were highly profitable to the breaker (B) sector and suggests why the integrated (Y) sector pursued all of the activities open to it. The overall conclusion is that all but the strictly feeding sectors (S, F) of the fed beef system (A) enjoyed positive returns in 1974. The level of the magnitude of those returns, however, was such that only the breaker sector could afford to meet the minimum premiums required by the cow-calf (C), stocker (S), and feeder (F) sectors to produce the heaviest possible CHHE fed steer.

A Comparison of Optimum Programs by Type for the Integrated (Y) Sector

The optimum program for any sector under the set of 1974 prices and costs is expressed in terms of one type, one feeding regime, and one fed weight. The identification of the one optimum type does not mean that the other two types were unprofitable. For this reason, there is interest in determining the relative profitability of each type. In addition, the similarities and differences in their optimum programs are also important.

Although the question is applicable to all sectors, limitations of time and funds required that the analysis be restricted to the integrated (Y) sector. The integrated sector was chosen for study because the model made more sets of activities available to it than did any other micro sector of the fed beef system. It is, therefore, more representative of the fed beef system. In addition, the earlier analyses inferred that the cow-calf (C) sector would simply produce and sell the calf; that the strictly feeding sectors (S, F) would not feed, and that the packer and breaker sectors would optimize with the heaviest possible fed steer of any type.

According to Table XXXVIII, optimization of the integrated (Y) sector by type would yield returns of $72.32 from the JRAN, $75.75 from the HEHE, and $95.99 from the CHHE. The interesting analysis, however, is in the analysis of the similarities and differences in the optimum programs of each type as presented in Table XXXIX.

TABLE XXXVIII

LEVEL OF RETURNS REALIZED BY THE INTEGRATED (Y) SECTOR FOR THE SET OF 1974 PRICES AND COSTS BY TYPE OF CATTLE

		Type	
	JRAN	HEHE	CHHE
Returns	$72.32	$75.75	$95.99

The interpretation of Table XXXIX follows the MPSX identification scheme outlined in Table XV. The numbers under the feedstuff purchase activities represent the quantities of each feedstuff used by the integrated (Y) sector in pursuit of the optimum program for each type. Application of the data in tables interspersed throughout the text and appendices within the framework of the model produced Tables XXXVIII and XXXIX.

The similarities in the optimum program include production and transfer of the feeder calf by the integrated (Y) sector because

TABLE XXXIX

OPTIMUM PROGRAMS BY TYPE OF CATTLE WITHIN THE INTEGRATED (Y) SECTOR FOR THE SET OF 1974 PRICES AND COSTS

Type of Cattle		
JRAN	HEHE	CHHE
CSPUR (1202)	CSPUR (1346)	CSPUR (1530)
CORNPUR (1520)	CORNPUR (1857)	CORNPUR (1914)
SUPPUR (46)	SUPPUR (55)	SUPPUR (58)
SBOMPUR (269)	SBOMPUR (310)	SBOMPUR (342)
JCCOPY	HCCOPY	CCCOPY
JT455YY	HT450YY	CT493YY
DJL1Y7T1	DHL1Y7T	DCL1Y7T1
DJL2Y7T1	DHL2Y7T	DCL2Y7T1
DJH2Y3T1	DHH2Y3T1	DCH2Y3T1
GJH1Y3T1	DHH3Y3T1	GCH1Y3T1
KJXH1Y	DHH4Y3T1	KCXH1Y
LJMH1YT	GHH3Y3T1	LCMH1YT
	KHXH3Y	
	LHMH3YT	

FCCOP<FCAC for all types. Another similarity is that all types are carried to their optimum slaughter weight under feeding regime 3T. A final similarity is that the quality grade at the optimum slaughter weight is 100 percent good, and the yield grade is 2.5.

The differences in each type's optimum program focus on slaughter weight and differences in feed consumption. In general, the JRAN and CHHE are slaughtered at the first high energy slaughter weight permitted by the model, whereas the HEHE is not slaughtered until the third high energy slaughter weight is attained. Tables XVI, XVII, and XVIII show that these are the last discrete weights producing yield grades of 2.5. Differences in feed consumption are tied to high energy weights obtained under compensatory gain feeding regimes.

The differences enumerated in Table XL are more detailed. They suggest that JRAN is least profitable for the integrated (Y) sector because its optimum program yields the least amount of lean meat. It also suggests that the CHHE has greater potential for additional lean meat production because its attained level of compositional maturity is the lowest at any comparable point along the time continuum.

Effects of Varying Corn and Corn Silage Prices

Any number of variables can be studied profitably within the fed beef system. This analysis concentrates on the two principal feedstuffs, corn and corn silage, used in the rations by the feeding sectors of the model. Regardless of its price, feed is one of the major ingredients in cattle feeding. Its cost influences type, feeding regime and fed weight variables associated with cattle feeding.

The optimum combination of these variables is a function of the relationships between feeder calf production or acquisition cost, expected fed steer prices, and cost of gain. Once the feeding program has begun, the only two variables subject to change are feeding regime and fed weight. In this model, the feeding regime is fixed after the first 133 days of feeding.

TABLE XL

VARIABLE DIFFERENCES IN EACH TYPE'S OPTIMAL PROGRAM FOR THE INTEGRATED (Y) SECTOR FOR 1974 PRICES AND COSTS

Variable	Type		
	JRAN	HEHE	CHHE
Percent of attained compositional maturity	81.6	81.2	71.9
Sell weight	892	971	1031
Feed conversion ratio	6.07	6.07	6.63
COF/cwt	$40.32	$42.10	$40.79
COG/cwt	46.95	46.08	46.40
COG:FC/cwt	35.88	35.85	36.85
Pounds of lean	403	425	476

The primary focus is on the effects of changes in the cost of gain due to changing corn and/or corn silage prices. Changing the costs of corn and/or corn silage has the effect of implicitly altering the percentage, but not the magnitude, of non-feed interest and death loss costs relative to the 1974 base. Regardless of the direction of change in corn and corn silage costs, the overhead component of non-feed costs remains fixed.

The effects of change in costs of gain upon type, feeding regime, and fed weight will be investigated for cow-calf (C), feeder (F), and the integrated (Y) sectors. The selection of sector and feed cost changes to investigate is not exhaustive or exclusive, but representative of the most likely situations. The analysis of the effects of varying corn and corn silage prices will be compared against the benchmark results reported for the set of 1974 prices and costs.

Effects of Varying Corn Prices Given a Fixed Corn Silage Price Upon the Cow-Calf (C) Sector

Study of the effects of changing feedstuff prices upon the cow-calf (C) sector provides an opportunity to analyze a sector that not only produces a feeder calf but that also has the option of selecting the most profitable type for sale as a feeder calf, or selecting the most profitable type for production and sale as a fed steer. According to Table XXII, a type is more profitable as a feeder calf (fed steer) when the net returns from the FCCOP<FCSP inequality is greater (less) than the net returns of the COF<FSSP inequality. Table XLI identifies the discrete corn price ranges, given a constant corn silage price of $9.51 per ton, over which a type, feeding regime, and fed weigh will prove to be most profitable for the cow-calf (C) sector. The only changes in programs over the $.24 per bushel price increments over a discrete range of corn prices are in the magnitudes of profit.

Under a set of 1974 prices and costs, the price of corn was $2.92 per bushel, and the calculated price of corn silage was $21.41 per ton. Under those sets of conditions, the FCCOP<FCSP and COG>FSSP inequalities prevailed so that the cow-calf sector optimized by producing and selling the JRAN feeder calf at weaning. According to Table XLI, corn prices below $1.00 per bushel result in an optimal program in which the cow-calf (C) sector produces and feeds HEHE to its maximum slaughter weight of 1116 pounds under the total high energy feeding regime 1T. For corn prices between $1.00 and $2.68 per bushel, the cow-calf sector continues to produce and feed HEHE under feeding regime 1T, but only to a slaughter weight of 996 pounds. At some corn price greater than or equal to $2.68 per bushel, the cow-calf sector ceases to feed, and optimizes by producing and selling the JRAN feeder calf.

The decision to feed rests upon the relationships between feeder calf acquisition costs, expected fed steer prices, and costs of gain. Because of the influence of derived demand, interest centers on the changing price relationships between feeder calf acquisition costs and fed steer prices both within and across the three types as costs of gain change in response to changing corn and corn silage prices. Within a type, note can be taken of the range of price changes in feeder calf acquisition cost or fed steer prices for multiples of $.24 changes in corn prices. Over types, the same ranges can be employed in a comparative fashion to arrive at relative profitability rankings between types.

Effect Upon FCCOP. HEHE is the most profitable calf to produce and feed up to a corn price within the range of $2.44 to $2.68 per bushel. HEHE was the most optimal type because the net product of the

TABLE XLI

IDENTIFICATION OF THE DISCRETE LOWER LIMIT AT WHICH VARYING CORN PRICES AND A FIXED CORN SILAGE PRICE OF $9.51 PER TON WILL EFFECT CHANGES IN PROFITS AND OPTIMUM PROGRAMS OVER ALL TYPES FOR THE COW-CALF (C) SECTOR

Variables	Discrete Lower Limits and Programs		
Corn price ($/bu)	$ .04	$ 1.00	$ 2.68
Corn silage price ($/ton)	9.51	9.51	9.51
Profits ($/head)	168.34	105.73	24.84
Program			
Feed purchases	CSPUR (916)	CSPUR (815)	
	CORNPUR (3157)	CORNPUR (2467)	
	SUPPUR (67)	SUPPUR (54)	
	SBOMPUR (328)	SBOMPUR (271)	
Feeder calf production	HCCOPC HT450CC	HCOOPC HT450CC	JCCOPC JL455CA
Feeding regime	DHH1CIT DHH2C1T1 DHH3C1T1 DHH4C1T1 DHH5C1T1 DHH6C1T1 DHH7C1T1 DHH8C1T1 DHH9C1T1 DHH0C1T1 LHGH9C1T	DHH1C1T DHH2C1T1 DHH3C1T1 DHH4C1T1 DHH5C1T1 LHGH4CIT	

margin in the COF<FSSP inequality times the fed steer weight was greater than similar products for the JRAN and CHHE. The recorded prices for these latter two types in Table XLII indicate how much their respective feeder calf costs of production, FCCOP, have to decline to make them as profitable as HEHE at each alternative price of corn. The differences between their base 1974 and recorded prices may be used as indicators of the least profitable type to the cow-calf (C) sector at alternative corn prices. Under this criterion, the type with the largest differeence would be the least profitable.

According to Table XLII, the differences on the JRAN are greater than the differences on the CHHE for all corn prices through $2.20 per bushel. Differences on the JRAN increase from $.72 to $1.07 with corn price increases, while the CHHE difference remains constant at $.45. Thus, the JRAN is considered the least profitable of all three types to the cow-calf (C) sector for corn prices below $2.20 per bushel.

At some corn price between $2.44 and $2.68 per bushel, the JRAN becomes the most profitable to the cow-calf (C) sector, and the relative profitability ranking between HEHE and CHHE becomes indeterminate. From the information in Tables XLI and XLII, it is concluded that the cow-calf sector (C) maximizes returns by producing and feeding HEHE up to some corn price between $2.44 and$2.68. For all greater corn prices, the cow-calf sector (C) maximizes returns by producing and selling the weaned JRAN feeder calf.

Effect Upon FCSP. At low corn and corn silage prices, the FSSP>COF inequality prevails and it is more profitable for the cow-calf (C) sector to produce and sell a fed steer instead of a feeder calf.

TABLE XLII

BASE 1974 AND MAXIMUM FEEDER CALF PRODUCTION COSTS ALLOWED TO THE COW-CALF (C) SECTOR TO MAINTAIN RETURNS BETWEEN TYPES FOR VARYING CORN PRICES AND A FIXED CORN SILAGE PRICE OF $9.51 PER TON

Levels of Returns ($)	Varying per Bushel Corn Price ($)	Feeder Calf Weight[a]	Base 1974 and Maximum Feeder Calf Cost of Production HEHE Base ($)	HEHE Maximum ($)	JRAN Base ($)	JRAN Maximum ($)	CHHE Base ($)	CHHE Maximum ($)
105.73	1.00	Weaning	38.30	BS*	34.76	34.04	35.39	34.94
93.40	1.24	Weaning	38.30	BS*	34.76	33.83	35.39	34.94
81.06	1.48	Weaning	38.30	BS*	34.76	33.69	35.39	34.94
68.73	1.72	Weaning	38.30	BS*	34.76	33.71	35.39	34.94
56.39	1.96	Weaning	38.30	BS*	34.76	33.72	35.39	34.94
44.06	2.20	Weaning	38.30	BS*	34.76	33.73	35.39	34.94
31.62	2.44	Weaning	38.30	BS*	34.76	BS	35.39	34.94
24.84	2.68	Weaning	38.30	BS	34.76	BS*	35.39	35.18
24.84	2.92	Weaning	38.30	BS	34.76	BS*	35.39	35.18

BS* means that the referenced type is part of the optimal solution. BS means that the referenced type is optimal, but not in the optimal solution.

[a]The weaned feeder calf weights are given in Tables LXV, LXVI, and LXVII of Appendix D.

According to Table XLI, the cow-calf sector feeds HEHE to a slaughter weight of 1116 pounds when corn prices are less than $1.00 per bushel, to 996 pounds when corn prices range between $2.44 and $2.68 per bushel, and produces and sells the JRAN feeder calf when corn prices move above $2.68 per bushel.

Relatively low feedstuff prices affect the cow-calf (C) sector in that the other cattle feeding sectors (S, F, Y) also find it more profitable to feed and bid up the feeder calf price. The problem then becomes one of determining minimum feeder calf selling prices for alternative types and weights of feeder calves given alternative prices of corn and corn silage at which the cow-calf (C) sector finds it as profitable to sell each type and weight of feeder calf as it does to feed a fed steer. Comparisons of the differences in the base 1974 prices and the minimum feeder calf selling prices in Table XLIII answer the additional questions of what type of feeder calf proves most and least profitable to the cow-calf (C) sector for alternative prices of corn and corn silage.

The minimum feeder calf selling prices required by type and feeder calf weight for alternative corn and corn silage prices are identified in Table XLIII. Identification of the most and least profitable types by alternative feeder calf weight for alternative corn prices given a fixed corn silage price of $9.51 per ton is summarized in Table XLIV.

In Table XLIII, the minimum feeder calf price recorded for weaned, L1 T and L2 T feeder calf weights is the price required by the cow-calf (C) sector to sell the associated type and weight of feeder calf to one of the three other feeding sectors (S, F, Y). The magnitude of difference between the base 1974 price and the recorded price in Table

TABLE XLIII

BASE 1974 AND MINIMUM FEEDER CALF SELLING PRICES NEEDED BY THE COW-CALF (C) SECTOR TO MAINTAIN RETURNS OVER ALL TYPES FOR VARYING CORN PRICES AND A FIXED CORN SILAGE PRICE OF $9.51 PER TON

Levels of Returns ($)	Varying per Bushel Corn Price ($)	Feeder Calf Weight	Base 1974 and Minimum Feeder Calf Selling Price HEHE Base ($)	HEHE Minimum ($)	JRAN Base ($)	JRAN Minimum ($)	CHHE Base ($)	CHHE Minimum ($)
105.73	1.00	Weaning	40.22	61.80	40.22	57.28	40.22	56.38
		L1 T	37.87	53.77	37.87	53.21	36.36	44.17
		L2 T	35.54	45.71	36.36	45.77	35.54	37.52
93.40	1.24	Weaning	40.22	59.06	40.22	54.36	40.22	53.88
		L1 T	37.87	51.93	37.87	51.06	36.36	42.03
		L2 T	35.54	44.14	36.36	43.89	35.54	35.63
81.06	1.48	Weaning	40.22	56.31	40.22	51.51	40.22	51.38
		L1 T	37.87	50.08	37.87	48.96	36.36	42.14
		L2 T	35.54	42.57	36.36	42.05	35.54	BS
68.73	1.72	Weaning	40.22	53.58	40.22	48.81	40.22	48.88
		L1 T	37.87	48.18	37.87	46.99	36.36	42.12
		L2 T	35.54	41.00	36.36	40.37	35.54	BS
56.39	1.96	Weaning	40.22	50.84	40.22	46.11	40.22	46.38
		L1 T	37.87	46.13	37.87	45.02	36.36	42.11
		L2 T	35.54	39.43	36.36	38.79	35.54	BS
44.06	2.20	Weaning	40.22	48.10	40.22	43.41	40.22	43.87
		L1 T	37.87	44.08	37.87	43.04	36.36	42.10
		L2 T	35.54	37.86	36.36	37.21	35.54	BS
31.72	2.44	Weaning	40.22	45.35	40.22	41.73	40.22	41.37
		L1 T	37.87	42.03	37.87	41.89	36.36	42.08
		L2 T	35.54	36.29	36.36	BS	35.54	BS
24.84	2.68	Weaning	40.22	43.82	40.22	BS*	40.22	BS
		L1 T	37.87	41.01	37.87	40.88	36.36	42.0
		L2 T	35.54	BS	36.36	BS	35.54	BS
24.84	2.92	Weaning	40.22	43.82	40.22	BS*	40.22	BS
		L1 T	37.87	41.01	37.87	41.09	36.36	42.06
		L2 T	35.54	35.62	36.36	BS*	35.54	BS

BS* means that the associated type and weight constitutes part of an optimal program; BS means that the asssociated type and weight is in the optimum solution, but not in the optimal program.

TABLE XLIV

AN IDENTIFICATION OF THE LARGEST AND SMALLEST MAGNITUDES OF DIFFERENCE FROM BASE 1974 PRICES FOR ALTERNATIVE FEEDER CALF WEIGHTS OVER ALTERNATIVE CORN PRICES GIVEN A FIXED CORN SILAGE PRICE OF $9.51 PER TON FOR THE COW-CALF (C) SECTOR

Feeder Calf Weights	Alternative Corn Prices per Bushel								
	≤ $1.00	$1.24	$1.48	$1.72	$1.96	$2.20	$2.44	$2.68	≤ $2.92
Weaning	HEHE (CHHE)	HEHE (CHHE)	HEHE (CHHE)	HEHE (JRAN)	HEHE (JRAN)	HEHE (JRAN)	HEHE (CHHE)	JRAN (HEHE)	JRAN (HEHE)
L1 T	HEHE (CHHE)	HEHE (CHHE)	HEHE (CHHE)	HEHE (CHHE)	HEHE (CHHE)	HEHE (JRAN)	CHHE (JRAN)	CHHE (JRAN)	CHHE (HEHE)
L2 T	HEHE (CHHE)	HEHE (CHHE)	HEHE C	HEHE C	HEHE C	HEHE C	HEHE J,C	H,J,C	H,J,C

XLIII indicates the relative profitability between the types for alternative corn prices and feeder calf weights. Thus, the larger (smaller) the magnitude of difference, the more (less) profitable that type and feeder calf weight for alternative corn prices and a fixed corn silage price of $9.51 per ton.

Criterion (7) in Table XXII suggests that as the COF increases, in this case due to increases in the price of corn, the heavier weight calf of any type becomes relatively more profitable to the feeding sector. The selling price of the heavier calf, L1 T and L2 T, increases relative to the selling price of the weaned calf in Table XLIII for successive increases in corn prices.

<u>Effect Upon FSSP</u>. As shown in Table XLI, the cow-calf (C) sector did not feed any type to its maximum slaughter weight for corn prices above $1.00 per bushel. Theoretically, optimization under a constant FSSP and FCAC given increasing COG situations results in a lowering of fed weights as COF increases. In other words, the fed weight becomes the variable, and FSSP and FCAC are the constants. When the production of a particular fed weight is of interest, the FSSP becomes the variable and the FSSW and FCAC become constants.

An earlier finding indicated that the packer (P) and breaker (B) sectors realized greatest returns from the heaviest fed weight of the largest mature type. The finding was extended to infer that these two sectors want the heaviest weight from any type.

Any feeding sector (C, S, F, Y) would provide the packer (P) and breaker (B) with the heaviest possible steer provided their returns from the associated set of activities would be equally as profitable as the existing optional set of activities. The level of the FSSP is the determining criterion. The set of varying FSSP required by the cow-calf (C) sector to feed each type to its maximum fed weight under increasing corn and corn silage prices is shown in Table XLV.

Maximum fed weight feeding raises two additional questions. The first question seeks to determine the most and least profitable types, while the second question seeks to determine the optimum feeding regime. Tables XLVI and XLVII were constructed from Table XLV to answer the first and second questions, respectively.

The difference between the price required to maintain returns and the base 1974 price is considered to be the premium. In Table XLV, the implicit maximum (minimum) premium for a given corn price serves to identify the least (most) profitable type. Table XLVI identifies the most and least profitable types to the cow-calf (C) sector for feeding to maximum weights given alternative corn prices.

Generalizations from Table XLVII show HEHE to be the most profitable under feeding regime 1T at corn prices of $2.20, $2.68, and $2.92 per bushel. JRAN is the most profitable under feeding regime 1T between corn prices of $1.24 and $2.44. CHHE is most profitable at $1.00 per bushel for feeding regimes 1T and 2T. The indeterminancy of of HEHE under feeding regimes 2T and 3T qualifies the observation that HEHE is the most profitable for these feeding regimes at corn prices greater than $1.24 per bushel.

Differences in the premiums between weaning and L1, weaning and L2, and between the L1 and L2 weights for a particular type and corn price in Table XLIII identify the most and least profitable feeding regimes by types and corn price for the cow-calf (C) sector. A summary

TABLE XLV

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS FOR ALTERNATIVE FEEDING REGIMES BY TYPES FROM THE COW-CALF (C) SECTOR FOR ALTERNATIVE CORN PRICES AND A $9.51 PER TON CORN SILAGE PRICE

Alternative per Bushel Corn Price	Base Price Feeding Regime	Minimum Fed Steer Price by Type[a] HEHE ($)	JRAN ($)	CHHE ($)
($)	Base Price	41.60	41.96	39.40
1.00	1T	42.47*	42.02	39.41
	2T	BS	42.04	39.47
	3T	BS	42.21	BS
1.24	1T	42.56*	42.21	39.91
	2T	BS	42.13	39.86
	3T	BS	42.20	39.62
1.48	1T	42.65*	42.43	41.48
	2T	BS	42.25	41.32
	3T	BS	42.23	40.92
1.72	1T	42.73*	42.72	43.03
	2T	BS	42.43	42.77
	3T	BS	42.32	42.20
1.96	1T	42.82	43.01	44.57
	2T	BS	42.62	44.19
	3T	BS	42.41	43.46
2.20	1T	42.90	43.29	46.10
	2T	41.66	42.80	45.61
	3T	BS	42.50	44.71
2.44	1T	42.99	44.02	47.63
	2T	42.25	43.43	47.04
	3T	41.65	43.03	45.97
2.68	1T	43.07	44.81	49.17
	2T	42.85	44.12	48.46
	3T	42.12	43.63	47.23
2.92	1T	43.16	46.26	50.70
	2T	43.45	45.47	49.88
	3T	42.59	44.88	48.48

[a]BS means that the activity is in solution at a level of 0.

*means that the activity is in the optimal solution.

TABLE XLVI

IDENTIFICATION OF THE MOST (AND LEAST) PROFITABLE TYPES BY FEEDING REGIME FOR THE COW-CALF (C) SECTOR FOR MAXIMUM WEIGHT FEEDING UNDER ALTERNATIVE CORN PRICES

Feeding Regime	Per Bushel Corn Price								
	$1.00	$1.24	$1.48	$1.72	$1.96	$2.20	$2.44	$2.68	$2.92
	CHHE	JRAN	JRAN	JRAN	JRAN	HEHE	JRAN	HEHE	HEHE
1T	(HEHE)	(HEHE)	(CHHE)	(CHHE)	(CHHE)	(CHHE)	(CHHE)	(CHHE)	(CHHE)
	CHHE	CHHE	JRAN	JRAN	JRAN	HEHE	HEHE	HEHE	HEHE
2T	H	H	H	H	H	(CHHE)	(CHHE)	(CHHE)	(CHHE)
	JRAN	CHHE	JRAN	JRAN	JRAN	JRAN	HEHE	HEHE	HEHE
3T	H,C	H	H	H	H	H	(CHHE)	(CHHE)	(CHHE)

TABLE XLVII

IDENTIFICATION OF THE MOST (AND LEAST) PROFITABLE FEEDING REGIMES BY TYPE FOR THE COW-CALF (C) SECTOR FOR MAXIMUM FED WEIGHT GIVEN VARYING CORN PRICES AND A FIXED CORN SILAGE PRICE OF $9.51 PER TON

	Per Bushel Corn Price								
Type	$1.00	$1.24	$1.48	$1.72	$1.96	$2.20	$2.44	$2.68	$2.92
HEHE	I[a]	I	I	I	I	I	3T (1T)	3T (1T)	3T (2T)
JRAN	1T (3T)	2T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)
CHHE	I	3T (1T)	2T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)	3T (1T)

of these differences in Table XLVII shows feeding regime 3T to be the most profitable, and 1T to be the least profitable. Exceptions are noted where at $1.00 per bushel, feeding regime 1T is most profitable and 3T is least profitable for JRAN, at $2.92 where feeding regime 2T is least profitable for HEHE, and at $1.48 where feeding regime 2T is most profitable for CHHE. In general, Table XLVII indicates that all types need high energy for profitable gains at maximum weights, but that low energy feeding for the first 133 days on feed is necessary for maximum profits when corn prices are relatively high.

Effects of Varying Corn and Corn Silage Prices Upon the Feeder (F) Sector

The feeder (F) sector can only buy the feeder calf, feed, and sell fed steers. Analysis of the feeder sector provides an opportunity to compare the effects of changing corn and corn silage prices upon a sector that has only feeding related opportunities against sectors that have opportunities other than feeding.

The feeder (F) sector feeds only when the basic inequality, FSSP $\geq$ COF, prevails. In this analysis, both corn and corn silage prices vary in the same direction. In addition, the corn silage price is tied to the price of corn.

The purpose of Table XLVIII is to identify the optimum programs for the feeder (F) sector in terms of types, feeding regimes, and fed weights under varying corn and corn silage prices. The feeder (F) sector did not feed in 1974 because the COF>FSSP. For some fed weights and feeding regimes, FCAC>FSSP. At all fed weights, COG>FSSP.

According to Table XLVIII, the feeder (F) sector feeds HEHE to a

TABLE XLVIII

IDENTIFICATION OF THE DISCRETE LOWER LIMIT FOR WHICH VARYING SETS OF CORN AND CORN SILAGE PRICES EFFECT CHANGES IN PROFITS AND OPTIMUM PROGRAMS OVER ALL TYPES FOR THE FEEDER SECTOR (F)

Variables	Discrete Lower Limits and Programs				
Corn price ($/bu)	$.04	$1.24	$1.72	$1.96	$2.20
Corn silage price ($/ton)	3.56	11.00	13.97	15.46	16.94
Profit ($/head)	147.60	54.89	18.87	1.59	
Program					
Feed purchases	CSPUR	CSPUR	CSPUR	CSPUR	
	(947)	(1247)	(1495)	(1340)	
	CORNPUR	CORNPUR	CORNPUR	CORNPUR	
	(3376)	(3147)	(2926)	(2479	
	SUPPUR	SUPPUR	SUPPUR	SUPPUR	
	(71)	(74)	(74)	(63)	
	SBOMPUR	SBOMPUR	SBOMPUR	SBOMPUR	N
	(348)	(363)	(398)	(346)	O
Feeder calf Acquisition	HCCOPC	HCCOPC	HCCOPC	JCCOPC	F
	HL450CA	HL450CA	HL450XA	JL455XA	E
					E
Type and Feeding Regime	HB450FA	HB450FA	HB450FA	BJ455FA	D
	DHH1F1A	DHL1F7A	DHL1F7A	DJL1F7A1	I
	DHH2F1A1	DHH1F2A1	DHL2F7A1	DJL2F7A1	N
	DHH3F1A1	DHH2F2A1	DHH2F3A1	DJH2F3A1	G
	DHH4F1A1	DHH3F2A1	DHH3F3A1	DJH3F3A1	
	DHH5F1A1	DHH4F2A1	DHH4F3A1	DJH4F3A1	
	DHH6F1A1	DHH5F2A1	DHH5F3A1	DJH5F3A1	
	DHH7F1A1	DHH6F2A1	DHH6F3A1	DJH6F3A1	
	DHH8F1A1	DHH7F2A1	DHH7F3A1	DJH7F3A1	
	DHH9F1A1	DHH8F2A1	DHH8F3A1	DJH8F3A1	
	DHH F1A1	DHH9F2A1	DHH9F3A1		
	LHGH9F1A	DHHOF2A1	DHHOF3A1		
		LHGH9F2A	LHGH9F3A	LJGH7F3A	

slaughter weight of 1116 pounds for some corn and associated corn silage price between \$1.72 and \$1.96 per bushel. For some corn and associated corn silage price between \$1.00 and \$1.24 per bushel, the feeder switches from feeding regime 1A to 2A. For some corn and associated corn silage price between \$1.48 and \$1.72, the feeder switches from feeding regime 2A to 3A. At some corn price between \$1.72 and \$1.96 per bushel, the feeder switches from feeding HEHE to its maximum slaughter weight of 1116 pounds under feeding regime 3A to the feeding of JRAN to a slaughter weight of 1032 pounds under feeding regime 3A. At some corn and associated corn silage price between \$1.96 and \$2.20, the feeder (F) stops feeding because the COF>FSSP.

Effects of Varying Corn Prices Given a Fixed Corn Silage Price Upon the Feeder (F) Sector

Through varying the price of corn while holding the price of corn silage fixed, a common base is created for comparing the optimum feeder (F) program against the optimum cow-calf (C) program. The analysis of the optimum program for each type follows the rationale and procedures followed in analyzing the integrated (Y) sector under the set of 1974 prices and costs.

In the first analysis of the feeder sector under varying corn and corn silage prices, only HEHE and JRAN types were in solution in the optimal programs. It is recognized, however, that all types become profitable when the COF becomes cheap enough. Table XLIX identifies the varying corn prices, given a fixed price of corn silage, at which the optimum feeding regime and fed weight change for each type.

The interpretation of Table XLIX for any one type is based upon the position of the horizontal lines separating fed weights and/or feeding regimes. Thus, the most profitable fed weight and feeding regime for the for the JRAN for corn prices between \$.04 and \$.74 per bushel is 1100 pounds produced under feeding regime 1A. For corn prices between \$.74 and \$1.24, the most profitable program for the JRAN entails feeding to 1075 pounds under feeding regime 1A. Between \$1.24 and \$1.48, the most profitable program maintains the fed weight of 1075 pounds, but under feeding regime 2A. At some corn price between \$1.96 and \$2.20 per bushel, the most profitable program maintans feeding to 1075 pounds of fed weight, but switches from feeding regime 2A to 3A. Beyond that corn price, the feeder sector stops feeding all together. Comparable interpretations of Table XLIX apply to HEHE and CHHE.

TABLE XLIX

OPTIMUM WEIGHTS AND FEEDING REGIMES BY TYPES FOR THE FEEDER (F) SECTOR GIVEN VARYING PER BUSHEL CORN PRICES, P_c, AND A FIXED CORN SILAGE PRICE OF \$9.51 PER TON

Range in Corn Price/Bushel	Optimum Weights and Feeding Regimes by Type of Cattle		
	JRAN	HEHE	CHHE
$\$.04 \leq P_c < .52$	[1100]	[1163]	[1261]
$.52 \leq P_c < .74$	1A		
$.74 \leq P_c < 1.00$	[1075]		
$1.00 \leq P_c < 1.24$	1A	1A	1A
$1.24 \leq P_c < 1.48$	2A		[1112]
$1.48 \leq P_c < 1.72$		2A	2A
$1.72 \leq P_c < 1.96$			
$1.96 \leq P_c < 2.20$	3A	3A	3A
$2.20 \leq P_c$	No Feeding	No Feeding	No Feeding

Effect Upon FCAC. It was noted that FCAC>FSSP for the majority of fed weights and for some feeding regimes. As explained earlier, relatively cheap COG increases the demand for, and the price of, all types and weights of feeder calves. The demand is greatest for the weaned calf, however.

The cow-calf (C) sector is one of two suppliers of feeder calves to the feeder (F) sector. Thus, it would be expected that cheap feed would be reflected in relatively high feeder calf "laid-in" costs. Table L shows the maximum feeder calf "laid-in" costs that the feeder sector (F) can afford to pay for non-optimal types and weights of feeder calves so as to maintain returns for alternative prices of corn. The difference between the maximum "laid-in" and the base 1974 feeder calf cost is the minimum discount required by the feeder to feed that particular type and weight of feeder calf. An ascending order of minimum discounts across types identifies the most and least profitable types of feeder calf for a specific feeder calf weight. Similar ordering within a type identifies the most and least profitable feeder calf within a type for specific corn prices. The existence of BS entries creates indeterminancies which prohibit inferences about the relative profitabilities among types and weights of feeder calves.

The extensive analysis performed for the cow-calf (C) sector regarding its FCAC cannot be repeated for the feeder (F) sector because of the larger number of BS entries. Note can be taken in Table L, however, that discounts are necessary on all L2 feeder calf weights. This suggests that feeding regimes 5T, 5A, 8T, and 8A are not likely to be profitable for the feeder (F) sector.

TABLE L

A COMPARISON OF 1974 BASE AND MAXIMUM "LAID-IN" FEEDER CALF ACQUISITION COSTS BETWEEN TYPES NECESSARY TO MAINTAIN RETURNS TO THE FEEDER (F) SECTOR FOR VARYING CORN PRICES AND A $9.51 PER TON CORN SILAGE PRICE

Varying Per Bushel Corn Price	Feeder Calf Weight[a]		Base 1974 and Maximum "Laid-in" Costs by Type HEHE Base	HEHE Maximum	JRAN Base	JRAN Maximum	CHHE Base	CHHE Maximum
$1.00	Weaning		$41.52	BS*	$41.50	BS	$41.43	BS
	L1	T	38.97	BS	38.99	BS	37.38	BS
		A	38.98	$38.91	39.01	BS	37.39	BS
	L2	T	36.48	33.41	37.33	$34.25	36.42	$32.47
		A	36.49	33.91	37.34	34.72	36.43	32.88
$1.24	Weaning		$41.52	BS*	$41.50	BS	$41.43	BS
	L1	T	38.97	BS	38.99	BS	37.38	BS
		A	38.98	38.98	39.01	BS	37.39	BS
	L2	T	36.48	33.28	37.33	$34.31	36.42	$32.55
		A	36.49	33.79	37.34	34.79	36.43	32.91
$1.48	Weaning		$41.52	BS*	$41.50	BS	$41.43	BS
	L1	T	38.97	BS	38.99	BS	37.38	BS
		A	38.98	$38.98	39.01	BS	37.39	BS
	L2	T	36.48	32.77	37.33	$34.29	36.42	$32.64
		A	36.49	33.28	37.34	34.77	36.43	32.98
$1.72	Weaning		$41.52	BS*	$41.50	BS	$41.43	BS
	L1	T	38.97	$38.97	38.99	BS	37.38	BS
		A	38.98	38.98	39.01	BS	37.39	BS
	L2	T	36.48	32.16	37.33	$34.33	36.42	31.68
		A	36.49	32.68	37.34	34.81	36.43	32.01
$1.96	Weaning		$41.52	BS*	$41.50	BS	$41.43	BS
	L1	T	38.97	BS	38.99	BS	37.38	BS
		A	38.98	$38.98	39.01	BS	37.39	BS
	L2	T	36.48	31.64	37.33	$33.85	36.42	$30.33
		A	36.49	32.16	37.34	34.33	36.43	30.65
$2.20	Weaning		$41.52	BS	$41.50	BS	$41.43	BS
	L1	T	38.97	BS	38.99	BS	37.38	BS
		A	38.98	$38.98	39.01	BS	37.39	BS
	L2	T	36.48	30.59	37.33	$32.21	36.42	$29.11
		A	36.49	31.10	37.34	32.67	36.43	29.41

[a]The weaned feeder calf weights are given in Tables LXV, LXVI, and LXVII of Appendix D.

BS implies that activity is in the basis at a zero level. BS* means that the referenced type and feeding regime is in the optimal solution.

Effect Upon FSSP. Table L1 shows the minimum fed steer prices required by the feeder (F) sector to feed each type to its maximum fed weight under alternative feeding regimes for alternative prices of corn given a fixed corn silage price. The existence of so many indeterminate situations makes reproductions of Tables XLVI and XLVII with accompanying analyses for the feeder (F) sector of limited value. Where available, minimum premiums and relative profitability analyses of types for given feeding regimes and the relative profitability among feeding regimes with a type can be calculated by procedures outlined earlier.

Effects of Varying Corn Prices and Relatively Fixed Corn Silage Prices Upon the Integrated (Y) Sector

The integrated (Y) sector's response to alternative corn prices is of importance because this sector has the opportunity to engage in the collective set of activities open to all of the other micro sectors of the fed beef system. The optimal program for the integrated (Y) sector under 1974 prices and costs is reproduced in Table LII for comparison against the optimal programs associated with alternative sets of corn prices and relatively cheap corn silage prices.

According to Table LII, the integrated (Y) sector produces and transfers the CHHE feeder calf, feeds, slaughters, breaks the carcass, and sells the lean meat up to some corn price between $4.60 and $4.84 per bushel and corn silage price of $24.48 per ton. At some slightly higher price, the integrated (Y) sector optimizes by ceasing its feeding and related slaughtering, breaking, and selling lean meat activities

TABLE LI

MINIMUM FED STEER PRICES REQUIRED TO MAINTAIN RETURNS WHILE YIELDING MAXIMUM FED WEIGHTS FOR ALTERNATIVE FEEDING REGIMES BY TYPES FROM THE FEEDER (F) SECTOR FOR ALTERNATIVE CORN PRICES AND A $9.51 PER TON CORN SILAGE PRICE

Alternative Per Bushel Corn Price	Base Price Feeding Regime	Minimum Fed Steer Prices by Type[a]		
		HEHE	JRAN	CHHE
$1.00	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	BS
	2A	BS	$42.12	$39.46
	3A	BS	BS	39.61
	4T	BS	42.07	BS
	4A	BS	BS	BS
	5T	BS	42.08	BS
	5A	BS	42.08	BS
	6T	BS	42.24	39.58
	6A	BS	42.07	39.55
$1.24	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	$39.79
	2A	BS*	$42.17	39.75
	3A	BS	BS	39.79
	4T		42.16	39.77
	4A	BS	BS	39.70
	5T	BS	42.17	39.76
	5A	BS	42.17	39.73
	6T	BS	42.21	39.82
	6A	BS	42.16	39.77
$1.48	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	$40.36
	2A	BS	$42.31	40.20
	3A	BS*	BS	40.13
	4T	$40.35	42.31	40.22
	4A	BS	BS	40.08
	5T	BS	42.26	40.21
	5A	BS	42.26	40.17
	6T	BS	42.25	40.15
	6A	$40.23	42.25	40.09
$1.72	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	$41.00
	2A	BS	$42.49	40.73
	3A	BS*	BS	40.56
	4T	$42.49	42.51	41.40
	4A	BS	BS	40.46
	5T	BS	42.35	40.65
	5A	BS	42.35	40.61
	6T	BS	42.34	41.20
	6A	$42.27	42.34	40.90
$1.96	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	41.66
	2A	BS	$42.68	41.28
	3A	BS*	BS	41.00
	4T	$42.95	43.05	42.89
	4A	BS	BS	40.84
	5T	BS	42.44	41.10
	5A	BS	42.44	41.06
	6T	BS	42.76	42.57
	6A	42.64	42.43	42.28
$2.20	Base Price	$39.92	$41.96	$39.40
	1A	BS	BS	42.06
	2A	BS	$42.86	42.58
	3A	BS	BS	42.19
	4T	$43.75	44.35	44.28
	4A	BS	BS	41.20
	5T	BS	42.52	41.52
	5A	BS	42.53	41.48
	6T	BS	43.95	43.83
	6A	$43.34	43.60	43.55

[a]BS means that the feeding regime is in the basis, but at a zero level.
BS* means that the feeding regime is in the optimal solution.

TABLE LII

IDENTIFICATION OF THE DISCRETE LOWER LIMIT AT WHICH VARYING CORN PRICES AND AN AVERAGE CORN SILAGE PRICE EFFECT CHANGES IN PROFITS AND OPTIMUM PROGRAMS OVER ALL TYPES FOR THE INTEGRATED (Y) SECTOR

Variables	Discrete Lower Limits on Feedstuff Prices, Corresponding Profits and Optimum Programs					
Corn Price ($/bu)	$ .04	$ 1.00	$ 1.48	$ 2.44	$ 2.92[1]	$ 4.84
Associated Average Corn Silage Price ($/ton)	$ 3.54	$ 3.58	$ 3.61	$ 3.67	$21.41	$24.48
Profits ($/head)	$319.60	$246.28	$213.74	$152.28	$95.99	$24.84
Program Feed Purchases	CSPUR (1074) CORNPUR (3738) SUPPUR (78) SBOMPUR (387)	CXPUR (1434) CORNPUR (3486) SUPPUR (80) SBOMPUR (410)	CSPUR (1723) CORNPUR (3230) SUPPUR (82) SBOMPUR (450)	CSPUR (1588) CORNPUR (2305) SUPPUR (66) SBOMPUR (374)	CSPUR (1530) CORNPUR (1915) SUPPUR (58) SBOMPUR (342)	
Feeder Calf Production	CCCOPY CT493YY	CCCOPY CT493YY	CCCOPY CT493YY	CCCOPY CT493YY	CCCOPY CT493YY	JCCOPY JL455YA
Feeding Regime and Fed Weight	DCH1Y1T1 DCH2Y1T1 DCH3Y1T1 DCH4Y1T1 DCH5Y1T1 DCH6Y1T1 DCH7Y1T1 DCH8Y1T1 DCH9Y1T1 DCH0Y1T1	DCL1Y7T1 DCH1Y2T1 DCH2Y2T1 DCH3Y2T1 DCH4Y2T1 DCH5Y2T1 DCH6Y2T1 DCH7Y2T1 DCH8Y2T1 DCH9Y2T1 DCH0Y2T1	DCL1Y7T1 DCL2Y7T1 DCH2Y3T1 DCH3Y3T1 DCH4Y3T1 DCH5Y3T1 DCH6Y3T1 DCH7Y3T1 DCH8Y3T1 DCH9Y3T1 DCH0Y3T1	DCL1Y7T1 DCL2Y7T1 DCH2Y3T1 DCH3Y3T1 DCH4Y3T1 DCH5Y3T1	DCL1Y7T1 DCL2Y7T1 DCH2Y3T1	
Slaughtering	GCH9Y1T1	GCH9Y2T1	GCH9Y3T1	GCH4Y3T1	GCH1Y3T1	
Carcass-Breaking	KCXH9Y	KCXH9Y	KCXH9Y	CKXH4Y	KCXH1Y	
Lean Meat Sale	LCMH9YT	LCMH9YT	LCMH9YT	LCMH4YT	LCMH1YT	

[1]The 1974 set of prices and optimal program for the integrated (Y) sector.

and concentrating solely on production and sale of the JRAN feeder calf at weaning like the cow-calf (C) sector did at some corn price between $2.44 and $2.68 per bushel.

The integrated (Y) sector feeds the CHHE throughout the set of feedstuff prices permitting feeding. The feeding regimes and fed weights to which it feeds the CHHE, however, change for different sets of corn and corn silage prices. As feedstuff prices increase, feeding regimes change. For further increases, the fed weights within each regime change.

At the lowest set of corn and corn silage prices, the CHHE is fed under feeding regime 1T to its maximum fed weight of 1261 pounds. At some price of corn between $.76 and $1.00 per bushel and corn silage price between $3.56 and $3.58 per ton, the optimum program switches from feeding regime 1T to 2T. Between $1.24 and $1.48 corn and maximum $3.61 corn silage, the optimum feeding regime switches from 2T to 3T. The optimum feeding regime of 3T remains effective for all other sets of corn and corn silage prices.

Optimum fed weights change at three sets of corn and corn silage prices. Between some corn price of $2.20 and $2.44, it switches from the maximum of 1261 to 1136. Between some corn price of $2.68 and $2.92, it switches from 1136 to 1074 pounds of fed weight. Beyond that corn price, feeding to 1074 pounds continues up to some corn price between $4.60 and $4.84, where it ceases all together.

The earlier analyses of 1974 prices and costs of the packer (P) and breaker (B) sectors indicated that their activities were profitable at all fed weights. The same set of analyses showed that feeding was totally unprofitable. At lower feedstuff prices, feeding became profitable and the HEHE and JRAN types were fed. These facts and the analysis of Table LII suggest that the integrated (Y) sector fed CHHE at high feedstuff prices because its slaughtering and breaking activities produced enough greater returns to cover feeding losses. For the integrated (Y) sector, the CHHE yielded greater returns than did the HEHE and JRAN, because it produced more lean meat and any added costs were not sufficient to offset the advantage of the higher level of lean meat.

A Summary of the Effects of Varying Corn Prices Upon the Cow-Calf (C), Feeder (F), and Integrated (Y) Sectors

Table LIII shows the changes in the optimal feeding programs of three micro sectors which enjoy the same technical and economic efficiencies, but which have differing sets of activities available to them under varying feedstuff prices. The optimal programs associated with each sector have been explained earlier. A general review puts the optimal programs of all three sectors in perspective.

Both the cow-calf (C) and feeder (F) sectors optimize by feeding HEHE to its maximum fed weight of 1163 pounds under feeding regime 1T. The cow-calf sector, however, reduces the fed weight to 1037 pounds at some corn price between \$.76 and \$1.00 per bushel. Feeding regime 1T to a fed weight of 1037 pounds is continued until the cow-calf (C) sector stops feeding all together at some corn price between \$2.44 and \$2.68 per bushel. The feeder (F) sector continues to feed HEHE to its maximum fed weight of 1163 pounds to some corn price between \$1.72 and \$1.96. The feeder (F) uses three feeding regimes. The feeder (F)

TABLE LIII

A SUMMARY OF OPTIMUM TYPES, FED WEIGHTS, AND FEEDING REGIMES FOR ALTERNATIVE CORN PRICES FOR THE COW-CALF (C), FEEDER (F), AND INTEGRATED (Y) SECTORS

	Alternative Corn Price												
Sector	$.04	$.28	$.52	$.76	$1.00	$1.24	$1.48	$1.72	$1.96	$2.20	$2.44	$2.68	$2.92...$4.84	
Cow-Calf (C)[1]	HEHE 1163 1T				HEHE 1037 1T							JCCOPC JL455CA No feeding		
Feeder (F)[2]	HEHE 1163 1A					HEHE 1163 2A		HEHE 1163 3A	JRAN 1075 3A	No feeding				
Integrated (Y)[2]	CHHE 1261 1T				CHHE 1261 2T		CHHE 1261 3T				CHHE 1136 3T		CHHE 1074 3T	JCCOPY JL455YA No feeding

[1]Varying corn price and fixed corn silage price.

[2]Varying corn and corn silage prices.

sector then switches to the feeding of JRAN to 1075 pounds for some corn price between \$1.96 and \$2.20.

The differences in these two programs may be explained in terms of the cost of feeding to the two sectors. While the $FCCOP_{(C)} < FCAC_{(F)}$ inequality is favorable to the cow-calf (C) sector, its COG is greater since the corn silage it uses in the analysis costs more than the corn silage used by the feeder (F) sector for all corn prices below \$1.00 per bushel. Since IT is the optimal program for the cow-calf (C) sector, it optimized by lowering fed weight for some corn price between \$.76 and \$1.00 per bushel to maintain the profit maximizing FSSP=COF equality. The constant price of corn silage sustains this optimal program up to some corn price between \$2.44 and \$2.68 per bushel.

The price of corn silage is not constant for the feeder (F) sector. The optimal program entails three changes in feeding regimes while maintaining maximum fed weight for HEHE. This achieves the lowest COG with increasing corn and corn silage costs by employment of the MRTS principle between inputs.

For some corn and associated corn silage price between \$1.72 and \$1.96 per bushel, the feeder (F) sector finds it necessary to switch to the faster maturing JRAN, which it feeds to less than maximum weight in order to achieve the FSSP=COF equality. This result is compatible with real world observations where high feed prices bring forth shifts to faster maturing types and lower fed weights on all types.

The varying corn silage price for the feeder (F) sector is the 1974 corn silage price derived from the formula based corn price. The varying corn silage price for the integrated (Y) sector is little more than the custom charge of chopping free corn for corn prices below

$2.92 per bushel. This analysis typifies a situation where roughage is available and has no other opportunities. For the stated purposes of comparing the optimizing behavior of feeding sectors with different opportunities, extremely cheap corn silage does not prove overly restrictive.

The slow maturing CHHE is the least profitable to feed by sectors that do not have slaughtering and breaking activities available to them. The relatively profitable breaking activities made CHHE feeding optimal for the integrated (Y) sector up to some price of corn between $4.60 and $4.84 per bushel.

The three changes in feeding regimes that took place up to some corn price between $2.20 and $2.44 per bushel corn is attributable to the operation of the MRTS principle. It demonstrates that practically free corn silage will not substitute for corn in CHHE feeding until the price of corn lies between $.76 and $1.00 per bushel. Even then, usage is limited until the price of corn lies getween $1.24 and $1.48 per bushel.

At some corn price between $2.20 and $2.44 per bushel, the integrated (Y) sector finds it necessary to reduce the fed weight from 1261 to 1136 pounds in order to satisfy the profit maximizing MR=MC axiom associated with feeder calf producing, feeding, slaughtering, carcass breaking, and lean meat selling activities. A reduction in fed weight to 1074 pounds is again necessary at $2.92 corn and $21.41 corn silage. Feeding and associated slaughtering and carcass breaking activities cease for the integrated (Y) sector at some corn price between $4.60 and $4.84 per bushel.

Absence of Total Low Energy Feeding Program

Throughout all analyses, no sector optimized through use of one of the low energy feeding regimes to a final fed or slaughter weight. On a pound of feed basis, the low energy rations are less expensive than are the high energy rations, but on a COD basis they are relatively expensive. There are two resons for this conclusion.

First, a larger percentage of the feed consumed in a low energy feeding program goes for body maintenance than in a high energy ration. This leaves less total energy for weight gain. Secondly, a low energy ration yields a smaller fed weight for the same number of feeding days than does the high energy ration. The higher fed weights command higher selling prices because quality grade composition contains proportionately more Choice than Good quality grade meat. This higher price is applicable to the total weight of the steer so that returns are greater even over the lighter weights available from low energy feeding. The necessary condition, however, is that the high energy weight first be attained so that its higher price can apply to the low energy weight.

This rationale offers some explanation as to why the compensatory gain feeding regimes were prevalent in optimal programs as corn prices increased. The low energy rations were used to substitute for the high energy ration up to the point where continued use of the low energy ration would deny high energy fed weight returns.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Background

Beef is a popular source of protein. Tremendous capital and labor resources are committed to its production, processing, and distribution. The beef marketing system, ranging from production to consumption, is a composite of many complex activities requiring important decisions at each stage of activity. Theoretically, the behavior of the decision makers at each sector is guided by the price signals of the open market system.

The price mechanism functions as a coordinating mechanism for the activities associated with lean meat production, processing, and distribution. The functional division and recombination of the various economic activities permits the delineation of six micro sectors within the fed beef system. Functional activities include feeder calf production, feeding, slaughtering, and carcass breaking.

Purcell and his colleagues (12)(51)(53)(54)(55) have documented inefficiencies and operational inconsistencies within subsystems or sectors of the fed beef system. Even if each sector optimizes returns in accordance with received price signals, each tends to optimize considering an intermediate product. The final product from the total of all identifiable sectors may be less than the optimal quantity and quality of lean meat possible from the committed resources if the various activities were organized and handled differently. The various attempts at vertical coordination suggests that the micro sectors are aware of the problem, but that past vertical coordination efforts have not been successful in securing the various intermediate products necessary to ensure optimization of the total fed beef system.

The major exogenous variable in the production of fed beef is the price of feed grains. Forages can substitute for grains, but not with the same level of technical efficiency. Derived demand relationships exist between intermediate products, between intermediate and final products, and between all products and exogenous inputs.

In this study, corn serves as the proxy for grain while corn silage serves as the proxy for forages. A major objective was to measure and analyze the magnitudes and directions of changing relationships between the feeder calf as an input and the fed steer as either an input or output to the relevant micro sectors given price changes in corn and corn silage.

Feeding activities are open to the cow-calf (C), stocker (S), feeder (F), and integrated (Y) sectors. Feeder calf production is available only to (C) and (Y). Slaughtering is available to the packer (P) and integrated (Y) sector. Carcass breaking is available to the breaker (B) and integrated (Y) sectors. The micro sectors (C, S, F, P, B) are hypothesized to operate at least partly independently of each other and represent the potential participants in vertical coordination ventures.

A linear programming model was the primary tool of analysis. Model construction permitted optimization to each of the micro sectors, including the integrated (Y) sectors, and to the fed beef system (A) as the composite of all micro sectors in the absence of vertical integration. The objectives measure the costs of departures from the optimum program in order to achieve maximum fed weight production from each type, estimate the premiums and/or discounts required on feeder calves and fed steers to effect higher levels of coordination, and analyze changes in optimum programs given varying sets of grain and forage prices.

Procedure

The birth weights, weaning weights, and three of the fed steer weights used in this study are recorded in production studies from the Meat Animal Research Center (MARC) at Clay Center, Nebraska (71). The MARC also reported the contents of the four low energy rations that constituted the diet of the fed steer. Calculations of the NE_m and NE_g in these rations showed them to be at a relatively low level.

A Beef Gain Simulator was developed at Oklahoma State University on the basis of Loftgreen and Garrett's net energy system of equations. The Beef Gain Simulator was used to reproduce the low energy growth curve. Four high energy rations were specified, and their NE_m and NE_g contents were used to generate a high energy growth curve. Compensatory gain situations were then created for analysis. The growth curves were modeled for three representative types of cattle: Jersey-Angus (JRAN), Hereford-Hereford (HEHE), and Charolais-Hereford (CHHE).

Data bases were derived from secondary sources using procedures, assumptions, and techniques outlined in Chapter III and the appendices. Estimates of yield grade, quality grade, and dressing percent value attributes were made at 25-pound weight increments for the fed steers. These estimates are based on Nelson's set of regression equations for each attribute and type (44). The value associated with each attribute is a function of the relationship of fed weight to mature weight for each type of cattle.

Costs and feed consumption data were extracted from the Beef Gain Simulator or from stated procedures. Revenue was the product of weight and price. The price of the fed steer, carcass, and lean meat was a function of the quality grade of the product.

The framework for analysis of the MPSX output was built around a feeding decisions criterion table. This table established the relationships which had to prevail in order for feeding to be profitable between feeder calf acquisition cost (FCAC), feeder calf cost of production (FCCOP), feeder calf selling price (FCSP), cost of gain (COG), and fed steer selling price (FSSP). The table made a distinction between decisions prior to feeding and decisions once feeding was under way.

The MPSX format was adapted to model the entire beef production-marketing system through the carcass breaking function. Activities were generated to allow each of the sectors to perform functions or combinations of functions comparable to empirical situations. Transfer activities were incorporated to move the beef animal vertically through the system. Objective functions were generated to allow optimization to each micro sector, to the entire process modeled as an integrated sector, and to the fed beef system (A) where exchange processes were involved. Overall, the model was capable of generating the following information:

(1) The type feeding regime and fed weights of cattle which would

be optimum for each sector as compared to the fed beef system;

(2) The program required in feeding to maximum slaughter weights;

(3) The profits which accrued to the sector or system being optimized, and

(4) Premiums and discounts required on feeder calves and fed steers to effect a higher level of inter-sector coordination. Parametric runs were employed to investigate changes in optimum programs due to varying feed grain and forage prices.

Results

The Optimum Sector Programs Under the Set of 1974 Prices and Costs

The Fed Beef System (A). As the total system, optimization of the fed beef system alone indicates the coordinated performance of a collective set of activities by the open market micro sectors. Comparisons are then possible with the integrated (Y) sector. Optimizing to (A) identifies the optimum combination in terms of type, feeding regime, and both quantity and quality grade of fed weight, carcass weight, and lean which maximizes performance and efficiency of the exchange system.

Under the set of 1974 prices and costs, the optimum program for the fed beef system (A) is also the optimum program for the integrated (Y) sector. The optimizing set of activities includes production and transfer of a 493 pound weaned CHHE feeder calf into the feedlot, feeding of a low energy ration for 133 days on low energy before switching to a high energy ration for another 63 days, slaughtering at the first high energy slaughter weight of 1031 pounds, breaking of the 615.11

pound, 2.5 yield grade, 100 percent Good carcass, and sale of 476.1 pounds of lean meat. Returns realized by both the fed beef system (A) and the integrated (Y) sector were $95.99 per head.

The Cow-Calf (C) Sector. Feeder calf production and either sale or feeding of its own feeder calf constitutes the range of activities available to the cow-calf (C) sector. Under the set of 1974 prices and costs, the cow-calf sector optimizes by producing and selling a weaned 455 pound JRAN feeder calf. Returns are $24.84 per head.

The Stocker (S) Sector. The stocker sector could buy only a feeder calf, feed and sell either a heavier feeder calf or a fed steer. Its feeding program could not include immediate placement of a weaned feeder calf upon the first high energy ration. Under the set of 1974 prices and costs, the stocker sector did not feed because the cost of feeding was greater than fed steer selling prices, COF>FSSP. Returns to the sector were therefore zero.

The Feeder (F) Sector. Like the stocker sector, the feeder sector is strictly a feeding sector as it has no access to non-feeding related activities. It is distinguished from the stocker sector by its access to feeding regime 1A in which the purchased weaned calf may be immediately placed upon the first high energy ration. Because the COF>FSSP, inequality prevailed under 1974 prices and costs, the feeder sector did not feed, and realized returns of zero. Computations of maximum discounts and minimum premiums suggest that the CHHE type would be the least profitable for the strictly feeding sectors (S, F) to feed under 1974 prices and costs.

The Optimum Integrated (Y) Sector. The integrated sector serves as a proxy for a vertically integrated operation, since it has access to feeder calf production, feeding, slaughtering, carcass breaking, and lean meat selling activities. Under the set of 1974 prices and costs, its optimum program became the optimum program for the fed beef system (A). Under this program, a CHHE was calved, fed, slaughtered, and broken at its lightest, possible high energy slaughter weight.

Although its technical and economic efficiencies are the same as any one of the other micro sectors, the ablility of the integrated (Y) sector to have profitable activities subsidize unprofitable activities is the key to its greater returns of $95.99 per head. Without subsidization, its returns and optimum program would have been the same as the cow-calf sector optimum program, namely, JRAN feeder calf production and sale at weaning with returns of $24.84.

Subsidization opportunities enabled the integrated (Y) sector to feed CHHE, the potentially least profitable type to feed under 1974 prices and costs. The CHHE, however, yields the greatest quantity of offal, carcass, and lean. Since the profitability of slaughtering and carcass breaking was a direct function of the quantities of respective intermediate products, the CHHE was the optimum type for the integrated (Y) sector since returns from slaughtering and breaking more than offset losses from feeding.

The Packer (P) Sector. Under the set of 1974 prices and costs, the packer (P) sector optimized by slaughtering and selling the carcass of the heaviest slaughter steer available. The optimum returns were generated by transforming a 1211 pound CHHE slaughter steer into 730.49

pounds of 2.5 yield grade carcass with a quality grade composition of 85 percent Good, 15 percent Choice. Returns were $11.26 per head. Since the offal value constituted over 90 percent of the returns to the packer sector and those returns are relatively low, it would not have been possible for the packer to pay the minimum premiums needed by the feeding sectors (C, S, F, Y) to feed steers of any type to maximum weight under the set of 1974 prices and costs.

The Boner (B) Sector. Like the packer, the boner sector optimizes with the heaviest possible carcass available to it. Returns from transforming the 730.49 pound CHHE carcass into 565.40 pounds of 85 percent Good, 15 percent Choice lean meat were $131.14 per head. The magnitude of returns allows the breaking sector to pay the minimum premiums required by the cow-calf (C), stocker (S), and feeder (F) sectors for producing a 1261 pound CHHE fed steer. Its returns, however, are not great enogh to have the integrated (Y) sector produce and sell a 1261 pound CHHE fed steer under 1974 prices and costs. The minimum premiums are greater for the integrated (Y) sector because fed steer sales deny access to the highly profitable carcass breaking activities.

Optimum Programs for Selected Sectors Under Varying Sets of Corn and Corn Silage Prices

For varying sets of corn and corn silage prices, the price of corn was allowed to vary in increments of $.24 per bushel. The price of corn silage was both held constant and allowed to vary in different analyses. Corn silage prices varying with corn prices create conditions in which the forage has alternative uses. A fixed corn silage price creates a condition in which the corn silage serves as a proxy for forages with no alternative use.

Theoretically, all sectors are affected by changing sets of corn and corn silage prices. The effects upon sectors with feeding activities are more direct and are manifested in terms of changes in feeding regimes, fed weights, and/or cattle types. As the price of corn increases relatively to the price of corn silage, there is substitution of corn silage for corn. The result is manifested in terms of more days being spent on low energy feeding before switching to high energy rations, or even by exclusive adherence to low energy feeding. The behavior is monitored through changes in feeding regimes.

Since increasing corn and corn silage prices increase the cost of gain, there is economic incentive to reduce the fed weight. Given that the marginal pounds of gain per pound of feed are greater at lighter weights, the cost of gain is also smaller. The adjustment of fed weights is explainable in terms of the VMP=MFC axiom.

Increasing cost of gain creates incentives for changes in type in response to the same MRTS and VMP=MFC principles affecting feeding regimes and fed weights. A change in type represents an adjustment on the basis of opportunity cost created by the set of activities open to the sector.

Changing corn and corn silage prices alter the relationships between the inputs and outputs associated with the sector of interest. The feeding sectors require that the feeder calf input be available at lower costs and/or the fed steer output command a greater return as corn and corn silage prices increase. Collectively, the feeding sectors can influence feeder calf prices, but they cannot influence fed steer prices. These derived demand relationships are expressed alternatively in terms of feeder calf discounts or fed steer premiums to the base set of 1974 prices.

Time and funds limitations restricted the number of sectors for which the effects of varying corn and corn silage prices could be analyzed. Sectors studied were chosen on the basis of activities open to them. The combination of sector and sets of varying corn and corn silage prices was chosen for its ability to represent the majority of likely situations.

The Cow-Calf (C) Sector. Because of its opportunity to engage in feeder calf production with either sale or feeding, the cow-calf (C) sector provides the opportunity to evaluate a less than fully vertically integrated sector. For some corn price less than $2.68 per bushel and a fixed corn silage price of $9.51 per ton, the cow-calf (C) sector optimized by switching from JRAN feeder calf production and sale to HEHE feeder calf production and fed steer sales.

When the price of corn is less than $1.00 per bushel, the cow-calf sector feeds HEHE to its maximum fed weight of 1163 pounds under the total high energy feeding regime (1T). For corn prices in the $1.00 - $2.68 per bushel range, the cow-calf (C) sector feeds HEHE to a fed weight of 1037 pounds under feeding regime 1T. Beyond $2.68, the cow-calf (C) sector optimizes by not feeding and producing a JRAN feeder calf for sale at weaning.

Results generated from the evaluation of alternative sets of corn and corn silage prices for the cow-calf (C) sector need to be analyzed in light of the cow-calf sector as a producer of its own feeder calf for its own feeding program, as a seller of a feeder calf, and as a fed steer producer. There are sets of corn and corn silage prices which makes one set of activities more profitable than another. The following statements are necessarily fairly general. Interest in the relative performance of a given type for a given corn price should be cross-referenced with the applicable table and discussion of Chapter V.

For use as an input in its own feeding program, the cow-calf sector found HEHE to be the most profitable up to some corn price between $2.44 and $2.68 per bushel. Above that price, the cow-calf (C) sector did not feed and JRAN was the most profitable. For some corn price less than $2.20, JRAN was the least profitable.

Regardless of the price of corn, the cow-calf (C) sector will produce a JRAN calf if it were to confine its activities to feeder calf production and sale. Consideration of the opportunity cost suffered by the cow-calf sector if it were to confine its activities to feeder calf production identifies the most and least profitable types to the cow-calf sector under varying sets of corn and corn silage prices. Accordingly, Table XLIV shows HEHE to be the most profitable and CHHE to be the least profitable for the cow-calf (C) sector to feed.

If the cow-calf sector were to feed a steer to maximum weight to enhance the position of the packer and breaker sectors, the largest premiums would have to be paid for the CHHE for corn prices greater than $1.48 per bushel. The smallest premiums vary between JRAN and HEHE. Thus, the CHHE is the least profitable for the cow-calf sector to produce and feed for corn prices greater than $1.48 per bushel. If the cow-calf sector were to feed any type to its maximum weight, losses would be least under a feeding program that used low energy feeding for 133 days before switching to high energy, feeding regime 3T, for all corn prices greater than $1.48 per bushel. For any corn price greater than $1.00 per bushel, the total high energy feeding regime, 1T, is the least profitable.

The Feeder (F) Sector. The feeder (F) sector provides an opportunity to determine the effects of changing sets of corn and corn silage prices upon a sector restricted to feeding activities. Neither one of the two strictly feeding sectors (S, F) fed under the set of 1974 prices and costs because the cost of feeding was greater than the fed steer selling price, COF>FSSP.

Under a situation in which forage has alternative uses other than feeding due to simultaneous variations in both corn and corn silage prices, the feeder (F) sector feeds HEHE up to some price between $1.96 and $2.20 per bushel and an associated corn silage price between $15.46 and $16.94 per ton. Up to some corn and associated corn silage price of $1.72 to $1.96 per bushel, the feeder (F) sector feeds HEHE to its maximum fed weight of 1163 pounds.

Feeding regimes, however, changed to include more days on low energy feeding at some corn and associated corn silage price between $1.00 and $1.24 per bushel and changed again to include more days on low energy between some corn price of $1.48 and $1.72. At some corn and associated corn silage price between $1.72 and $1.96, the feeder (F) sector optimizes by feeding a JRAN to a fed weight of 1075 pounds under a feeding regime requiring 133 days on low energy before switching to high energy, that is, feeding regime 3A. Under a situation in which forage had no alternative use as modeled by varying corn prices and a fixed corn silage price, there was no change in the optimum program for the feeder (F) sector.

All types are profitable for the feeder (F) sector to feed over some sets of corn and corn silage prices. Comparisons of the optimum programs of the less profitable JRAN and CHHE types against HEHE indicated that feeding ceases for all types for some corn price between $1.96 and $2.20 per bushel. JRAN feeding, however, entailed a reduction in maximum fed weight by 25 pounds and increased usage of corn silage at lower corn prices than did HEHE and CHHE. Although HEHE and CHHE increased corn silage usage at a common set of corn and corn silage prices, the CHHE reduced its maximum fed weight by 149 pounds while HEHE always maintained maximum fed weight.

As expected, the feeder (F) sector required larger discounts on the feeder calf and heavier premiums on the fed steer as the set of corn and corn silage prices increased. The large number of indeterminate solutions prohibited clearcut identifications of optimum types on the basis of premiums and discounts required for changing sets of corn and corn silage prices.

The Integrated (Y) Sector. The integrated (Y) sector offers the opportunity to study the effects of changing corn and relatively fixed corn silage prices upon a vertically integrated sector. Under the set of 1974 prices and costs, the integrated (Y) sector emerged as the optimum organizational structure for the fed beef system (A). Its optimum program was based upon a set of activities that resulted in the sale of 476.10 pounds of lean meat from a CHHE.

Because of the ability of the profitable sector(s) to subsidize the unprofitable sector(s), determinations were made of the relative optimum returns and program of all types to the system under the set of 1974 prices and costs. The JRAN had the smallest return of $72.32, followed by HEHE with returns of $75.75, and the CHHE with returns of $95.99 per head. The common characteristics in the program for each type included feeder calf production and transfers, use of the low energy feeding regime for 133 days before switching to high energy, and slaughter weights characterized by yield grade 2.5 carcasses and 100 percent Good quality grade cuts of lean meat.

Differences in the optimum program of each type were observed in cost of feeding, feed conversion ratios, percent of compositional maturity attained at slaughter, and pounds of lean. The significant observation was that the compositional maturity at the optimum slaughter weight was greatest for JRAN at 81.6 percent and least for CHHE at 71.9 percent. This infers that cheap feedstuff prices would be of relatively greater benefit to a CHHE than would high feedstuff prices to the JRAN.

Varying sets of corn prices using both minimal and relatively high corn silage prices resulted in optimal programs that always resulted in optimization with CHHE. The minimum fed weight of 1261 pounds prevailed up to some corn price between $2.20 and $2.44 per bushel. It then declined to 1136 pounds and was maintained at that weight for some corn price between $2.68 and $2.92 per bushel. Feeding and the subsequent slaughtering and carcass breaking activities ceased for some corn price between $4.60 and $4.84 per bushel.

Increasing successive usages of corn silage were noted at some corn price between $.77 and $1.00 per bushel and between some corn price between $1.20 and $1.48 per bushel. The subsidization of the feeding activities by the carcass breaking activities was the only reason the integrated (Y) sector program did not duplicate the cow-calf sector program.

Summary of the Effects of Varying Sets of Corn and Corn Silage Prices

Given other base 1974 prices and costs, cheaper sets of corn and corn silage prices make it profitable for all sectors with feeding opportunities to feed. The independent cow-calf (C), stocker (S), and feeder (F) sectors will optimize by feeding HEHE while the integrated (Y) will feed CHHE.

Returns from feeding other than the optimum type will be positive. The difference in optimum types between the independent micro sectors and the integrated micro sector is the latter's access to carcass breaking activities. Regardless of the feeding sector, increasing sets of corn and corn silage prices result in the use of more corn silage in the ration and lower fed weights. As a result of the opportunity costs associated with available activities, the cow-calf (C) sector stops feeding for some corn price between \$2.44 and \$2.68 per bushel. The feeder (F) stops at some corn price between \$1.96 and \$2.20 per bushel. The subsidization of its feeding program permits the integrated sector to feed for some corn price between \$4.60 and \$4.84 per bushel.

Even though greater quantities of corn silage were substituted as corn prices increased, low energy feeding until slaughter did not enter into any of the optimal programs regardless of the price of corn. Low weight gain and lower fed steer prices due to lower quality grades associated with the lower fed weights are the dominant reasons for this result.

Conclusions

The general conclusions of the study support conclusions drawn in Nelson's companion study (44). The objectives of this study were designed partly to satisfy Nelson's cited needs for more work in this area of vertical coordination. Therefore, there are general conclusions available from this study that either support or extend, but fail to refute, Nelson's general conclusions. Three common conclusions available from these two studies include:

(1) Demonstration of the ability to quantify the inability of the open market price mechanism as it presently functions to remove inter-level goal conflicts and operational inconsistencies within the fed beef sytem.

(2) Optimization of one micro sector often produces an intermediate product that is suboptimal to the micro sector that processes it further.

(3) Increases in the costs of feedstuffs, particularly corn, have greater effects upon fed weights and feeding regime than upon types of cattle.

General conclusions drawn from this study include:

(1) All sectors are affected eventually by changing sets of corn and corn silage prices. As feedstuffs prices increase, all feeding sectors demand larger discounts on all weights and types of feeder calf inputs and larger premiums for the fed steer output to continue feeding activities.

(2) The failure of the two heavier weighted feeder calves of any type to appear in any optimal program indicates that frequent

ownership transfers are not consistent with profit maximization objectives of any micro sector or of the fed beef system. This failure could also be attributed to two factors. First, feeder calf cost of production was cheaper than feeder calf acquisition cost, FCCOP<FCAC. Secondly, feedstuff prices favored the feeding of light calves or no feeding at all.

(3) The magnitude of returns realized by the independent boner-breaker (B) sector was sufficient to satisfy the premium requirements of the independent feeding sectors (C, S, F). Thus, a potential for vertical coordination existed under the set of 1974 prices and costs.

(4) The inability of the boner-breaker (B) sector to satisfy the premium requirements of the integrated (Y) sector for its fed steer indicates that vertical integration offers attractive returns to the organization that can assemble and coordinate the necessary capital and labor resources effectively.

(5) Although cheap on a per pound input basis, low energy feedstuffs are expensive on an output basis because of small live weight gains and lower returns from lower quality output. Low energy feedstuffs, however, are prominent in profitable compensatory gain feeding programs under conditions of increasing corn prices.

The possibility of vertically integrated micro sectors dominating the fed beef system is not very great. The need for and profitability of effective coordination of the technically related micro sectors has been established in both this study and its companion study. Totally integrated systems generate a larger profit because the input-output relationships between the vertical stages are managed more effectively.

The type of animal which maximizes returns to a particular sector or stage of activity is often not the type which is the optimal animal in terms of contribution to total system profits. Any price differences across types which are observed in empirical settings are either inconsistent with the true value of the animal to the total system, or are not of sufficient magnitude to effect change.

The hope of establishing Pareto optimality between the micro sectors of the fed beef system through vertical coordination is dimmed by the findings of the earlier subsector studies of the fed beef system conducted by Purcell and his colleagues. These studies point out the need to increase the level of knowledge about the system as a whole, its implicit and explicit inconsistencies, and possible arrangements for higher levels of coordination across the micro sectors. Dissemination of the findings of this study will constitute a first step toward that goal.

Limitations

Many of the limitations cited in the study by Nelson deserve mention. Such limitations include the static nature of the analysis which makes it impossible to consider change in price and cost relationships between the time of breeding and lean meat sales. Limitations are also inherent in the assumption of traditional profit maximizing behavior, perfect knowledge of levels, costs, and returns of inputs and outputs, the consideration of only steers, and the generation of findings in a one-steer unit.

A prime motivation for this study was the need to overcome the companion study's (44) cited limitation of only one feeding program and failure to consider alternative feeding rates, ration formulations, and stocker programs. These variables were incorporated into this study through use of the Oklahoma State University developed Beef Gain Simulator.

Limitations, however, exist with the Beef Gain Simulator. It is necessary to assign alternative combinations of feeder grades for different types, feeder calf weights and shrinkages to ensure "tracking" of the growth curve(s) of interest. The existing body of knowledge did not permit the imputations of economic value to the feeder calf with combination of feeder grades.

The NE_m and NE_g content of the ration is inputed into the Beef Gain Simulator. The calculations of these parameters are based on tables published by the National Research Council, NRC. The NRC tables, however, are not accurate for extremes in types of cattle. In addition, they assume stilbestrol-implanted cattle (22).

The emergence of compensatory gain feeding regimes in optimal programs under conditions of increasing sets of corn and corn silage prices assume that the digestive processes of the animal's body can make immediate adjustments from forage-based to grain-based rations. Such may not be the case.

The assumption of common economic and technical efficiencies between the micro sectors implies that the quality of management exists to maintain these efficiencies. Economic texts always cite management as a limiting resource. The lack of a homogeneous regional data base from which the coefficients were developed also detracts from the validity of the findings.

Analyses considered the effect of changes in only the exogenous feed grain sector. Endogenous or exogenous changes in other variables are real possibilities and they could alter the findings significantly. Fed steer prices, for example, assume exogenous demand schedules and relationships between Good and Choice beef. Changes in consumer preferences could easily alter the nature of this relationship and the validity of the findings.

Need for Further Study

A need exists for the establishment of predictable relationships among types, feeding regimes, and body composition at alternative weights. A requirement exists for establishing criteria by which to evaluate and assign grades to feeder calves.

Additional work needs to be done on the demand structure for beef. The demand structure for Good and Choice beef also needs to be estimated. In addition, actual industry realizations as opposed to the USDA standard 4.6 percent difference in lean meat between yield grades need to be incorporated into the analysis.

A need also exists for developing frameworks for analyzing the economies and diseconomies of vertical coordination. Similar frameworks need to be developed for identification and measurement of variables which contribute to a given sector's degree of bargaining power. The mechanics of alternative and potentially feasible means of distributing premiums and discounts between the sectors of the fed beef system need to be developed in order to make coordination a more viable alternative.

Conditions conducive to profitable low energy feeding programs need to be identified within the context of a systems analysis. Optimizing criteria for breaking carcasses need to be developed and incorporated into the study.

A need exists to consolidate the Oklahoma State University work on the subject of goal conflicts, operational inconsistencies, and the quantitative measurements of the costs of ignorance to the sectors of the fed beef system. Where applicable, the work of the regional task forces should be incorporated into this same area. As this effort gets under way, behavioral scientists should look into the most effective means for getting sector participants together in a mutually beneficial self-help effort.

A SELECTED BIBLIOGRAPHY

(1) Agrawal, R. C. and Earl O. Heady. Operations Research Methods for Agricultural Decisions. Ames, Iowa: The Iowa State University Press, 1972.

(2) Beneke, Raymond R. and Ronald Winterboer. Linear Programming Applications to Agriculture. Ames: The Iowa State University Press, 1973.

(3) Blaich, O. P. "Integration in Theory With an Application to Hogs." Journal of Farm Economics, Vol. 42 (December, 1960), pp. 1280-1293.

(4) Brant, Bill. "Economics of Scale in Beef Production." (Paper presented at Great Plains and Western Outlook Conference, Durango, Colorado, July 29-31, 1969). Agricultural Economics Paper-6914, Oklahoma State University.

(5) Brody, S. Bioenergetics and Growth. New York: Reinhold Publishing Co., 1945.

(6) Brungardt, V. H. Efficiency and Profit Differences of Angus, Charolais, and Hereford Cattle Varying in Size and Growth. Madison, Wisconsin: University of Wisconsin, College of Agricultural and Life Sciences, Research Reports R2397, R2398, R2399, R2400, and R2401, 1972.

(7) Clifton, Elliott S. "Effects on the Meat Packing Firm of Short-Run Price Variations in Livestock." Journal of Farm Economics, Vol. 39 (December, 1957), pp. 1645-1654.

(8) Collins, Norman R. "Changing Role of Price in Agricultural Marketings." Journal of Farm Economics, Vol. 41 (August, 1959), pp. 528-534.

(9) Crom, Richard. "A Research and Information Program for the Beef Subsector." (Unpub. USDA paper, Washington: Economic Research Service, January, 1973.)

(10) Dinkel, C. A. and D. D. Dearborn. Choosing Breeds and Crossbreeding Systems by Computer. Brookings: South Dakota State University Agricultural Experiment Station Animal Science Series 72-26, 1972.

(11) Dorfman, Robert. Application of Linear Programming to the Theory of the Firm. Berkeley, California: Bureau of Business and Economic Research, 1951.

(12) Dunn, Terry L. and Wayne D. Purcell. "Economic Implications of Conflict and Inconsistency in the Beef Marketing System: The Feeder- Packer Subsector." Stillwater, Oklahoma: Oklahoma Agricultural Experiment Station Bulletin B-700, 1972.

(13) Erickson, Donald B. and Richard W. Litchy. "Cost Analyses of Systems to Distribute Fresh and Frozen Meats." Frozen Meat - Its Distribution Cost, Acceptance, and Cooking and Eating Qualities. Manhattan: Kansas Agricultural Research Publication 166, 1973.

(14) Farris, D. E. and W. C. Couvillion. "Vertical Coordination of Beef in the South - Nature of Different Systems." Southern Cooperative Series Bulletin 192. College Station: Texas Agricultural Experiment Station, August, 1975, p. 14.

(15) Farris, Donald E. and Ed Williams. "Potential Efficiencies of Integrated Cattle Operations Compared to the Open Market System." Beef Cattle Research in Texas, 1973, PR-3218, 1974.

(16) Farris, Donald E. and Raymond A. Dietrich. "Economics of Alternative Beef Production Systems and Locations." Paper presented at Forage-Fed Beef Research Workshop, New Orleans, Louisiana, October 20, 1975. College Station, Texas: Texas A. & M. University, Department of Agricultural Economics, 1975.

(17) Fowler, M. A., S. A. Adeyanju, Wise Burroughs and E. A. Kline. "Net Energy Evaluation of Beef Cattle Rations With and Without Stilbestrol." Journal of Animal Science, Vol. 30, 1970, pp. 291-296.

(18) Fox, Danny G. Use of Energy Values in Ration Formulation. Great Plains Beef Cattle Feeding Handbook, GPE-1000, October, 1972.

(19) French, Ben C. "The Subsector as a Conceptual Framework for Guiding and Conducting Research. American Journal of Agricultural Economics, Vol. 56 (December, 1974), pp. 1014-1022.

(20) Gee, Dan H. Quality and Yield Grades for Beef. Great Plains Beef Cattle Feeding Handbook, GPE-1903, January, 1973.

(21) Gill, Donald R. Formulating Rations for Finishing Cattle. Great Plains Beef Cattle Feeding Handbook, GPR-1600, October, 1972.

(22) Gill, Donald. Net Energy Requirements of Feedlot Cattle. Great Plains Beef Cattle Feeding Handbook, GPR-1001, December, 1972.

(23) Gill, Donald R. and Joseph L. Gray. Beef Gain Simulator. Computer Center, Oklahoma State University, May, 1975.

(24) Goodrich, R. D. "Production of Choice Cattle With Desirable Yield Grades Through Feeding." Paper presented at Midwest Section of Animal Science Meeting, Chicago, Illinois, November, 1974.

(25) Goodwin, John D. "Economic Pressures for Vertically Integrated Beef Production." Sixth Annual Oklahoma Cattle Feeders' Seminar Proceedings, Stillwater, Oklahoma: Oklahoma State University, Departments of Agricultural Economics and Animal Science, 1970.

(26) Gray, Roger W. "The Changing Role of Price." Journal of Farm Economics, Vol. 46 (February, 1964), pp. 117-127.

(27) Guftason, Ronald A. "Optimum Decisions for a Fixed Feedlot Facility With Linear Programming." (Unpub. M. S. Thesis, Oklahoma State University, Stillwater, 1968.)

(28) Hayek, F. A. "The Use of Knowledge in Society." American Economic Review, Vol. 35 (September, 1945), pp. 522-534.

(29) Heady, Earl D. and Wilfred Candlec. Linear Programming Methods. Ames, Iowa: The Iowa State University Press, 1958.

(30) Joandet, G. E. and T. C. Cartwright. "Modeling Beef Production Systems." Journal of Animal Science, Vol. 41 (April, 1975), pp. 1238-1246.

(31) Johnson, Ralph. An Economic Evaluation of Alternative Marketing Methods for Fed Cattle. Lincoln, Nebraska: Nebraska Agricultural Experiment Station Bulletin 520, 1972.

(32) Johnson, Ronald R. "Compensatory Gain -- Fact or Fiction -- And Its Implication in Cattle Feeding." Oklahoma Cattle Feeders Seminar Proceedings. Stillwater, Oklahoma: Oklahoma State University, Departments of Agricultural Economics and Animal Science, 1971, pp. 1H-7H.

(33) Jones, Jake H. Jr. "A Linear Programming Derivation of Optimum Range Rations From Alternative Nutritive Specifications in a Whole Beef Farm Framework." (Unpub. Ph.D. Dissertation, Oklahoma State University, Stillwater, 1974.)

(34) Kletke, D. and T. R. Nelson. Custom Rates for Summer and Fall Jobs, 1974-75. OSU Extension Facts No. 126, April, 1974.

(35) Klosterman, E. W., L. G. Sanford, C. F. Parker. "Effect of Cow Size and Condition and Ration Protein Content Upon Maintenance Requirements of Mature Beef Cows." Journal of Animal Science, Vol. 27 (1968), p. 242.

(36) Kohls, Richard L. "A Critical Evaluation of Agricultural Marketing Research." Journal of Farm Economics, Vol. 39 (December, 1957), pp. 1600-1609.

(37) Laird, Anna Kane. "Postnatal Growth of Birds and Mammals." Growth, Vol. 30 (September, 1966), pp. 349-363.

(38) Laster, D. B. "Effects of Calving Difficulty on Calf Mortality and Postpartum Rebreeding." U. S. Meat Animal Research Center 1973 Beef Cattle Research Progress Report. May, 1973, pp. 41-46.

(39) Logan, Samuel H. "Economics of Scale in Cattle Slaughtering Plants." Supplementary Study No. 2 to Organization and Competition in the Livestock and Meat Industry, Technical Study No. 1, National Commission on Food Marketing, June, 1966.

(40) McCoy, Hohn H. Livestock and Meat Marketing. Westport, Connecticut: The Avi Publishing Company, Inc., 1972.

(41) McMeekem, C. P. Principles of Animal Production. Whitcombe and Tombe, Ltd., London, 1959.

(42) Mighell, Ronald L. and Lawrence A. Jones. Vertical Coordination in Agriculture. Washington: Economic Research Service, Agricultural Economic Report No. 19, 1963.

(43) National Research Council. Nutrient Requirements of Beef Cattle. 4th Ed., National Academy of Sciences, Washington, D. C., 1970.

(44) Nelson, Kenneth E. "A System Analysis of Information and Communication in Beef Marketing." (Unpub. Ph.D. Dissertation, Oklahoma State University, 1976.)

(45) Nelson, Kenneth E. and Wayne D. Purcell. "A Quantitative Approach to the Feedlot Replacement Decision." Southern Journal of Agricultural Economics, Vol. 4 (July, 1972), pp. 143-149.

(46) Oklahoma State Department of Agriculture. Oklahoma Agriculture 1974. Oklahoma City: Oklahoma Crop and Livestock Reporting Service, 1975.

(47) Owens, F. H. "Can we Change Body Composition With Feeding?" Oklahoma State University, Kansas-Oklahoma Beef Cattle Conference, Wichita, Kansas, November, 1975.

(48) Palsson, H. and J. B. Verges. "Effects of the Plane of Nutrition on Growth and Development of Carcass Quality in Lambs. Part II. Effects of Lambs of 30 Pound Carcass Weight." Journal of Animal Science, Vol. 42 (1952), p. 93.

(49) Plaxico, James S. "Discussion - Simplified Presentation and Logical Aspects of Linear Programming Technique. Journal of Farm Economics, Vol. 36 (1954), pp. 1048-1050.

(50) Preston, R. L. "Effects of Nutrition on the Body Composition of Cattle and Sheep." Paper presented to the Georgia Nutrition Conference February 18, 1971). Wooster, Ohio: Ohio Research and Development Center, 1971.

(51) Purcell, Wayne D. "An Appraisal of the Information System in Beef Marketing." (Unpub. Ph.D. Dissertation, Michigan State University, 1968.)

(52) Purcell, Wayne D. "Identification and Communication of Product Attributes Relation to Vertical Coordination in Beef Marketing." Workshop Proceedings Vertical Coordination in Livestock Marketing, Southern Regional Livestock Marketing Research Committee, Houston, Texas, March 11-14, 1969, pp. 78-90.

(53) Purcell, Wayne D. and R. L. Tapp. "Variable Procedure in Carcass Grade and Weight Sales of Slaughter Beef: Implications to Oklahoma Cattle Feeders." Stillwater: Oklahoma Agricultural Experiment Station Bulletin B-699, 1969.

(54) Purcell, Wayne D. and Kenneth E. Nelson. "Recent Changes in Beef Grades: Issues and Analysis of the Yield Grade Requirement." Stillwater: Oklahoma Agricultural Experiment Station Journal Article 3007, 1976.

(55) Rothwell, P. James and Wayne D. Purcell. Economic Implications of Conflict and Inconsistency in the Beef Marketing System: The Producer-Feeder Subsector. Stillwater: Oklahoma Agricultural Experiment Station Bulletin B0704, 1972.

(56) Self, H. L. "Factors Affecting Shrink in Feeder Cattle." Precondition Seminar Sponsored by Oklahoma State University and Elance Products Co., 1967, pp. 75-81.

(57) Shaeffer, James D. "Changing Orientation of Marketing Research." American Journal of Agricultural Economics, Vol. 50 (December, 1968), pp. 1437-1449.

(58) Sharkey, Roy L. Jr. Crop and Livestock Budgets North Central Oklahoma. Budget Identification Number 112012184 321 1., Budget Record Number 335. Stillwater: Oklahoma State University, p. 93.

(59) Smith, G. M. "Genetic Variation in Feed Efficiency at Age, Weight and Composition End Points." Beef Improvement Federation Proceedings, Des Moines, Iowa, May, 1975, pp. 20-28.

(60) Stuedemann, J. A., J. J. Guenther, S. A. Ewing, R. D. Morrison and G. U. Odell. "Effect of Nutritional Level Imposed From Birth to Eight Months of Age on Subsequent Growth and Development Patterns of Full-Fed Beef Calves." Journal of Animal Science, Vol. 27 (January, 1968), pp. 234-241.

(61) Topeo, David G. "Influence of Energy Consumption During Growth on Carcass Composition of Feedlot Cattle." Ames: Iowa Agricultural and Home Economics Experiment Station Animal Science Leaflet R183, 1975.

(62) Trifton, Raphael. "Guides for Speculation About the Vertical Integration of Agriculture With Allied Industries." Journal of Farm Economics, Vol. 41 (November, 1959), pp. 734-746.

(63) USDA Agricultural Prices. Washington: Crop Reporting Board, Monthly Publications.

(64) USDA Cattle. Washington: Statistical Reporting Service, Statistical Bulletin 503, 1974.

(65) USDA Livestock and Meat Statistics, Supplement for 1973. Washington: Economic Research Service, Statistical Bulletin No. 1974.

(66) USDA Livestock and Meat Statistics, Supplement for 1974. Washington: Economic Research Service, Statistical Bulletin No. 543, 1975.

(67) USDA Livestock, Meat, and Wool Market News. Consumer and Marketing Study, 1974 Weekly Issues.

(68) USDA Livestock Slaughter Annual Summary 1973. Washington: Statistical Reporting Service, April, 1974.

(69) USDA Marketing and Transportation Situation. Economic Research Service. Washington: May, 1975.

(70) USDA Number of Livestock Slaughter Plants. March 1, 1970. Washington: Statistical Reporting Service, May, 1970.

(71) USDA U. S. Meat Animal Research Center Germ Plasma Evaluation Program Progress Report. U. S. Meat Animal Research Center Report No. 1, ARS-NC-13, March, 1974.

(72) Wagner, Donald G. "The Effect of Feedlot In-Weight on the Costs and Efficiencies of Gain." Seventh Annual Oklahoma Cattle Feeders' Seminar Proceedings, Stillwater, Oklahoma: Oklahoma State University, Departments of Agricultural Economics and Animal Science, 1971.

(73) Watson, Donald Stevenson. Price Theory and Its Uses. Dallas, Texas: Houghton Mifflin Co., 1968.

(74) Williams, Ed and Donald E. Farris. Economics of Beef Cattle Systems - From Weaning Age to Slaughter. Departmental Information Report No. 74-3. College Station, Texas. Department of Agricultural Economics and Rural Sociology, 1974.

(75) Winchester, C. F., R. E. Davis, and R. L. Hines. Malnutrition of Young Cattle: Effect on Feed Utilization, Eventual Body Size and Meat Quality. Washington: U. S. Department of Agriculture, Technical Bulletin 1374, 1967.

APPENDIX A

THE PROCEDURE AND EQUATIONS FOR ESTIMATING

VALUES OF BODFAT (%) BY TYPE

THE PROCEDURE AND EQUATIONS FOR ESTIMATING VALUES OF BODFAT (%) BY TYPE

The rationale and equations for estimating BODFAT (%) are outlined in the companion study (44). The purpose of this appendix is to present the three equations used to derive the values of BODFAT (%) for each of the three types of cattle.

The first equation defines the percent fat in the empty body.

(1) PCTFAT = BODFAT (%) = EMBOFAT.

A second equation in Nelson's study states (44, p. 92) that

$$(2)\ \text{PCTFAT} = 1.5224 + .59531\ \text{PCMTWT} - .00908\ (\text{PCMTWT})^2 + .00007\ (\text{PCMTWT})^3$$

The pounds of mature weights recorded for each type in Table XII of the companion study are: JRAN, 1,138.7, HEHE, 1,244.9, and CHHE, 1,494.4.

A third equation provides for the calculation of the only independent variable, PCMTWT, in the second equation. The magnitude of this variable is a function of the relationship between the fed weight of interest and the mature weight of the particular type.

$$(3)\ \text{PCMTWT} = \frac{\text{discrete fed weight}}{\text{mature weight for type}}$$

APPENDIX B

AN OUTLINE OF THE DATA AND PROCEDURES FOR DETERMINING RATION NET ENERGY VALUES AND COST

AN OUTLINE OF THE DATA AND PROCEDURES FOR DETERMINING RATION NET ENERGY VALUES AND COST

The column headings of Table XIV provide an introduction to this appendix. The ration number denotes the numerical sequence in which the rations were fed.

The number of days that each ration was fed was based on the length of time that the U. S. Meat Animal Research Center (MARC) fed its rations. The MARC used three rations in 1970, but four rations in 1971 and 1972. A decision was made to use the longest interval of time between the MARC rations as the number of days for which the first three rations would be fed. The fourth ration is fed after the first 133 days on feed until slaughter, but for no longer than an additional 146 days. The maximum days on feed may not exceed 279.

Absolute Cost Per Hundredweight

In this study, absolute means zero moisture content in the feedstuff. The derivation of the absolute cost per hundredweight of each ration requires numerous digressions into identification of ration ingredients, the 1974 costs of those ingredients, the moisture content of the ingredients, and the composition of the ration. Those digressions can be followed by the common column headings of Tables LIV through LXI.

TABLE LIV

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFF FOR LOW ENERGY RATION NO. 1

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	85.5	40	34.2000	72.4991	.73	52.9243	.43	31.1746	.0268	$1.9430
Corn	7.7	89	6.8530	14.5274	1.02	14.8179	.67	9.7334	.0608	.8833
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	5.3	89	4.7170	11.4735	.87	9.9819	.59	6.7694	.1153	1.3229
Total	100.0	-	47.1730	1000.0000	-	77.7241	-	47.6774	-	4.1867
Adjusted Total						78		48		$4.19

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LV

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR LOW ENERGY RATION NO. 2

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	77.9	40	31.1600	61.3374	.73	44.7763	.43	26.3751	.0268	$1.6438
Corn	15.9	89	14.1510	27.8558	1.02	28.4129	.67	18.6634	.0608	1.6936
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	4.6	89	4.0940	9.3069	.87	8.0970	.59	5.4911	.1153	1.0731
Total	100.0	-	50.8010	100.000	-	81.2862	-	50.5296	-	4.4480
Adjusted Total						81		51		$4.45

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LVI

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR LOW ENERGY RATION NO. 3

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	67.5	40	27.0000	48.2143	.73	35.1964	.43	20.7321	.0268	$1.2921
Corn	25.0	89	22.2500	39.7321	1.02	40.5267	.67	26.6205	.0608	2.4157
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	6.0	89	5.2500	10.5536	.87	9.1816	.59	6.2266	.1153	1.2168
Total	100.0	-	56.0000	100.000	-	84.9047	-	53.5792	-	4.9621
Adjusted Total						85		54		$4.96

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LVII

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR LOW ENERGY RATION NO. 4

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/1b)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/1b)	(9) Total NE_g (5) (8)	(10) Absolute Price/1b ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	60.0	40	24.0000	40.2266	.78	29.3654	.43	17.2974	.0268	$1.0781
Corn	33.8	89	30.0820	50.4207	1.02	51.4291	.67	33.7819	.0608	3.0656
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	4.7	89	4.0800	7.8527	.87	6.8318	.59	4.6331	.1153	.9054
Total			59.6620	100.0000	-	87.6263	-	55.7124	-	5.0866
Adjusted Total						88		56		$5.09

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LVIII

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR HIGH ENERGY RATION NO. 1

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	68.0	40	27.2000	48.7892	.73	35.6161	.48	20.9794	.0268	$1.3076
Corn	25.0	80	22.2500	39.9103	1.02	40.7085	.67	26.7399	.0608	2.4265
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	5.5	89	4.8000	9.8004	.87	8.5263	.69	5.7822	.1153	1.1300
Total	100.0	-	55.7500	99.9999	-	84.8509	-	53.5015	-	4.9016
Adjusted Total				100		85		54		$4.90

[1]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LIX

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR HIGH ENERGY RATION NO. 2

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	53.0	40	21.2000	33.5975	.73	24.5262	.43	14.4469	.0268	$ .9004
Corn	40.0	89	35.6000	56.4184	1.02	57.5468	.67	37.8003	.0608	3.4302
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	5.5	89	4.8000	8.4842	.87	7.3813	.59	5.0057	.1153	.9782
Total	100.0	-	63.1000	-	-	89.4543	-	57.2529	-	5.3463
Adjusted Total						89		57		$5.35

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LX

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR HIGH ENERGY RATION NO. 3

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	38.0	40	15.2000	21.5756	.78	15.7502	.43	9.2775	.0268	$ .5782
Corn	55.0	89	48.9500	69.4819	1.02	70.8715	.67	46.5529	.0608	4.2245
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	5.5	89	4.8000	7.4425	.87	6.4750	.59	4.3911	.1153	.8581
Total	100.0	-	70.4500	100.0000	-	93.0967	-	60.2215	-	5.6983
Adjusted Total						93		60		$5.70

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

TABLE LXI

COMPUTATIONS OF NE_m, NE_g, AND COSTS BY FEEDSTUFFS FOR HIGH ENERGY RATION NO. 4

(1) Feedstuff	(2) As Fed Composition (%)	(3) Dry Matter (%)	(4) Dry Matter Composition (2) (3)	(5) Absolute % Composition $\frac{4}{\Sigma(4)}$	(6) NE_m (mcal/lb)	(7) Total NE_m (5) (6)	(8) NE_g (mcal/lb)	(9) Total NE_g (5) (8)	(10) Absolute Price/lb ($)	(11) Absolute Ration Cost (cwt) (5) (10)
Corn Silage	23.0	40	9.2000	11.8252	.73	8.6324	.43	5.0848	.0268	$ .3169
Corn	70.0	89	62.3000	80.0771	1.02	81.6786	.67	53.6517	.0608	4.8687
Supplement	1.5	100	1.5000	1.5000	0	0	0	0	.0250	.0375
Soybean Meal[a]	5.5	89	4.8000	6.5977	.87	5.7400	.59	3.8926	.1153	.7607
Total	100.0	-	77.8000	-	-	96.0510	-	62.6191	-	5.9838
Adjusted Total						96		63		$5.98

[a]The percentage composition of the soybean meal is a residual percentage, since the absolute percentage composition of the supplement is fixed at 1.5 percent of the ration.

Identification of Ration Ingredients

The feedstuffs in the MARC rations are listed in the first common column of Tables LIV through LXI. The feedstuffs in the rations that are of primary importance are corn silage and corn. The two other feedstuffs are soybean meal and supplement. The supplement consists of vitamin, mineral, salt, and antibiotic premix.

Within the set of rations, the NE_m and NE_g content increases with increases in the ration number. As the ration number increases, the corn percentage increases while the corn silage percent decreases.

The calculations of NE_m and NE_g for the low energy rations are based on the compositions of the ration. The "as fed" compositions of the four low energy rations in common column 2 are weighted average compositions derived from the reported compositions of the MARC rations (71). The weights of the rations were based on the number of days each ration was fed in 1970, 1971, and 1972. The weighted average of each feedstuff was obtained by multiplying the respective number of days each ration was fed in 1970, 1971, and 1972 by the percentage composition of that feedstuff in the ration.

Computations of weighted average compositions for the high energy rations are not necessary since composition was specified arbitrarily. Before discussing the absolute composition of the rations, it is necessary to consider the moisture contents of the corn silage, corn, supplement, and soybean meal feedstuffs. The reciprocal of the moisture content is the dry matter content.

Moisture Content of Feed Ingredients

The moisture content of any feed, especially corn silage, is a variable that affects both net energy values and cost. For purposes of this study, the moisture contents of the feedstuffs were assumed to be the same as those used by the National Research Council (NRC). The dry matter contents of the feedstuffs are given in common column 3 of Tables LIV through LXI.

To compute the net energy values of any one of the rations and its cost on an absolute basis, first convert the composition of the ration from its "as fed" to its absolute moisture basis. To make this conversion, multiply the dry matter content of each feed in column 3 by the "as fed" composition of the feedstuff given in column 2. Record the product in column 4 as the feedstuff's adjusted dry matter composition. Then, sum the products. Next, divide each feedstuff's adjusted dry matter composition by the sum of the product. Record the dividend as the feedstuff's absolute percentage composition in column 5.

"As Fed" and Absolute Feed Costs

The "as fed" U. S. 1974 corn price was $2.92 for a 54-pound bushel. The U. S. 1974 soybean meal price was $10.26 per hundredweight (63). The U. S. average price was used for these two feeds since neither is produced extensively in Oklahoma. An informed Oklahoma State University extension nutritionist suggested a price of $2.50 per hundredweight for the supplement.

A price for corn silage was calculated since no U. S. price prevails and its characteristics restrict its use and sale to the immediate area of its production. An unpublished accepted formula used by the Oklahoma State University extension specialists to calculate corn silage prices is:

$$\begin{matrix}\text{corn silage} \\ \text{price/ton}\end{matrix} = (6.19)\left(\begin{matrix}\text{corn} \\ \text{price/bu}\end{matrix}\right) - 1.79 + \begin{matrix}\text{custom chopping} \\ \text{charge/ton}\end{matrix}$$

The coefficient, 6.19, reflects the 6.19 bushels or 334.26 pounds of corn in a ton of corn silage. The remaining 1665.74 pounds consist of stalks, leaves, and cobs. The significance and source of the 1.79 constant is unknown. A custom charge of $5.11 is based on an OSU Fact Sheet, and reflects adjustment to a 1974 base (34). Application of the formula provided a 1974 "as fed" tonnage price for corn silate of $21.39.

The dry matter content of the feedstuff is used to convert the "as fed" price of each feed to an absolute price. Dividing the "as fed" price per pound by the dry matter content yields the absolute price per pound reported in column 10.

The preceding discussion has identified procedures and data sources for derivation of the absolute net energy values and cost per hundredweight of each ration. The next task is to combine the ration data reported by the MARC and procedures so as to derive the quantities necessary for input into the Beef Gain Simulator.

The most effective summary of the preceding discussion and check on the subsequent calculations of energy values and costs may be obtained through review of the column headings of Table LIV. Rounding errors occur in column 5 for soybean meal because the soybean meal and premix were combined and reported as 90 percent dry matter supplement in original calculations. Regardless of ration number, the absolute composition of the salt and premix was fixed at .5 and 1.0 percent, respectively. The remainder of the supplement is recorded as the absolute composition of soybean meal.

Computations and derivations of values shown in columns 1 through 4 are either self-explanatory and/or have been developed in accordance with previously described procedures. The NE_m and NE_g values recorded for each feedstuff in columns 6 and 8 are directly from the NRC tables following conversions from kilograms to pounds.

The derivation of the total NE_m and NE_g available from a given ration is obtained by multiplying the respective values in columns 6 and 8 by the absolute percentage composition of the ration shown in column 5. The product is the particular feedstuff's contribution to the overall NE_m and NE_g content of the ration. The individual feedstuff's NE_m and NE_g contributions are then summed with the resulting sum being rounded and recorded as the total NE_m and NE_g of the ration in columns 7 and 9.

The computation of ration cost on a hundredweight basis is achieved through multiplication of each feedstuff's absolute price per pound by its absolute percentage composition. The resulting product is the individual feedstuff's contribution to total ration cost. Summation followed by rounding the resulting products in column 11 yields the per hundredweight absolute cost of the ration.

APPENDIX C

BEEF GAIN SIMULATOR INPUT DATA FOR TYPE BY FEEDING REGIME

TABLE LXII

BEEF GAIN SIMULATOR INPUT DATA FOR HEHE BY FEEDING REGIME

Input	Feeding Regime[a] 1T	1A	2T	2A	3T	3A	4T	4A	5T	5A	6T	6A	7T	7A	8T	8A	9T	9A
Sex	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Purchase Weight	450	450	450	450	450	450	579	568	722	713	579	568	450	450	579	568	722	713
Purchase Cost/cwt	37.19	40.22	37.19	40.22	37.19	40.22	37.87	37.87	35.54	35.54	37.87	37.87	37.19	40.22	37.87	37.87	35.54	35.54
Starting Factor	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
Feeder Grade	0	5.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medical Cost/Head	0	3.00	0	3.00	0	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0	3.00	3.00	3.00	3.00	3.00
Shrinkage Percent	6	9.50	6	9.50	6	9.50	0	0	0	0	0	0	6	9.50	0	0	0	0
Selling Weight	1162	1162	1162	1163	1162	1163	1162	1163	1162	1163	1162	1163	1090	1090	1090	1090	1090	1090
Selling Price/cwt	41.81	41.81	41.81	41.81	41.81	41.81	41.96	41.96	41.81	41.81	41.81	41.81	41.81	41.96	41.96	41.96	41.96	41.96
Equity Head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Rate Percent	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Overhead/Headday	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15
FTT + Comm/Head	1.35	2.85	1.35	2.85	1.35	2.85	3.35	3.31	3.80	3.78	3.35	3.31	1.35	2.85	3.35	3.31	3.80	3.78
IN DATE	Enter current numerical month, day, year date																	
Death 1	1	1.5	1	1.5	1	1.5	1	1	1	1	1	1	1	1.5	1	1	1	1
Day 1	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Death 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	1	1	1	1
Day 2	254	254	254	254	254	254	177	177	121	121	177	177	254	254	177	177	121	121
Print Increment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ration Data[b]																		
R1(0-28) 28	H; 4.68	H; 5.10	L; 4.68	L; 5.10	L; 4.68	L; 5.1	N/A[c]	N/A	N/A	N/A	N/A	N/A	L; 4.68	L; 5.10	N/A	N/A	N/A	N/A
R2 (29-77) 49	H; 4.68	H; 5.10	L; 4.68	L; 5.10	L; 4.68	L; 5.1	N/A	N/A	N/A	N/A	N/A	N/A	L; 4.68	L; 5.10	N/A	N/A	N/A	N/A
R3 (78-133) 56	H; 4.68	H; 5.10	H; 7.80	H; 8.35	L; 4.68	L; 5.1	H; 11.68	H; 11.96	N/A	N/A	L; 8.49	L; 8.75	L; 4.68	L; 5.10	L; 8.46	L; 8.75	N/A	N/A
R4 (134-279) 147	H; 4.68	H; 5.10	H; 4.68	H; 5.10	H; 7.80	H; 8.35	H; 3.09	H; 3.49	H; 8.68	H;9.17	H; 6.28	H; 6.70	L; 4.68	L; 5.10	L; 3.10	L; 3.49	L; 5.53	L; 6.00
R5					H; 4.68	H; 5.05			H; 1.69	H;1.96	H; 3.03	H; 3.44					L; 1.80	L; 2.15
R6											H; 3.03	H; 3.29						

[a]Feeding regimes described in Table XX

[b]R1 refers to the first of either the low or high energy rations fed for the first 28 days. The associated entry opposite the ration number and under the feeding regime column indicates whether the ration is low, L, or high, H, energy and the feeder grade associated with that ration over the first 28 days. R2 defines the second of the four rations fed from day 29 through 77. R3 applies to the third of the four rations which is fed from day 78 through 133. R4, R5, and R6 apply to the last of the four rations which is fed from day 134 through 279.

[c]N/A implies that the indicated ration is not employed in the referenced feeding regime.

TABLE LXIII

BEEF GAIN SIMULATOR INPUT DATA FOR JRAN BY FEEDING REGIME

Input	Feeding Regime[a]																	
	1T	1A	2T	2A	3T	3A	4T	4A	5T	5A	6T	6A	7T	7A	8T	8A	9T	9A
Sex	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Purchase Weight	455	455	455	455	455	455	563	551	692	683	563	551	455	455	563	551	692	683
Purchase Cost/cwt	33.66	40.22	33.66	40.22	33.66	40.22	37.87	37.87	36.36	36.36	37.87	37.87	33.66	40.22	37.87	37.87	36.36	36.36
Starting Factor	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
Feeder Grade	2.6	0	0	0	0	0	0	0	0	0	0	0	2.6	0	0	0	0	0
Medical Cost/Head	0	3.00	0	3.00	0	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0	3.00	3.00	3.00	3.00	3.00
Shrinkage Percent	6	9.5	6	9.5	6	9.5	0	0	0	0	0	0	6	9.5	0	0	0	0
Selling Weight	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1030	1030	1030	1030	1030	1030
Selling Price/cwt	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.96	41.96	41.96	41.96	41.96	41.96
Equity/Head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Rate Percent	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Overhead/Headday	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15
FRT + Comm/Head	1.36	2.86	1.36	2.86	1.36	2.86	3.30	3.26	3.71	3.68	3.30	3.26	1.36	2.86	3.30	3.26	3.71	3.68
IN DATE	Enter current numerical month, day, year date																	
Death 1	1.0	1.5	1.0	1.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.0	1.0	1.0	1.0
Day 1	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Death 2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1	1	1	1.0	1.0	1.0	1.0	1.0	1.0
Day 2	254	254	254	254	254	254	177	177	121	121	177	177	254	254	177	177	1.21	121
Print Increment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ration Data[b]																		
R1 (0- 28) 28	H; 2.60	H; 3.01	L; 2.60	L; 3.05	L; 2.60	L; 3.05	N/A[c]	N/A	N/A	N/A	N/A	N/A	L; 2.60	L; 3.05				
R2 (29- 77) 49	H; 2.60	H; 3.01	L; 2.60	L; 3.05	L; 2.60	L; 3.05	N/A	N/A	N/A	N/A	N/A	N/A	L; 2.60	L; 3.05				
R3 (78-133) 56	H; 2.60	H; 3.01	H; 5.52	H; 6.00	L; 2.60	L; 3.05	H; 9.20	H; 9.60	N/A	N/A	L; 6.35	L; 6.80	L; 2.60	L; 3.05	L; 6.40	L; 6.80		
R4 (134-279) 14	H; 2.60	H; 3.01	H; 2.60	H; 3.00	H; 5.52	H; 5.95	H; 1.27	H; 1.63	H; 6.45	H;7.10	H; 4.15	H; 4.70	L; 2.60	L; 3.05	L; 1.25	L; 1.65	L; 3.60	L; 4.10
R5					H; 2.60	H; 3.00			H; .01	H; .15	H; 1.27	H; 1.52					L; .05	L; .28
R6											H; 1.27	H; 152						

[a]Feeding regimes described in Table XX

[b]R1 refers to the first of either the low or high energy rations fed for the first 28 days. The associated entry opposite the ration number and under the feeding regime column indicates whether the ration is low, L, or high, H, energy and the feeder grade associated with that ration over the first 28 days. R2 defines the second of the four rations fed from day 29 through 77. R3 applies to the third of the four rations which is fed from day 78 through 133. R4, R5, and R6 apply to the last of the four rations which is fed from day 134 through 279.

[c]N/A implies that the indicated ration is not employed in the referenced feeding regime.

TABLE LXIV

BEEF GAIN SIMULATOR INPUT DATA FOR CHHE BY FEEDING REGIME

									Feeding Regime									
Input	1T	1A	2T	2A	3T	3A	4T	4A	5T	5A	6T	6A	7T	7A	8T	8A	9T	9A
Sex	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Purchase Weight	493	493	493	493	493	493	641	629	798	789	641	629	493	493	641	629	798	789
Purchase Cost/cwt	34.37	40.22	34.37	40.22	34.37	40.22	36.36	36.36	35.54	35.54	36.36	36.36	34.37	40.22	36.36	36.36	35.54	35.54
Starting Factor	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
Feeder Grade	6.9	0	0	0	0	0	0	0	0	0	0	0	6.90	7.35	0	0	0	0
Medical Cost/Head	0	3.00	0	3.00	0	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0	3.00	3.00	3.00	3.00	3.00
Shrinkage Percent	6	9.5	6	9.5	6	9.5	0	0	0	0	0	0	6	9.5	0	0	0	0
Selling Weight	1261	1261	1261	1261	1261	1261	1261	1261	1261	1261	1261	1261	1189	1189	1189	1189	1189	1189
Selling Price/cwt	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81	41.81
Equity/Head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest Rate Percent	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Overhead/Headday	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15
FRT + Comm/Head	1.48	2.98	1.48	2.98	1.48	2.98	3.55	3.51	4.05	4.02	3.55	3.51	1.48	2.98	3.55	3.51	4.05	4.02
IN DATE									Enter current numerical month, day, year data									
Death 1	1.0	1.5	1.0	1.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.0	1.0	1.0	1.0
Day 1	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Death 2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Day 2	254	254	254	254	254	254	177	177	121	121	177	177	254	254	177	177	121	121
Print Increment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ration Data[b]																		
R1 (0- 28) 28	H; 6.90	H; 7.35	L; 6.90	L; 7.35	L; 6.90	L; 7.35							L; 6.9	L; 7.35				
R2 (29- 77) 49	H; 6.90	H; 7.35	L; 6.90	L; 7.35	L; 6.90	L; 7.35							L; 6.9	L; 7.35				
R3 (78-133) 56	H; 6.90	H; 7.35	L;10.33	H;10.83	L; 6.90	L; 7.35	H;14.4	H;14.8			L;11.20	L;11.46	L; 6.9	L; 7.35	L;11.20	L;11.40		
R4 (134-279) 147	H; 6.90	H; 7.35	H; 6.90	H; 7.35	H;10.10	H;10.60	H; 5.15	H; 5.51	H;11.00	H;11.40	H; 8.35	H; 8.77	L; 6.9	L; 7.35	L; 5.10	L; 5.55	L; 7.90	L; 8.25
R5					H; 6.90	H; 7.35	/		3.5	H; 3.90	H; 5.10	H; 5.51					L; 3.55	L; 3.98
R6											H; 5.10	H; 5.51						

[a]Feeding regimes described in Table XX

[b]R1 refers to the first of either the low or high energy rations fed for the first 28 days. The associated entry opposite the ration number and under the feeding regime column indicates whether the ration is low, L, or high, H, energy and the feeder grade associated with that ration over the first 28 days. R2 defines the second of the four rations fed from day 29 through 77. R3 applies to the third of the four rations which is fed from day 78 through 133. R4, R5, and R6 apply to the last of the four rations which is fed from day 134 through 279.

[c]N/A implies that the indicated ration is not employed in the referenced feeding regime.

APPENDIX D

FEEDER CALF ACQUISITION COSTS BY TYPE AND WEIGHT

TABLE LXV

COMPONENT AND TOTAL ACQUISITION COSTS FOR ALTERNATIVE HEHE FEEDER CALF WEIGHTS

Weight Designation		Sell Weight[a]	Purchase Price ($/cwt)	Component Acquisition Costs				Total Cost
				Purchase	Medical	Trucking[b]	Commission	
Weaning		450	$40.22	$180.99	$3.00	$1.35	$1.50	$186.84
L1	T	579	37.87	219.27	3.00	1.85	1.50	225.62
L1	A	568	37.87	215.10	3.00	1.81	1.50	221.41
L2	T	722	35.54	256.60	3.00	2.30	1.50	263.40
L2	A	713	35.54	253.40	3.00	2.28	1.50	260.18

[a]Sell weight, with the exception of weaning, is 94 percent of the live weight.

[b]Trucking cost based on live feeder calf weight, a $.20/cwt/100 miles charge, and an assumed haul of 150 miles.

TABLE LXVI

COMPONENT AND TOTAL ACQUISITION COSTS FOR ALTERNATIVE JRAN FEEDER CALF WEIGHTS

Weight Designation		Sell Weight[a]	Purchase Price ($/cwt)	Component Acquisition Costs				Total Cost
				Purchase	Medical	Trucking[b]	Commission	
Weaning		455	$40.22	$183.00	$3.00	$1.36	$1.50	$188.86
L1	T	563	37.87	213.21	3.00	1.80	1.50	219.51
L1	A	551	37.87	208.66	3.00	1.76	1.50	214.92
L2	T	692	36.36	251.61	3.00	2.21	1.50	258.32
L2	A	683	36.36	248.34	3.00	2.18	1.50	255.02

[a]Sell weight, with the exception of weaning, is 94 percent of the live weight.

[b]Trucking cost based on live feeder calf weight, a $.20 cwt/100 miles charge, and an assumed haul of 150 miles.

TABLE LXVII

COMPONENT AND TOTAL ACQUISITION COSTS FOR ALTERNATIVE CHHE FEEDER CALF WEIGHTS

Weight Designation		Sell Weight[a]	Purchase Price ($/cwt)	Component Acquisition Costs				Total Cost
				Purchase	Medical	Trucking[b]	Commission	
Weaning		493	$40.22	$198.28	$3.00	$1.48	$1.50	$204.26
L1	T	641	36.36	233.07	3.00	2.05	1.50	239.62
L1	A	629	36.36	228.70	3.00	2.01	1.50	235.21
L2	T	798	35.54	283.61	3.00	2.55	1.50	290.66
L2	A	789	35.54	280.41	3.00	2.52	1.50	287.43

[a]Sell weight, with the exception of weaning, is 94 percent of the live weight.

[b]Trucking cost based on live feeder calf weight, a $.20/cwt/1p0 mile charge, and an assumed haul of 150 miles.

APPENDIX E

AN ILLUSTRATIVE TABLE OF FEED CONSUMPTION AND NON-FEED COSTS DATA FOR ALTERNATIVE FED WEIGHTS OF HEHE UNDER FEEDING REGIME IN GIVEN BASE 1974 PRICES AND COSTS

TABLE LXVIII

DAYS ON FEED, FEED CONSUMPTION, AND NONFEED COSTS OVER INCREMENTAL FED WEIGHTS FOR HEHE UNDER FEEDING REGIME 1T

Production and Cost Variables	Fed Weights										
	817	962	987	1,011	1,037	1,061	1,087	1,111	1,137	1,162	Total
Days on feed	133	52	10	10	11	11	12	12	14	14	279
Feed-consumption											
Corn silage	635	113	22	22	23	23	25	25	28	28	944
Corn	1249	765	147	147	159	158	171	168	193	191	3348
Supplement	31	14	3	3	3	3	3	3	4	4	71
Soybean meal	171	63	12	12	13	13	14	14	16	16	344
Non-feed costs											
Overhead	$19.95	$7.80	$1.50	$1.50	$1.65	$1.65	$1.80	$1.80	$2.10	$2.10	$41.85
Death loss	3.36	.80	.17	.17	.20	.21	.23	.24	.29	.30	5.97
Interest	12.09	6.73	1.44	1.49	1.69	1.75	1.97	2.03	2.46	2.55	34.20
Total	$35.40	$15.33	$3.11	$3.16	$3.54	$3.61	$4.00	$4.07	$4.85	$4.95	$82.02

APPENDIX F

AN OUTLINE OF THE PROCEDURES FOLLOWED IN DEVELOPMENT OF THE QUALITY GRADE DISTRIBUTION, YIELD GRADE, AND DRESSING PERCENT NUMERICAL VALUES FOR A GIVEN FED WEIGHT BY TYPE

INTRODUCTION

This appendix establishes and illustrates procedures for derivation of the quality grade distribution, yield grade, and dressing percent. Determinations of both quality grade distribution and yield grade are based on fed weight. The determination of dressing percent is based on the sell or slaughter weight which is 96 percent of the fed weight. Although derived on fed weight bases, values of the attributes hold for the carcass and lean meat.

Nelson's quality grade, yield grade, and dressing percent prediction equations were based on percent of fat in the body (44). Appendix A outlines procedures and equations for computing the percent of fat in the body given the types fed and mature weights. Because the percent of fat in the body is a function of the type's mature weight, the numerical values for quality grade, yield grade, and dressing percent vary between types for the same fed weight.

The OMNITAB programs in Tables LXXII, LXXIII, and LXXIV of Appendix G were used to calculate the numerical values of quality grade, yield grade, and dressing percent for all possible fed weights for each type in accordance with Nelson's prediction equations (44, pp. 96-98). Numerical values for quality grade and yield grade are indexes which need to be translated in accordance with Tables XI and XIII, respectively. The calculated dressing percent is the dressing percent used to calculate the pounds of carcass available from a given type's fed weight.

The sectors engaged in feeding and packing activities are affected directly by the quality grade weighted price of the fed steer. A hypothetical 955 pound HEHE fed steer is used to illustrate the procedures followed in deriving that price.

Derivation of the Quality Grade Weighted Price

Two key assumptions underlying development of the quality grade weighted price include a 150 pound fed weight range in a typical pen of fed steers, and the sale of fed steers in 25 pound increments. The fed weight of interest, 955 pounds or average fed weight, is 955 pounds. A 150 pound weight range means that the fed weights vary between 880 and 1030 pounds. The 25 pound fed weight increment becomes the standard error. It also becomes the multiple for derivation of the alternative fed weights normally distributed around the mean weight of 955 pounds.

Applicability of the Z-Distribution

Since the true mean and standard error is known and a normal distribution of fed weights is assumed, the applicable statistical technique is the Z-statistic. Its formula is given as

$$Z = \frac{|X - U|}{\sigma} \tag{0.1}$$

In terms of this analysis, it may be written as

$$Z = \frac{\left|\begin{matrix}\text{ranged fed} \\ \text{weight of} \\ \text{interest}\end{matrix} - \begin{matrix}\text{fed weight} \\ \text{of interest}\end{matrix}\right|}{25} \tag{0.2}$$

Since a normal distribution of fed weights is assumed, the Z statistic can be computed for either the lower half or upper half of the fed weight range with the resulting distribution being equally applicable to both ends of the range. Calculations, Z-statistics, and percentage distribution of the lower end of the 955 pound fed weight are summarized in Table LXIX. Figure 8 provides a graphical summary.

TABLE LXIX

AN ILLUSTRATION OF Z-STATISTIC CALCULATIONS, THEORETICAL FREQUENCIES, AND FREQUENCY DISTRIBUTIONS OF LOWER WEIGHT INCREMENTS FOR A 955 POUND HEHE FED STEER

Ranged Fed Weight	Fed Weight	Z	Theoretical Frequency	Frequency Distribution
			(%)	(%)
930	955	1.0	34.13	34
905	955	2.0	47.72	14
880	955	3.0	49.87	2

Quality grades associated with each of the seven fed weights in Table LXIX and Figure 8 were calculated with the OMNITAB program in Table LXXII. The yield grades and dressing percents for those fed weights were calculated simultaneously with the quality grade.

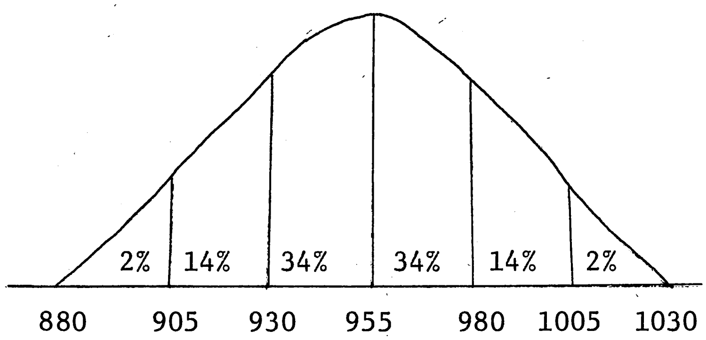


Figure 8. The Percentage Distribution of Fed Weights

Creation of a Working Table

Table LXX presents the mean fed weight, its six incremental fed weights, the associated numerical quality grades, and the percentage distribution of the quality grades. For the 955 pound HEHE steer, the low end of the range is 880 pounds. Succeeding weights, in multiples of 25 pounds, are generated until the upper end of the range is reached at 1030 pounds.

Table XI is used to translate the numerical quality grade quantities into their designated quality grades. According to Tables XI and LXX, the quality grade distribution for a 955 pound fed HEHE steer is 98 percent Good and 2 percent Good +. Since the analysis does not provided for price discrimination within a quality grade, the applicable price is based on 100 percent Good. This quality grade distribution applies to the steer, the carcass, and the lean meat.

If the percentage distribution would have encompassed more than one quality grade, the percentage distribution of each quality grade would have been multiplied by the associated quality grade price for the product. The 1974 product prices used to determine the quality grade weighted prices for the fed steer, carcass, and lean meat products are summarized in Table LXXI. The quality grade weighted prices by types for alternative fed weights are presented in Tablex LXXV, LXXVI, and LXXVII of Appendix H.

TABLE LXX

A SUMMARY OF THE QUALITY GRADE DISTRIBUTION ASSOCIATED WITH A HEHE FED WEIGHT OF 955 POUNDS

Incremental Fed Weight	Numberical Quality Grade[a]	Quality Grade Distribution
		(%)
880	8.27	
905	8.38	2
930	8.52	14
955	8.67	34
980	8.83	34
1005	9.00	14
1030	9.18	2

[a]Quality grade designations associated with the numerical quality grades are listed in Table XI. The applicable interpretation is: 8 = Good, and 9 = Good +

TABLE LXXI

AVERAGE 1974 PER POUND PRICES ACCORDING TO QUALITY GRADE AND WEIGHT FOR THE FED STEER, CARCASS, AND LEAN MEAT PRODUCTS OF THE FED BEEF SYSTEM

Quality Grade	Fed Steer Weight Range	Price	Carcass Weight Range	Price	Lean Price
Good	900-1100	$.3876	500-600	$.6304	$1.193
	1100-1300	.3898	600-700	.6288	
			700-800	.6288	
Choice	900-1100	$.4196	500-600	$.6709	$1.243
	1100-1300	.4181	600-700	.6732	
			700-800	.6653	

Derivation of Yield Grade by Type for a Given Fed Weight

The yield grade for a given type and fed weight is calculated by the applicable OMNITAB program in accordance with Nelson's yield grade prediction equation (44, p. 96). Unlike quality grade, the analysis does not assume any distribution of yield grades over a fed weight range of 150 pounds. In addition, the calculated numerical index values for yield grade are rounded to the midpoint of the yield grade. Thus, any calculated yield grade from 2.0 to 2.9 is read as 2.5. Table XIII is used to determine the percent of the carcass that yields trimmed retail cuts. The yield grade for the 955 pound HEHE fed steer is 2.69, which rounds off to 2.5. According to Table XIII, 77.4 pounds of trimmed retail cuts are available from every 100 pounds of carcass. All yield grades values derived in this study may be found in either Appendix I or Appendix J.

Derivation of Dressing Percent by Type for a Given Weight

The dressing percent for a given fed weight by type is calculated simultaneously with quality grade and yield grade. The calculations are based on Nelson's prediction equation for dressing percent (44). Calculation of the dressing percent, however, is based on the sell, and not on the fed weight. The dressing percent for the 955 pound HEHE fed steer producing 544 pounds of sell weight is 60.28. All dressing percents derived in this study are consolidated in Appendices I and J.

APPENDIX G

OMNITAB PROGRAMS FOR CALCULATING QUALITY GRADES, YIELD GRADES, AND DRESSING PERCENTS FOR FED WEIGHTS BY TYPE

TABLE LXXII

OMNITAB PROGRAM FOR CALCULATING QUALITY GRADES, YIELD GRADES, AND DRESSING PERCENTS FOR ALTERNATIVE HEHE FED WEIGHTS

```
OMNITAB YG,QG AND DP COMPUTATIONS FOLLOWING NELSON OCTOBER 28, 1975
DIMENSION THE WORKSHEET TO HAVE 165 ROWS AND 30 COLUMNS
READ THE FOLLOWING DATA INTO COL 1
HEAD COL 1 / LIVE WEIGHT
FIXED WITH 6 DIGITS TO THE RIGHT OF THE DECIMAL POINT
ADD 1244.9 TO 0.0 AND STORE IN COL 5
DIVIDE 1 BY 5 AND STORE IN COL 4
ADD .01 TO 0.0 AND STORE IN COL 3
DIVIDE 4 BY 3 AND STORE IN COL 6
HEAD COL 6 / PCMTWT
RAISE 6 TO THE 2.0 POWER AND STORE IN COL 7
RAISE 6 TO THE 3.0 POWER AND STORE IN COL 8
ADD 1.5224 TO 0.0 AND STORE IN COL 9
HEAD COL 9 / BODFAT INCT
ADD .59531 TO 0.0 AND STORE IN COL 10
ADD -.00908 TO 0.0 AND STORE IN COL 11
ADD .00007 TO 0.0 AND STORE IN COL 12
MULTIPLY 10 BY 6 AND STORE IN COL 13
MULTIPLY 11 BY 7 AND STORE IN COL 14
MULTIPLY 12 BY 8 AND STORE IN COL 15
ADD 9 TO 13 AND STORE IN COL 16
ADD 16 TO 14 AND STORE IN COL 17
ADD 17 TO 15 AND STORE IN COL 18
HEAD COL 18 / BODFAT PCT
ADD .27859 TO 0.0 AND STORE IN COL 19
ADD .09519 TO 0.0 AND STORE IN COL 20
MULTIPLY 20 BY 18 AND STORE IN COL 21
ADD 19 TO 21 AND STORE IN COL 22
HEAD COL 22 / YIELD GRADE
ADD 4.1932 TO 0.0 AND STORE IN COL 23
ADD .17646 TO 0.0 AND STORE IN COL 24
MULTIPLY 24 BY 18 AND STORE IN COL 25
ADD 23 TO 25 AND STORE IN COL 26
HEAD COL 26 / QUALITY GRD
ADD 57.054 TO 0.0 AND STORE IN COL 27
ADD .13410 TO 0.0 AND STORE IN COL 28
MULTIPLY 28 BY 18 AND STORE IN COL 29
ADD 27 TO 29 AND STORE IN COL 30
HEAD COL 30 / DRESS PCT
PRINT 6,7,8,9,13,14,15,18
PRINT 1,6,18,22,26,30
STOP
```

TABLE LXXIII

OMNITAB PROGRAM FOR CALCULATING QUALITY GRADES, YIELD GRADES, AND DRESSING PERCENTS FOR ALTERNATIVE JRAN FED WEIGHTS

```
OMNITAB YG,QG AND DP COMPUTATIONS FOLLOWING NELSON OCTOBER 28, 1975
DIMENSION THE WORKSHEET TO HAVE 125 ROWS AND 39 COLUMNS
READ THE FOLLOWING DATA INTO COL 1
HEAD COL 1 / LIVE WEIGHT
FIXED WITH 6 DIGITS TO THE RIGHT OF THE DECIMAL POINT
ADD 1138.7 TO 0.0 AND STORE IN COL 5
DIVIDE 1 BY 5 AND STORE IN COL 4
ADD .01 TO 0.0 AND STORE IN COL 3
DIVIDE 4 BY 3 AND STORE IN COL 6
HEAD COL 6 / PCMTWT
RAISE 6 TO THE 2.0 POWER AND STORE IN COL 7
RAISE 6 TO THE 3.0 POWER AND STORE IN COL 8
ADD 1.5224 TO 0.0 AND STORE IN COL 9
HEAD COL 9 / BODFAT INCT
ADD .59531 TO 0.0 AND STORE IN COL 10
ADD -.00908 TO 0.0 AND STORE IN COL 11
ADD .00007 TO 0.0 AND STORE IN COL 12
MULTIPLY 10 BY 6 AND STORE IN COL 13
MULTIPLY 11 BY 7 AND STORE IN COL 14
MULTIPLY 12 BY 8 AND STORE IN COL 15
ADD 9 TO 13 AND STORE IN COL 16
ADD 16 TO 14 AND STORE IN COL 17
ADD 17 TO 15 AND STORE IN COL 18
HEAD COL 18 / BODFAT PCT
ADD .27859 TO 0.0 AND STORE IN COL 19
ADD .09519 TO 0.0 AND STORE IN COL 20
MULTIPLY 20 BY 18 AND STORE IN COL 21
ADD 19 TO 21 AND STORE IN COL 22
HEAD COL 22 / YIELD GRADE
ADD 4.1932 TO 0.0 AND STORE IN COL 23
ADD .29558 TO 0.0 AND STORE IN COL 31
ADD .17646 TO 0.0 AND STORE IN COL 24
MULTIPLY 24 BY 18 AND STORE IN COL 25
ADD 23 TO 31 AND STORE IN COL 32
ADD 32 TO 25 AND STORE IN COL 26
HEAD COL 26 / QUALITY GRD
ADD 57.054 TO 0.0 AND STORE IN COL 27
ADD .13410 TO 0.0 AND STORE IN COL 28
ADD -1.26882 TO 0.0 AND STORE IN COL 33
MULTIPLY 28 BY 18 AND STORE IN COL 29
ADD 27 TO 33 AND STORE IN COL 34
ADD 34 TO 29 AND STORE IN COL 30
HEAD COL 30 / DRESS PCT
PRINT 6,7,8,9,13,14,15,18
PRINT 1,6,18,22,26,30
STOP
```

TABLE LXXIV

OMNITAB PROGRAM FOR CALCULATING QUALITY GRADES, YIELD GRADES, AND DRESSING PERCENTS FOR ALTERNATIVE CHHE FED WEIGHTS

```
OMNITAB YG,QG AND DP COMPUTATIONS FOLLOWING NELSON OCTOBER 28, 1975
DIMENSION THE WORKSHEET TO HAVE 125 ROWS AND 39 COLUMNS
READ THE FOLLOWING DATA INTO COL 1
HEAD COL 1 / LIVE WEIGHT
FIXED WITH 6 DIGITS TO THE RIGHT OF THE DECIMAL POINT
ADD 1494.4 TO 0.0 AND STORE IN COL 5
DIVIDE 1 BY 5 AND STORE IN COL 4
ADD .01 TO 0.0 AND STORE IN COL 3
DIVIDE 4 BY 3 AND STORE IN COL 6
HEAD COL 6 / PCMTWT
RAISE 6 TO THE 2.0 POWER AND STORE IN COL 7
RAISE 6 TO THE 3.0 POWER AND STORE IN COL 8
ADD 1.5224 TO 0.0 AND STORE IN COL 9
HEAD COL 9 / BODFAT INCT
ADD .59531 TO 0.0 AND STORE IN COL 10
ADD -.00908 TO 0.0 AND STORE IN COL 11
ADD .00007 TO 0.0 AND STORE IN COL 12
MULTIPLY 10 BY 6 AND STORE IN COL 13
MULTIPLY 11 BY 7 AND STORE IN COL 14
MULTIPLY 12 BY 8 AND STORE IN COL 15
ADD 9 TO 13 AND STORE IN COL 16
ADD 16 TO 14 AND STORE IN COL 17
ADD 17 TO 15 AND STORE IN COL 18
HEAD COL 18 / BODFAT PCT
ADD .27859 TO 0.0 AND STORE IN COL 19
SUBTRACT .40517 FROM 0.0 AND STORE IN COL 35
ADD .09519 TO 0.0 AND STORE IN COL 20
MULTIPLY 20 BY 18 AND STORE IN COL 21
ADD 19 TO 35 AND STORE IN COL 36
ADD 36 TO 21 AND STORE IN COL 22
HEAD COL 22 / YIELD GRADE
ADD 4.1932 TO 0.0 AND STORE IN COL 23
ADD .48188 TO 0.0 AND STORE IN COL 31
ADD .17646 TO 0.0 AND STORE IN COL 24
MULTIPLY 24 BY 18 AND STORE IN COL 25
ADD 23 TO 31 AND STORE IN COL 32
ADD 32 TO 25 AND STORE IN COL 26
HEAD COL 26 / QUALITY GRD
ADD 57.054 TO 0.0 AND STORE IN COL 27
ADD .13410 TO 0.0 AND STORE IN COL 28
ADD .51274 TO 0.0 AND STORE IN COL 33
MULTIPLY 28 BY 18 AND STORE IN COL 29
ADD 27 TO 33 AND STORE IN COL 34
ADD 34 TO 29 AND STORE IN COL 30
HEAD COL 30 / DRESS PCT
PRINT 6,7,8,9,13,14,15,18
PRINT 1,6,18,22,26,30
STOP
```

APPENDIX H

ILLUSTRATIVE TABLES OUTLINING THE DETERMINATION OF QUALITY GRADE WEIGHTED PRICES FOR THE FED STEER, CARCASS, AND LEAN MEAT PRODUCTS ASSOCIATED WITH THE FED WEIGHTS OF DIFFERENT TYPES

TABLE LXXV

A SUMMATION TABLE OF QUALITY GRADE WEIGHTED PRICES FOR THE FED STEER, CARCASS, AND LEAN MEAT PRODUCTS ASSOCIATED WITH THE FED WEIGHTS OF HEHE

(1) Plane of Nutrition and Weight Code	(2) Fed Weight (lbs)	(3) Range in Weight[a]	(4) Quality Grade Composition (Good,Choice) (%)	(5) Associated 1974 (Good,Choice) Average Fed Steer Price ($/lb)	(6) Weighted Fed Steer Price ($/lb) 4x5	(7) Slaughter Weight .96x1	(8) Gross Feeding Sector Returns ($)	(9) Dressing Percent (%)	(10) Cold Carcass Weight 7x9x.985	(11) Associated 1974 Carcass Price[b] ($/lb)	(12) Weighted Quality Grade Carcass Price ($/lb) 4x11	(13) Base Carcass Returns 10x12	(14) Offal Value[c] $.0382x7	(15) Yield Grade[d]	(16) Pounds of Lean in Carcass 10x15	(17) Associated 1974 Lean Meat Prices ($/lb)	(18) Weighted Lean Meat Price ($/lb) 4x17	(19) Gross Returns to Carcass Breaking Sector 16x18
Low; L3	955	886-1036	(100,0)	(.3876,0)	.3876	917	355.43	60.31	544.74	(.6304,0)	.6304	343.24	35.26	2.7/2.5	421.43	(1.193,0)	1.1930	$502.77
Low; L4	989	914-1064	(100,0)	(.3876,0)	.3876	949	367.83	60.43	564.88	(.6304,0)	.6304	356.10	36.25	2.8/2.5	437.22	(1.193,0)	1.1930	521.60
Low; L5	1015	940-1090	(100,0)	(.3876,0)	.3876	974	377.52	60.55	580.91	(.6304,0)	.6304	366.21	37.21	2.9/2.5	449.62	(1.193,0)	1.1930	536.50
Low; L6	1040	965-1115	(100,0)	(.3876,0)	.3876	998	386.82	60.67	596.40	(.6304,0)	.6304	375.97	38.12	3.0/3.5	434.18	(1.193,0)	1.1930	517.98
Low; L7	1064	989-1139	(99,1)	(.3876,.4181)	.3879	1021	396.05	60.79	611.36	(.6288,.6732)	.6292	384.67	39.00	3.1/3.5	445.07	(1.193,1.243)	1.1935	531.19
Low; L8	1090	1065-1215	(93,7)	(.3876,.4181)	.3897	1046	407.66	60.94	627.87	(.6288,.6732)	.6319	396.75	39.96	3.2/3.5	457.09	(1.193,1.243)	1.1965	546.91
High; H2	962	887-1037	(100,0)	(.3876,0)	.3876	924	358.14	60.32	549.00	(.6304,0)	.6304	346.09	35.30	2.7/2.5	424.93	(1.193,0)	1.1930	505.94
High; H3	987	912-1062	(100,0)	(.3876,0)	.3876	948	367.44	60.42	564.19	(.6304,0)	.6304	355.67	36.21	2.8/2.5	436.68	(1.193,0)	1.1930	520.96
High; H4	1011	936-1086	(100,0)	(.3876,0)	.3876	971	376.36	60.53	578.93	(.6304,0)	.6304	364.96	37.09	2.9/2.5	448.09	(1.193,0)	1.1930	534.57
High; H5	1037	962-1112	(100,0)	(.3876,0)	.3876	996	386.05	60.66	595.11	(.6304,0)	.6304	375.16	38.05	3.0/3.5	433.24	(1.193,0)	1.1930	516.86
High; H6	1061	986-1136	(99,1)	(.3876,.4181)	.3879	1019	395.28	60.78	610.06	(.6288,.6732)	.6292	383.85	38.93	3.1/3.5	444.12	(1.193,1.243)	1.1935	530.06
High; H7	1087	1012-1162	(94,6)	(.3876,.4181)	.3894	1044	406.56	60.93	626.57	(.6288,.6732)	.6315	395.68	39.88	3.2/3.5	456.14	(1.193,1.243)	1.1960	545.54
High; H8	1111	1036-1186	(72,28)	(.3876,.4181)	.3961	1067	422.68	61.07	641.84	(.6288,.6732)	.6412	411.55	40.76	3.3/3.5	467.26	(1.193,1.243)	1.2070	563.98
High; H9	1137	1062-1212	(33,67)	(.3876,.4181)	.4080	1092	445.57	61.23	658.60	(.6288,.6732	.6585	433.69	41.71	3.5/3.5	479.46	(1.193,1.243)	1.2265	588.06
High; H0	1162	1087-1237	(7,93)	(.3876,.4181)	.4160	1116	464.22	61.39	674.84	(.6288,.6732)	.6701	452.21	42.63	3.6/3.5	491.28	(1.193,1.243)	1.2395	608.94

[a] The study assumes a 150 pound weight distribution in a pen of fed steers.

[b] Carcass price changes with a change in either or both quality grade or carcass weight. See Table LXXI in Appendix F.

[c] Average offal value in 1974 was $3.82 per hundred weight.

[d] The estimated yield grade is rounded to the midpoint of the yield grade range, estimated yield grade/midpoint yield grade. The pounds of lean in a yield grade 2.5 carcass is 77.4 percent of cold carcass weight, whereas the pounds of lean in a yield grade 3.5 carcass is 72.8 percent.

TABLE LXXVI

A SUMMATION TABLE OF QUALITY GRADE WEIGHTED PRICES FOR THE FED STEER, CARCASS, AND LEAN MEAT PRODUCTS ASSOCIATED WITH THE FED WEIGHTS OF JRAN

(1) Plane of Nutrition and Weight Code	(2) Fed Weight (lbs)	(3) Range in Weight[a]	(4) Quality Grade Composition (Good,Choice) (%)	(5) Associated 1974 (Good,Choice) Average Fed Steer Price ($/lb)	(6) Weighted Fed Steer Price ($/lb) 4x5	(7) Slaughter Weight .96x1	(8) Gross Feeding Sector Returns	(9) Dressing Percent (%)	(10) Cold Carcass Weight 7x9x.985	(11) Associated 1974 Carcass Price[b] ($/lb)	(12) Weighted Quality Grade Carcass Price ($/lb) 4x11	(13) Base Carcass Returns 10x12	(14) Offal Value[c] $.0382x7	(15) Yield Grade[d]	(16) Pounds of Lean in Carcass 10x15	(17) Associated 1974 Lean Meat Prices ($/lb)	(18) Weighted Lean Meat Price ($/lb) 4x17	(19) Gross Returns to Carcass Breaking Sector 16x18
Low; L3	929	854-1004	(100,0)	(.3876,.0)	.3876	892	345.74	59.28	520.85	(.6304,0)	.6304	328.34	34.07	2.9/2.5	403.14	(1.193,0)	1.193	$480.95
Low; L4	955	880-1030	(96,4)	(.3876,.4196)	.3889	917	356.62	59.66	538.88	(.6304,.6709)	.6320	340.57	35.03	3.0/3.5	392.30	(1.193,1.243)	1.1950	468.80
Low; L5	980	905-1055	(79,21)	(.3876,.4196)	.3943	941	371.04	59.82	554.46	(.6304,.6709)	.6389	354.24	35.95	3.1/3.5	403.65	(1.193,1.243)	1.2035	485.79
Low; L6	1004	929-1079	(50,50)	(.3876,.4196)	.4036	964	389.07	60.00	569.72	(.6304,.6709)	.6506	370.66	36.82	3.3/3.5	414.76	(1.193,1.243)	1.2180	505.18
Low; L7	1030	955-1105	(46,54)	(.3876,.4196)	.4049	989	400.45	60.20	586.45	(.6304,.6709)	.6523	382.54	37.78	3.4/3.5	426.94	(1.193,1.243)	1.2200	520.87
High: H2	929	854-1004	(100,0)	(.3876,.4196)	.3876	892	345.74	59.28	520.85	(.6304,0)	.6304	328.34	34.07	2.9/2.5	403.14	(1.193,0)	1.1930	480.95
High; H3	949	874-1024	(98,2)	(.3876,.4196)	.3882	911	353.65	59.39	532.93	(.6304,.6709)	.6312	336.39	34.80	3.0/3.5	387.97	(1.193,1.243)	1.1940	463.24
High; H4	975	900-1050	(84,16)	(.3876,.4196)	.3927	936	367.57	59.54	548.93	(.6304,.6709)	.6369	349.61	35.76	3.1/3.5	399.62	(1.193,1.243)	1.2010	479.94
High: H5	1000	925-1075	(50,50)	(.3876,.4196)	.4036	960	387.46	59.69	564.43	(.6304,.6709)	.6506	367.22	36.67	3.2/3.5	410.91	(1.193,1.243)	1.2180	500.49
High; H6	1024	949-1099	(48,52)	(.3876,.4196)	.4042	983	397.33	59.85	579.50	(.6304,.6709)	.6515	377.54	37.55	3.4/3.5	421.88	(1.193,1.243)	1.2190	514.27
High; H7	1050	975-1125	(34,66)	(.3876,.4196)	.4087	1008	411.97	60.03	596.03	(.6304,.6709)	.6571	391.65	38.51	3.5/3.5	433.91	(1.193,1.243)	1.2260	531.97
High; H8	1075	1000-1150	(0,100)	(.3876,.4196)	.4196	1032	433.03	60.21	612.05	(.6288,.6732)	.6732	412.03	39.42	3.7	445.57	(1.193,1.243)	1.2430	553.84
High; H9	1100	1025-1175	(0,100)	(.3876,.4196)	.4196	1056	443.10	60.41	628.36	(.6288,.6732)	.6732	423.01	40.34	3.8/3.5	457.45	(1.193,1.243)	1.2430	568.61

[a] The study assumes a 150 pound weight distribution in a pen of fed steers.

[b] Carcass price changes with change in either or both quality grade or carcass weight. See Table LXII in Appendix F.

[c] Average offal value in 1974 was $3.82 per cwt.

[d] The estimated yield grade is rounded to the midpoint of the yield grade range, estimated yield grade/midpointyield grade. The pounds of lean in a yield grade 2.5 carcass is 77.4 percent of cold carcass weight, whereas the pounds of lean in a yield grade 3.5 carcass is 72.8 percent.

TABLE LXXVII

A SUMMATION TABLE OF QUALITY GRADE WEIGHTED PRICES FOR THE FED STEER, CARCASS, AND LEAN MEAT PRODUCTS ASSOCIATED WITH THE FED WEIGHTS OF CHHE

(1) Plane of Nutrition and Weight Code	(2) Fed Weight (lbs)	(3) Range in Weight[a]	(4) Quality Grade Composition (Good,Choice) (%)	(5) Associated 1974 (Good,Choice) Average Fed Steer Price ($/lb)	(6) Weighted Fed Steer Price ($/lb) 4x5	(7) Slaughter Weight .96x1	(8) Gross Feeding Sector Returns ($)	(9) Dressing Percent (%)	(10) Cold Carcass Weight 7x9x.985	(11) Associated 1974 Carcass Price[b] ($)	(12) Weighted Quality Grade Carcass Price ($/lb) 4x11	(13) Base Carcass Returns ($) 10x12	(14) Offal Value[c] $.0382x7	(15) Yield Grade[d]	(16) Pounds of Lean in Carcass 10x15	(17) Associated 1974 Lean Meat Prices ($/lb)	(18) Weighted Lean Meat Price ($/lb) 4x17	(19) Gross Returns to Carcass Breaking Sector 16x18
Low; L3	1073	998-1148	(100,0)	(.3876,0)	.3876	1030	399.23	60.56	614.41	(.6288,0)	.6288	386.34	$39.35	2.1/2.5	475.55	(1.193,0)	1.193	$567.33
Low; L4	1090	1015-1165	(100,0)	(.3876,0)	.3876	1046	405.43	60.61	624.47	(.6288,0)	.6288	392.67	39.96	2.1/2.5	483.34	(1.193,0)	1.193	576.62
Low; L5	1113	1038-1188	(100,0)	(.3898,0)	.3898	1068	416.31	60.68	638.34	(.6288,0)	.6288	401.39	40.80	2.2/2.5	494.08	(1.193,0)	1.193	589.44
Low; L6	1139	1064-1214	(100,0)	(.3898,0)	.3898	1093	426.05	60.77	654.25	(.6288,0)	.6288	411.39	41.75	2.3/2.5	506.39	(1.193,0)	1.193	604.12
Low; L7	1164	1089-1239	(100,0)	(.3898,0)	.3898	1117	435.41	60.86	669.61	(.6288,0)	.6288	421.05	42.67	2.3/2.5	518.28	(1.193,0)	1.193	618.31
Low; L8	1189	1114-1264	(100,0)	(.3898,0)	.3898	1141	444.76	60.95	685.01	(.6288,0)	.6288	430.73	43.59	2.4/2.5	530.20	(1.193,0)	1.193	632.53
High; H2	1074	999-1149	(100,0)	(.3876,0)	.3876	1031	399.62	60.57	615.11	(.6288,0)	.6288	386.78	39.38	2.1/2.5	476.10	(1.193,0)	1.193	567.99
High; H3	1087	1012-1162	(100,0)	(.3876,0)	.3876	1044	404.65	60.61	623.28	(.6288,0)	.6288	391.92	39.88	2.1/2.5	482.42	(1.193,0)	1.193	575.53
High; H4	1112	1037-1187	(100,0)	(.3898,0)	.3898	1068	416.31	60.68	638.34	(.6288,0)	.6288	401.39	40.80	2.2/2.5	494.08	(1.193,0)	1.193	589.44
High; H5	1136	1061-1211	(100,0)	(.3898,0)	.3898	1091	425.27	60.76	652.95	(.6288,0)	.6288	410.57	41.68	2.3/2.5	505.38	(1.193,0)	1.193	602.92
High; H6	1161	1086-1236	(100,0)	(.3898,0)	.3898	1115	434.63	60.85	668.30	(.6288,0)	.6288	420.23	42.59	2.3/2.5	517.26	(1.193,0)	1.193	617.09
High; H7	1187	1112-1262	(100,0)	(.3898,0)	.3898	1140	444.37	60.94	684.30	(.6288,0)	.6288	430.29	43.55	2.4/2.5	529.65	(1.193,0)	1.193	631.87
High; H8	1212	1137-1287	(100,0)	(.3898,0)	.3898	1164	453.73	61.04	699.85	(.6288,0)	.6288	440.07	44.46	2.5/2.5	541.68	(1.193,0)	1.193	646.22
High; H9	1235	1160-1310	(98,2)	(.3898,.4196)	.3904	1186	463.01	61.13	714.13	(.6288,.6653)	.6295	449.54	45.31	2.6/2.5	552.74	(1.193,1.243)	1.194	659.97
High; H0	1261	1186-1336	(85,15)	(.3898,.4181)	.3940	1211	477.13	61.24	730.49	(.6288,.6653)	.6343	463.35	46.26	2.6/2.5	565.40	(1.193,1.243)	1.2004	678.71

[a]The study assumes a 150 pound weight distribution in a pen of fed steers.

[b]Carcass price changes with a change in either or both quality grade or carcass weight. See Table LXXI in Appendix F.

[c]Average offal value in 1974 was $3.82 per hundred weight.

[d]The estimated yield grade is rounded to the midpoint of the yield grade range, estimated yield grade/midpoint yield grade. The pounds of lean in a yield grade 2.5 carcass is 77.4 percent of cold carcass weight, whereas the pounds of lean in a yield grade 3.5 carcass is 72.8 percent.

APPENDIX I

SLAUGHTERING ACTIVITY DATA BY TYPES

AND FED WEIGHTS

TABLE LXXVIII

HEHE SLAUGHTERING ACTIVITY DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Plane of Nutrition	Live Fed Weight	Slaughter Weight	Quality Grade Composition (Good-Choice)	Yield Grade[a]	Dressing Percent	Hot Carcass Weight	Cold Carcass Weight	Weighted Price/cwt Cold Carcass	Base Value Cold Carcass ($)	Additional Pounds lean in Carcass[b]	Slaughtering Sector's Per Pound Share of Additional Lean[c]	Premium (Discount) to Slaughtering Sector	Gross Carcass Returns to Slaughtering Sector	Fixed Slaughter Costs	Carcass Transportation Costs	Carcass Chilling and Storage Cost	Gross Slaughter Cost	Offal Value	Net Slaughter Cost	Gross Total Returns to Slaughtering Sector[d]
		.96 x 2	%			3 x 6	.985 x 7		8 x 9				10 + 13		$.0138 x 8	$.017 x 8	15+16+17	$.0382x3	18-19	14-20
Low	955	917	(100,0)	2.7/2.5	60.28	552.77	544.48	$63.04	$343.24	25.05	$.5965	$14.94	$358.18	$13.61	$7.51	$ 9.26	$30.38	$35.03	($4.65)	$362.83
Low	989	949	(100,0)	2.8/2.5	60.43	573.48	564.88	63.04	356.10	25.98	.5965	15.50	371.60	13.61	7.80	9.60	31.01	36.25	(5.24)	376.84
Low	1,015	974	(100,0)	2.9/2.5	60.55	589.76	580.91	63.04	366.21	26.72	.5965	15.94	382.15	13.61	8.02	9.88	31.51	37.21	(5.70)	387.85
Low	1,040	998	(100,0)	3.0/3.5	60.67	605.49	596.40	63.04	375.97	0	-	0	375.97	13.61	8.23	10.14	31.98	38.12	(6.14)	382.11
Low	1,064	1,021	(99,1)	3.1/3.5	60.79	620.67	611.36	62.92	384.67	0	-	0	384.67	13.61	8.44	10.39	32.44	39.00	(6.56)	391.23
Low	1,090	1,046	(93,7)	3.2/3.5	60.94	637.43	627.87	63.19	396.75	0	-	0	396.75	13.61	8.66	10.67	32.94	39.96	(7.02)	403.77
High	963	924	(100,0)	2.7/2.5	60.32	557.36	549.00	$63.04	$346.09	25.25	$.5965	$15.06	$361.15	$13.61	$7.58	$ 9.33	$30.52	$35.30	($4.78)	$365.93
High	987	948	(100,0)	2.8/2.5	60.42	572.58	564.19	63.04	355.67	25.95	.5965	15.48	371.15	13.61	7.79	9.59	30.99	36.21	(5.22)	376.37
High	1,011	971	(100,0)	2.9/2.5	60.53	587.75	578.93	63.04	364.96	26.63	.5965	15.88	380.84	13.61	7.99	9.86	31.44	37.09	(5.65)	386.49
High	1,037	996	(100,0)	3.0/3.5	60.66	604.17	595.11	63.04	375.16	0	-	0	375.16	13.61	8.21	10.12	31.94	38.05	(6.11)	381.27
High	1,061	1,019	(99,1)	3.1/3.5	60.78	619.35	610.06	62.92	383.85	0	-	0	383.85	13.61	8.42	10.37	32.40	38.93	(6.53)	390.38
High	1,087	1,044	(94,6)	3.2/3.5	60.93	636.11	626.57	63.15	395.68	0	-	0	395.68	13.61	8.65	10.65	32.91	39.88	(6.97)	402.65
High	1,111	1,067	(72,28)	3.3/3.5	61.07	651.62	641.84	64.12	411.55	0	-	0	411.55	13.61	8.86	10.91	33.38	40.76	(7.38)	418.93
High	1,137	1,092	(33,67)	3.5/3.5	61.23	668.63	658.60	65.85	433.69	0	-	0	433.69	13.61	9.09	11.20	33.90	41.71	(7.81)	441.50
High	1,163	1,116	(7,93)	3.6/3.5	61.39	685.11	674.84	67.01	452.21	0	-	0	452.21	13.61	9.31	11.47	34.39	42.63	(8.24)	460.45

[a]Yield grade is rounded to the midpoint of the whole integer.

[b]For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield greater than 3.5, the multiple is -.046 times cold carcass weight.

[c]The slaughtering sector's per pound share of the additional lean is 50% of the quality grade weighted wholesale lean meat price.

[d]Model coefficients for slaughtering sectors are extracted from columns 14, 20, and 21. Slaughter steer acquisition costs for HEHE contained in Table LXXXIV of Appendix K.

TABLE LXXIX

JRAN SLAUGHTERING ACTIVITY DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Plane of Nutrition	Live Fed Weight	Slaughter Weight	Quality Grade Composition (Good-Choice)	Yield Grade[a]	Dressing Percent	Hot Carcass Weight	Cold Carcass Weight	Weighted Price/cwt Cold Carcass	Base Value Cold Carcass ($)	Additional Pounds lean in Carcass[b]	Slaughtering Sector's Per Pound Share of Additional Lean[c]	Premium (Discount) to Slaughtering Sector	Gross Carcass Returns to Slaughtering Sector	Fixed Slaughter Costs	Carcass Transportation Costs	Carcass Chilling and Storage Cost	Gross Slaughter Cost	Offal Value	Net Slaughter Cost	Gross Total Returns to Slaughtering Sector[d]
		.96x2	%			3x6	.985x7		8x9				10+13		$.0138x8	$.017x8	15+16+17	$.0382x3	18-19	14-20
Low	929	892	(100,0)	2.9/2.5	59.28	528.78	520.85	$63.04	$328.34	23.96	$.5965	$14.29	$342.63	$13.61	$7.19	$8.85	$29.65	$34.07	$(4.42)	$347.05
Low	955	917	(96,4)	3.0/3.5	59.66	547.08	538.88	63.20	340.57	0	-	-	340.57	13.61	7.44	9.16	30.21	35.03	(4.82)	345.39
Low	980	941	(79,21)	3.1/3.5	59.82	562.91	554.46	63.89	354.24	0	-	-	354.24	13.61	7.65	9.43	30.69	35.95	(5.26)	359.50
Low	1004	964	(50,50)	3.3/3.5	60.00	578.40	569.72	65.06	370.66	0	-	-	370.66	13.61	7.86	9.69	31.16	36.82	(5.66)	376.32
Low	1030	989	(46,54)	3.4/3.5	60.20	595.38	586.45	65.23	382.54	0	-	-	382.54	13.61	8.09	9.97	31.67	37.78	(6.11)	388.65
High	929	892	(100,0)	2.9/2.5	59.28	528.78	520.85	$63.04	$328.34	23.96	$.5965	$14.29	$342.63	$13.61	$7.19	$8.85	$29.65	$34.07	$(4.42)	$347.05
High	949	911	(98,2)	3.0/3.5	59.39	541.04	532.93	63.12	336.39	0	-	-	336.39	13.61	7.35	9.06	30.02	34.80	(4.78)	341.17
High	975	936	(84,16)	3.1/3.5	59.54	557.29	548.93	63.69	349.61	0	-	-	349.61	13.61	7.58	9.33	30.52	35.76	(5.24)	354.85
High	1000	960	(50,50)	3.2/3.5	59.69	573.02	564.43	65.06	367.22	0	-	-	367.22	13.61	7.79	9.60	31.00	36.67	(5.67)	372.89
High	1024	983	(48,52)	3.4/3.5	59.85	588.33	579.50	65.15	377.54	0	-	-	377.54	13.61	8.00	9.85	31.46	37.55	(6.09)	383.63
High	1050	1008	(34,66)	3.5/3.5	60.03	605.10	596.03	65.71	391.65	0	-	-	391.65	13.61	8.23	10.13	31.97	38.51	(6.54)	398.19
High	1075	1032	(0,100)	3.7/3.5	60.21	621.37	612.05	67.32	412.03	0	-	-	412.03	13.61	8.45	10.40	32.46	39.42	(6.96)	418.99
High	1100	1056	(0,100)	3.8/3.5	60.41	637.93	628.36	67.32	423.01	0	-	-	423.01	13.61	8.67	10.68	32.96	40.34	(7.38)	430.39

[a]Yield grade is rounded to the midpoint of the whole integer.

[b]For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield greater than 3.5, the multiple is -.046 times cold carcass weight.

[c]The slaughtering sector's per pound share of the additional lean is 50% of the quality grade weighted wholesale lean meat price.

[d]Model coefficients for slaughtering sectors are extracted from columns 14, 20, and 21. Slaughter steer acquisition costs for JRAN contained in Table LXXXV of Appendix K.

TABLE LXXX

CHHE SLAUGHTERING ACTIVITY DATA

1 Plane of Nutrition	2 Live Fed Weight	3 Slaughter Weight .96x2	4 Quality Grade Composition (Good-Choice) %	5 Yield Grade[a]	6 Dressing Percent	7 Hot Carcass Weight 3x6	8 Cold Carcass Weight .985x7	9 Weighted Price/cwt Cold Carcass	10 Base Value Cold Carcass ($) 8x9	11 Additional Pounds Lean in Carcass[b]	12 Slaughtering Sector's Per Pound Share of Additional Lean[c]	13 Premium (Discount) to Slaughtering Sector	14 Gross Carcass Returns to Slaughtering Sector 10+13	15 Fixed Slaughter Costs	16 Carcass Transporta- tion Costs $.0138x8	17 Carcass Chilling and Storage Cost $.017x8	18 Gross Slaughter Cost 15+16+17	19 Offal Value $.0382x3	20 Net Slaughter Cost 18–19	21 Gross Total Returns to Slaughtering Sector[d] 14–20
Low	1073	1030	(100,0)	2.1/2.5	60.56	623.77	614.41	$62.88	$386.34	28.26	$.5965	$16.86	$403.20	$13.61	$8.48	$10.44	$32.53	$39.35	$(6.82)	$410.02
Low	1090	1046	(100,0)	2.1/2.5	60.61	633.98	624.47	62.88	392.67	28.73	.5965	17.14	409.81	13.61	8.62	10.62	32.85	39.96	(7.11)	416.92
Low	1113	1068	(100,0)	2.2/2.5	60.68	648.06	638.34	62.88	401.39	29.36	.5965	17.51	418.90	13.61	8.81	10.85	33.27	40.80	(7.53)	426.43
Low	1139	1093	(100,0)	2.3/2.5	60.77	664.22	654.25	62.88	411.39	30.10	.5965	17.95	429.34	13.61	9.03	11.12	33.76	41.75	(7.99)	437.33
Low	1164	1117	(100,0)	2.3/2.5	60.86	679.81	669.61	62.88	421.05	30.80	.5965	18.37	439.42	13.61	9.24	11.38	34.23	42.67	(8.44)	447.86
Low	1189	1141	(100,0)	2.4/2.5	60.95	695.44	685.01	62.88	430.73	31.51	.5965	18.80	449.53	13.61	9.45	11.65	34.71	43.59	(8.88)	458.41
High	1074	1031	(100,0)	2.1/2.5	60.57	624.48	615.11	62.88	386.78	28.30	$.5965	$16.88	$403.66	$13.61	$8.49	$10.46	$32.56	$39.38	$(6.82)	$410.48
High	1087	1044	(100,0)	2.1/2.5	60.61	632.77	623.28	62.88	391.92	28.67	.5965	17.10	409.02	13.61	8.60	10.60	32.81	39.88	(7.07)	416.09
High	1112	1068	(100,0)	2.2/2.5	60.68	648.06	638.34	62.88	401.39	29.36	.5965	17.51	418.90	13.61	8.81	10.85	33.27	40.80	(7.53)	426.43
High	1136	1091	(100,0)	2.3/2.5	60.76	662.89	652.95	62.88	410.57	30.04	.5965	17.92	428.49	13.61	9.01	11.10	33.72	41.68	(7.96)	436.45
High	1161	1115	(100,0)	2.3/2.5	60.85	678.48	668.30	62.88	420.23	30.74	.5965	18.34	438.57	13.61	9.22	11.36	34.19	42.59	(8.40)	446.97
High	1187	1140	(100,0)	2.4/2.5	60.94	694.72	684.30	62.88	430.29	31.48	.5965	18.78	449.07	13.61	9.44	11.63	34.68	43.55	(8.87)	457.94
High	1212	1164	(100,0)	2.5/2.5	61.04	710.51	699.85	62.88	440.07	32.19	.5965	19.20	459.27	13.61	9.66	11.90	35.17	44.46	(9.29)	468.56
High	1235	1186	(98,2)	2.6/2.5	61.13	725.00	714.13	62.95	449.54	32.85	.5970	19.61	469.15	13.61	9.85	12.14	35.60	45.31	(9.71)	478.86
High	1261	1211	(85,15)	2.6/2.5	61.24	741.62	730.49	63.43	463.35	33.60	.6002	20.17	483.52	13.61	10.08	12.42	36.11	46.26	(10.15)	493.67

[a] Yield grade is rounded to the midpoint of the whole integer.

[b] For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield grade greater than 3.5, the multiple is -.046 times cold carcass weight.

[c] The slaughtering sector's per pound share of the additional lean is 50% of the quality grade weighted wholesale lean meat price.

[d] Model coefficients for slaughtering sectors are extracted from columns 14, 20, and 21. Slaughter steer acquisition costs for CHHE contained in Table LXXXVI of Appendix K.

APPENDIX J

WORKING TABLES OF COST AND REVENUE COEFFICIENTS FOR CARCASS-BREAKING ACTIVITIES BY TYPES AND FED WEIGHTS

TABLE LXXXI

HEHE CARCASS-BREAKING ACTIVITY DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plane of Nutrition and Weight Code	Live Fed Weight	Cold Carcass Weight	Quality Grade Composition (Good-Choice) Percent	Yield Grade[a]	Additional Pounds of Lean in Carcass	Carcass Acquisition Cost	Fixed Cost of Breaking, Boning, and Grinding	Carcass Storage Cost $.0078x3	Pounds of Lean in Carcass 5x3	Lean Distribution Cost $.0556x10	Total Carcass Breaking Sector Cost 7+8+9+11	Total Cost Less Carcass Acquisition 12-7	Quality Grade Composite Price/lb Lean	Gross Returns[c] 10x14
Low; L3	955	544.48	(100, 0)	2.7/2.5	25.05	$358.18	$26.91	$4.25	421.42	$23.43	$412.77	$54.59	$1.193	$502.77
Low; L4	989	564.88	(100, 0)	2.8/2.5	25.98	371.60	26.91	4.41	437.22	24.31	427.23	55.63	1.193	521.60
Low; L5	1015	580.91	(100, 0)	2.9/2.5	26.72	382.15	26.91	4.53	449.62	25.00	438.59	56.44	1.193	536.40
Low; L6	1040	596.40	(100, 0)	3.0/3.5	0	375.97	26.91	4.65	434.18	24.14	431.67	55.70	1.193	517.98
Low; L7	1064	611.36	(99, 1)	3.1/3.5	0	384.67	26.91	4.77	445.07	24.75	441.10	56.43	1.1935	531.19
Low; L8	1090	627.87	(93, 7)	3.2/3.5	0	396.75	26.91	4.90	457.09	25.41	453.97	57.22	1.1965	546.91
High; H2	963	549.00	(100, 0)	2.7/2.5	25.25	$361.15	26.91	$4.28	424.94	$23.63	$415.97	54.82	$1.193	$506.94
High; H3	987	564.19	(100, 0)	2.8/2.5	25.95	371.15	26.91	4.40	436.68	24.28	426.74	55.59	1.193	520.96
High; H4	1011	578.93	(100, 0)	2.9/2.5	26.63	380.84	26.91	4.52	448.09	24.91	437.18	56.34	1.193	534.57
High; H5	1037	595.11	(100, 0)	3.0/3.5	0	375.16	26.91	4.64	433.24	24.09	430.80	55.64	1.193	516.86
High; H6	1061	610.06	(99, 1)	3.1/3.5	0	383.85	26.91	4.76	444.12	24.69	440.21	56.36	1.1935	530.06
High; H7	1087	626.57	(94, 6)	3.2/3.5	0	395.68	26.91	4.89	456.14	25.36	452.84	57.16	1.1960	545.54
High; H8	1111	641.84	(72,28)	3.3/3.5	0	411.55	26.91	5.01	467.26	25.98	469.45	57.90	1.2070	563.98
High; H9	1137	658.60	(33,67)	3.5/3.5	0	433.69	26.91	5.14	479.46	26.66	492.40	58.71	1.2265	588.06
High; H0	1163	674.84	(7,93)	3.6/3.5	0	452.21	26.91	5.26	491.28	27.32	511.70	59.49	1.2395	608.94

[a]Yield grade is rounded to the midpoint of the integer.

[b]For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield grade greater than 3.5, the multiple is -.046 times cold carcass weight.

[c]Model coefficients for carcass-breaking sector are extracted from columns 7, 13, and 15.

TABLE LXXII

JRAN CARCASS-BREAKING ACTIVITY DATA

1 Plane of Nutrition and Weight Code	2 Live Fed Weight	3 Cold Carcass Weight	4 Quality Grade Composition (Good-Choice) Percent	5 Yield Grade[a]	6 Additional Pounds of Lean in Carcass	7 Carcass Acquisition Cost	8 Fixed Cost of Breaking, Boning, and Grinding	9 Carcass Storage Cost $.0078x3	10 Pounds of Lean in Carcass 5x3	11 Lean Distribution Cost $.0556x10	12 Total Carcass Breaking Sector Cost 7+8+9+11	13 Total Cost Less Carcass Acquisition 12-7	14 Quality Grade Composite Price/lb Lean	15 Gross Returns[c] 10x14
Low; L3	929	520.85	(100, 0)	2.9/2.5	23.96	$342.63	$26.91	$ 4.06	403.14	$22.41	$396.01	$53.38	$1.1930	$480.95
Low; L4	955	538.88	(96, 4)	3.0/3.5	0	340.57	26.91	4.32	392.30	21.81	393.49	52.92	1.1950	468.80
Low; L5	980	554.46	(79,21)	3.1/3.5	0	354.24	26.91	4.32	403.65	22.44	407.91	53.67	1.2035	485.79
Low; L6	1004	569.72	(50,50)	3.3/3.5	0	370.66	26.91	4.44	414.76	23.06	425.07	54.41	1.2180	505.18
Low; L7	1030	586.45	(46,54)	3.4/3.5	0	382.54	26.91	4.57	426.94	23.74	437.76	55.22	1.2200	520.87
High; H2	929	520.85	(100, 0)	2.9/2.5	23.96	342.63	26.91	$4.06	403.14	22.41	396.01	53.38	1.1930	480.95
High; H3	949	532.93	(98, 2)	3.0/3.5	0	336.39	26.91	4.16	387.97	21.57	389.03	52.64	1.1940	463.24
High; H4	975	548.93	(84,16)	3.1/3.5	0	349.61	26.91	4.28	399.62	22.22	403.02	53.41	1.2010	479.94
High; H5	1000	564.43	(50,50)	3.2/3.5	0	367.22	26.91	4.40	410.91	22.85	421.38	54.16	1.2180	500.49
High; H6	1024	579.50	(48,52)	3.4/3.5	0	377.54	26.91	4.51	421.88	23.46	432.43	54.89	1.2190	514.27
High; H7	1050	596.03	(34,60)	3.5/3.5	0	391.65	26.91	4.65	433.91	24.13	447.34	55.69	1.2260	531.97
High; H8	1075	612.05	(0,100)	3.7/3.5	0	412.03	26.91	4.77	445.57	24.77	468.48	56.45	1.2430	553.84
High; H9	1100	628.36	(0,100)	3.8/3.5	0	423.01	26.91	4.90	457.45	25.43	480.25	57.24	1.2430	568.61

[a]Yield grade is rounded to the midpoint of the integer.

[b]For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield greater than 3.5, the multiple is -.046 times cold carcass weight.

[c]Model coefficients for carcass-breaking sector are extracted from columns 7, 13, and 15.

TABLE LXXXIII

CHHE CARCASS-BREAKING ACTIVITY DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plane of Nutrition and Weight Code	Live Fed Weight	Cold Carcass Weight	Quality Grade Composition (Good-Choice) Percent	Yield Grade[a]	Additional Pounds of Lean in Carcass	Carcass Acquisition Cost	Fixed Cost of Breaking, Boning, and Grinding	Carcass Storage Cost $.0078x3	Pounds of Lean in Carcass 5x3	Lean Distribution Cost $.0556x10	Total Carcass Breaking Sector Cost 7+8+9+11	Total Cost Less Carcass Acquisition 12-7	Quality Grade Composite Price/lb Lean	Gross Returns[c] 10x14
Low; L3	1073	614.41	(100, 0)	2.1/2.5	28.26	$403.20	$26.91	$4.79	475.55	$26.44	$461.34	$58.14	$1.193	$567.33
Low; L4	1090	624.47	(100, 0)	2.1/2.5	28.73	409.81	26.91	4.87	483.34	26.87	468.46	58.65	1.193	576.62
Low; L5	1113	638.34	(100, 0)	2.2/2.5	29.36	418.90	26.91	4.98	494.08	27.47	478.26	59.36	1.193	589.44
Low; L6	1139	654.25	(100, 0)	2.3/2.5	30.10	429.34	26.91	5.10	506.39	28.16	489.51	60.17	1.193	604.12
Low; L7	1164	669.61	(100, 0)	2.3/2.5	30.80	439.42	26.91	5.22	518.28	28.82	500.37	60.95	1.193	618.31
Low; L8	1189	685.01	(100, 0)	2.4/2.5	31.51	449.53	26.91	5.34	530.20	29.48	511.26	61.73	1.193	632.53
High; H2	1074	615.11	(100, 0)	2.1/2.5	28.30	403.66	26.91	4.80	476.10	26.47	461.84	58.15	1.193	567.99
High; H3	1087	623.28	(100, 0)	2.1/2.5	28.67	409.02	26.91	4.86	482.42	26.82	467.61	58.59	1.193	575.53
High; H4	1112	638.34	(100, 0)	2.2/2.5	29.36	418.90	26.91	4.98	494.08	27.47	478.26	59.36	1.193	589.44
High; H5	1136	652.95	(100, 0)	2.3/2.5	30.04	428.49	26.91	5.09	505.38	28.10	488.59	60.10	1.193	602.92
High; H6	1161	668.30	(100, 0)	2.3/2.5	30.74	438.57	26.91	5.21	517.26	28.76	499.45	60.88	1.193	617.09
High; H7	1187	684.30	(100, 0)	2.4/2.5	31.48	449.07	26.91	5.34	529.65	29.45	510.77	61.70	1.193	631.87
High; H8	1212	699.85	(100, 0)	2.5/2.5	32.19	459.27	26.91	5.46	541.68	30.12	521.76	62.49	1.193	646.22
High; H9	1235	714.13	(98, 2)	2.6/2.5	32.85	469.15	26.91	5.57	552.74	30.73	532.36	63.21	1.194	659.97
High; H0	1161	730.49	(85,15)	2.6/2.5	33.60	483.52	26.91	5.70	565.40	31.44	547.57	64.05	1.2004	678.71

[a]Yield grade is rounded to the midpoint of the integer.

[b]For every rounded yield grade less than 3.5, the multiple is .046 times cold carcass weight. For every rounded yield greater than 3.5, the multiple is -.046 times cold carcass weight.

[c]Model coefficients for carcass-breaking sector are extracted from columns 7, 13, and 15.

APPENDIX K

FED STEER PURCHASE AND TOTAL ACQUISITION COSTS

BY TYPE AND FED WEIGHT

TABLE LXXXIV

HEHE FED STEER ACQUISITION COSTS FOR ALTERNATIVE WEIGHTS

Plane of Nutrition	Fed Weights	Total Acquisition Costs Purchase[a]	Trucking[b]	Buying[c]	Total Cost of Acquisition
Low	955	$355.43	$2.86	$1.50	$359.79
	989	367.83	2.97	1.50	372.30
	1015	377.52	3.04	1.50	382.06
	1040	386.82	3.12	1.50	391.44
	1064	396.05	3.19	1.50	400.74
	1090	407.63	3.27	1.50	412.40
High	962	358.14	2.89	1.50	362.53
	987	367.44	2.96	1.50	371.90
	1011	376.36	3.03	1.50	380.89
	1037	386.05	3.11	1.50	390.66
	1061	394.96	3.18	1.50	399.64
	1087	406.54	3.26	1.50	411.30
	1111	422.64	3.33	1.50	427.47
	1137	445.57	3.41	1.50	450.48
	1162	464.26	3.49	1.50	469.25

[a]Purchase cost = (slaughter weight) x (quality grade weighted feed steer price) where slaughter weight is 96 percent of fed weight. Quality grade weighted fed steer price is given in Table LXXV of Appendix H.

[b]Trucking = (fed weight)(.003).

[c]Buying cost is fixed at $1.50 per head.

TABLE LXXXV

JRAN FED STEER ACQUISITION COSTS FOR ALTERNATIVE WEIGHTS

Plane of Nutrition	Fed Weights	Total Acquisition Costs Purchase[a]	Trucking[b]	Buying[c]	Total Cost of Acquisition
Low	929	$345.74	$2.79	$1.50	$350.03
	955	356.62	2.86	1.50	360.98
	980	371.04	2.94	1.50	375.48
	1004	389.07	3.01	1.50	393.58
	1030	400.45	3.09	1.50	405.04
High	929	345.74	2.79	1.50	350.03
	949	535.65	2.85	1.50	358.00
	975	367.57	2.92	1.50	371.99
	1000	387.46	3.00	1.50	391.96
	1024	397.33	3.07	1.50	401.90
	1050	411.97	3.15	1.50	416.62
	1075	433.03	3.22	1.50	437.75
	1100	443.10	3.30	1.50	447.90

[a]Purchase cost = (slaughter weight) x (quality grade weighted fed steer price) where slaughter weight is defined as 96 percent of fed weight. Quality grade weighted fed steer price is given in Table LXXVI of Appendix H.

[b]Trucking = (fed weight)(.003)

[c]Buying cost is fixed at $1.50 per head.

TABLE LXXXVI

CHHE FED STEER ACQUISITION COSTS FOR ALTERNATIVE WEIGHTS

Plane of Nutrition	Fed Weights	Total Acquisition Costs			Total Cost of Acquisition
		Purchase[a]	Trucking[b]	Buying[c]	
Low	1073	$399.23	$3.22	$1.50	$403.95
	1090	405.43	3.27	1.50	410.20
	1113	416.31	3.34	1.50	421.15
	1139	426.05	3.42	1.50	430.97
	1164	435.41	3.49	1.50	440.41
	1189	444.76	3.57	1.50	449.83
High	1074	399.62	3.22	1.50	404.34
	1087	404.65	3.26	1.50	409.41
	1112	416.31	3.34	1.50	421.15
	1136	425.27	3.41	1.50	430.18
	1161	434.63	3.48	1.50	439.61
	1187	444.37	3.56	1.50	449.43
	1212	453.73	3.64	1.50	458.87
	1235	463.01	3.70	1.50	468.21
	1261	477.13	3.78	1.50	482.41

[a]Purchase cost = (slaughter weight) x (quality grade weighted fed steer price) where slaughter weight is defined as 96 percent of fed weight. Quality grade weighted fed steer price is given in Table LXXVII of Appendix H.

[b]Trucking = (fed weight)(.003)

[c]Buying cost is fixed at $1.50 per head.

APPENDIX L

PROCEDURES FOLLOWED IN UPDATING LOGAN'S PACKING PLANT TO A 1974 BASE PERIOD

HISTORY OF LOGAN'S STUDY

The original study was done in 1962 by Logan and King, using a 1960 data base for the Los Angeles area. Logan later updated the study for the Food Commission in 1966 (39). The updated study used revised labor coefficients as well as sets of 1965 prices and costs for Omaha. The 1966 update study constitutes the base for the calculations of slaughter cost for this study on a 1974 base. In order to maintain consistency, the 1974 update is based on indexes calculated from one source (69).

Procedures Employed in Updating to 1974 Period

A table identifying the most important elements of packing plant cost, Logan's 1965 estimates of these costs, and the updated costs to a 1974 base provides a working tool for the development of the killing cost coefficient. The underlying assumption is that the slaughter capacity of the plant is 120 head per hour.

As shown in Table LXXXVII, the total 1974 costs incurred by a 120-head per hour packing plant was $3,086,069. The total annual carcass output from the plant is 226,782. Thus, the total cost per carcass is $13.61.

TABLE LXXXVII

AN UPDATE OF LOGAN'S PACKING PLANT COSTS TO A 1974 BASE PERIOD

Element of Expense	Logan's Cost Estimate	1974 Cost Estimate
Labor (inc. management)	$1,208,584	$2,417,168
Equipment depreciation	31,312	50,119
Building depreciation	48,693	77,941
Annual property tax	23,223	40,926
Insurance	8,100	6,023
Interest	51,375	179,697
Other expenses	367,736	273,434
Utilities	54,819	40,761
Total annual cost	$1,793,842	$3,086,069

APPENDIX M

1974 WEEKLY AND ANNUAL AVERAGE BY-PRODUCT VALUES

TABLE LXXXVIII

1974 WEEKLY BY-PRODUCT VALUES PER HUNDREDWEIGHT
CONVERTED TO MONTHLY AND ANNUAL AVERAGES

Month	Week 1	2	3	4	5	Total	Average
January	$4.76	$4.93	$4.98	$4.96	-	$19.63	$4.91
February	4.84	4.83	4.76	4.78	-	19.21	4.80
March	4.73	4.55	4.39	4.36	$4.19	22.22	4.44
April	4.01	4.04	4.26	3.92	-	16.23	4.06
May	3.90	3.78	3.73	3.59	-	15.00	3.75
June	3.47	3.36	3.26	3.25	3.31	16.65	3.33
July	3.45	3.62	3.72	3.75	-	14.54	3.64
August	4.32	4.16	4.20	3.99	3.94	20.61	4.12
September	3.87	3.76	3.43	3.47	-	14.53	3.63
October	3.59	3.44	3.37	3.32	-	13.72	3.43
November	3.27	3.11	3.08	2.90	2.92	15.28	3.06
December	2.82	2.77	2.65	2.66	-	10.90	2.73
1974 Year	-	-	-	-	-	$198.52	$3.82

APPENDIX N

PROCEDURES FOR DEVELOPMENT OF CARCASS TRANSFORMATION COSTS FOR THE CARCASS-BREAKING SECTORS

A useful device for developing component 1974 per pound carcass transformation costs from a set of 1970 cost data is Table LXXXIX. It identifies the variable cost components, the 1970 per pound carcass cost, the 1970 index on a 1967 base, the adjusted 1967 per pound adjusted cost, 1974 index on a 1967 base, and the adjusted 1974 per pound carcass cost.

The 1974 component per pound carcass costs were derived through application of the following steps. First, each component 1970 per pound carcass cost was divided by the 1970 index value and the dividend recorded as the 1967 cost. The 1967 cost was then multiplied by the 1974 value and the product recorded as the 1974 per pound carcass cost. The columns of Table LXXXIV provide a self-explanatory example of those steps.

TABLE LXXXIX

DEVELOPMENT OF 1974 VARIABLE CARCASS PREPARATION COST

Variable Cost Component	1970 Carcass Cost Per Pound	1970 Index Value	1967 Carcass Cost Per Pound	1974 Index Value	1974 Carcass Cost Per Pound
Carcass storage	$.006	120	$.0050	157	$.0078
Wrapping and labelling of lean cuts	.027	108	.0250	151	.0378
Lean Cut storage	.002	120	.0017	157	.0026
Lean cut transportation	.011	117	.0094	162	.0152

APPENDIX O

EQUATIONS AND PROCEDURES FOLLOWED IN CALCULATING WHOLESALE LEAN MEAT PRICES ACCORDING TO QUALITY GRADE

There is no fabricated beef price series (44). It is necessary, therefore, to derive a price series for wholesale lean meat. To derive this series, first calculate the average 1974 retail price for all lean cuts. Then, using the reported carcass-retail price spread and assumptions of the distribution of the carcass-retail price spread between the carcass breaking sector and the retail outlet, compute the wholesale price of lean cuts. Finally, adjust the wholesale price for quality grade following Nelson (44).

Derivation of the Average 1974 Retail Lean Meat Price

The 1974 twelve month average per pound retail value of choice beef as calculated from USDA data is $.9838 (67). Since 70.9 pounds of beef are sold for every 100 pounds of carcass, divide the retail value by .709 to obtain the retail price per pound (67). With a retail value of $.9838 per pound in 1974, the calculated choice retail price per pound becomes $1.3876, or $1.388, which corresponds to a USDA report (69).

Derivation of the Wholesale Lean Meat Price

The USDA reports that the 1974 average retail price spread was $.414 (69). Carcass breaking costs are assumed to be 65 percent of the carcass-retail spread. Therefore, the remaining 35 percent or $.145 of the carcass-retail spread accrues to the retail outlet. With a choice per pound retail price of $1.388, the wholesale choice per pound price realized by the carcass breaking sector is $1.243.

Adjustment of Wholesale Price by Quality Grade

Nelson offers a procedure for adjusting the wholesale price to reflect retail price differentials between quality grades (44). Nelson's procedure calls for the establishment of value differences in 1000 pound fed steers on the basis of their quality grades. Once established, the differences are divided by 437 since the USDA assumes that 437 pounds of lean meat will be cut from a 1000 pound fed steer.

A uniform reported price series by quality grade and independent of fed weight was used to derive the differences in value between quality grades of a 1000 pound fed steer (66). The prices by quality grade, value for a 1000 pound fed steer, the net value difference between quality grades given that Choice quality grade serves as the standard, and the per pound net value difference between quality grades are given in Table XC. The caption and contents of Table XC summarize the procedure described above.

TABLE XC

PRICES AND VALUE DIFFERENCES BETWEEN QUALITY GRADES FOR A 1000 POUND FED STEER

Quality Grade	Price	Value for 1000 Pound Fed Steer	Net Value Difference	
			Total	Per Pound
Prime	$43.12	$431.20	$12.90	$.0295
Choice	41.83	418.30	0	0
Good	39.65	396.50	($21.80)	($.0499)

Fed steer prices in Table XC do not correspond with fed steer prices used in the study. Although both sets are from USDA sources, the set in Table XC is for all composite weights within the stated quality grades, whereas the other set is based on varying weight ranges within quality grades.

Calculating Wholesale Price for Lean Cuts on Basis of Quality Grade

The final step entails adjustment of the Choice wholesale price received by the carcass breaking sector for Prime and Good lean cuts. The prime and good wholesale lean meat prices per pound are derived with the following equations:

Estimated wholesale price per pound for prime lean meat	=	Choice wholesale price per pound received by carcass-breaking sector	+	Net value difference per pound for prime
	=	$1.243 + .030		
	=	$1.273		

Estimated wholesale price per pound for Good lean meat	=	Choice wholesale price per pound received by carcass-breaking sector	+	net value difference per pound of Good
	=	$1.243 - .050		
	=	$1.193		

VITA

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