OPTIMAL LOCATION OF BEEF ENTERPRISES UNDER CURRENT AND PROJECTED CONDITIONS -- AN INTERREGIONAL ANALYSIS

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PREFACE

This study was undertaken to analyze the interregional competition of the beef industry and to determine the optimum utilization of the resources in the beef industry. The overall objective was to determine simultaneously the geographical flows of stockers, feeders, meat and feed grains that minimizes the total cost of supplying beef to the consumer. The results were obtained by formulating mathematical models of the industry and generating solutions to these models by the use of linear programming procedures.

The author expresses appreciation to his major adviser, Dr. John W. Goodwin, for his guidance, and many suggestions in conducting this study and preparing this manuscript. Appreciation is expressed to Dr. Mack Leath of Marketing Economics Division, Economic Research Service, United States Department of Agriculture for his assistance in developing the appropriate models. Thanks are also given to the members of my advisery committee, Dr. Wayne Purcell, Dr. Vernon Eidman, Dr. John Franzmann, and Dr. Gladstone Stevens, Jr., for their suggestions concerning the conduct of this study and the preparation of the final manuscript.

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CHAPTER I

INTRODUCTION

In the early 1900's cattle were grazed in the West, shipped East for slaughter and there consumed. Because of the geographic locations of population and of slaughter and transportation facilities, the interregional flows of livestock and livestock products were fairly simple. Shifts in the geographic distribution and mode of beef production and in the geographic redistribution of population in the United States since World War II have created a complex pattern of interregional flows of beef and beef products. Between basic calf production and ultimate beef consumption, the activities of growing, fattening, slaughtering, breaking and distribution are involved.

The structure of the beef industry has changed significantly the last 10 years. The change may be attributed to many factors; however, increasing disposable per capita income would rank among the most important. This rapidly increasing income has allowed the average consumer to improve his standard of living by increasing average levels of red meat consumption--primarily beef. Per capita consumption of beef has increased from 85 pounds per person in 1960 to 113.7 pounds per person in 1970.[1] The increased demand has been met through increasing cow numbers, increasing feeding of beef cattle, and increasing feed grain production. The slaughter industry has been decentralized from the

Northern urban centers to locations of concentrated fed cattle production. Beef is now moved in carcass rather than live form.

The climatic conditions of the continental United States have resulted in areas of increasingly specialized agriculture. Wheat in the Southern High Plains, feed grain in the Mid-West, and truck farms along the seaboards are specialized enterprises which have developed. So far as beef cattle have been concerned, the general patterns of movement as late as 1950 followed those shown in Figure 1. Cattle were grown in the native ranges of the Western states and moved to the Mid-West for fattening. Live animals were shipped into the metropolitan areas along the Missouri River, in the Great Lakes area, and in the Northeast for slaughter and consumption.

Following World War II, the development of vast irrigation areas in the West and in the Plains states dramatically increased the crop production potential. Capital was readily available for farmers and investors to utilize the new irrigation technology. Some of the results were that large cattle feeding operations sprang up in the California-Arizona area. The flows of feeder cattle changed dramatically as the Desert areas of the Southwest began to build a vast feedlot empire.

Gradually, irrigation technology and capital flowed into the High Plains area of the United States. The traditional crops of cotton and wheat were limited by the acreage allotment restrictions introduced by the agricultural programs of the early 1950's. Producers discovered that wheat did not respond well enough to irrigation to justify the investment. Thus, large acreages in the Plains were converted to the irrigated production of feed grains and forage. Vast amounts of grain

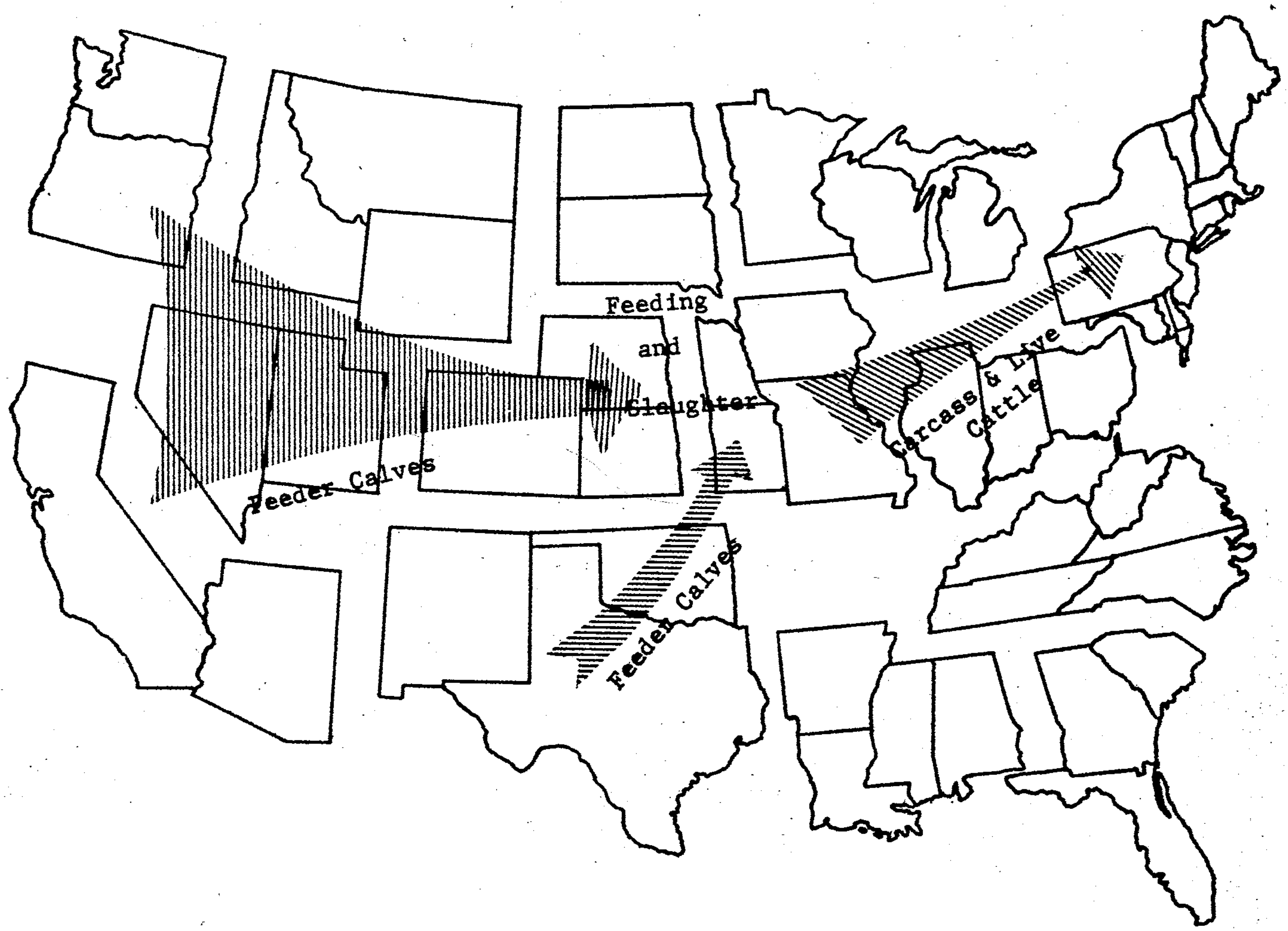

Figure 1. Movement of Cattle in the Early 50's

became available for livestock feeding operations. Large volumes of this grain were shipped into the desert feeding areas.

By the late 1950's, the presence of large grain supplies in the Plains encouraged the development of Plains feedlots. From the beginning, Plains feeding was concentrated in large operations that fed beef to the high Good and Choice grades. The relative proximity of the Southeast and Gulf Coast provided markets for the beef. The continued growth in Plains feeding further changed the flows of feeder cattle movement.

The location of stocker and cow-calf operations depends largely upon the availability of forage for growing purposes. Traditionally, beef cow operations have been concentrated in the Plains and Intermountain regions. However, the changing structure of Southern agriculture coupled with Federal agricultural programs generated sweeping changes in the patterns of Southern land usage. Large acreages were transferred from cotton to forage production. In addition, large acreages of abandoned cropland were converted to pasture. As a result, the Southern states have replaced the Intermountain West as the nation's secondary producer of feeder cattle (Figure 2).

The cattle business is important to the Western states, but if we consider the pattern of changes in the beef brood cow herd over the past fifty years, the South Central and Southeastern regions plus the states of Iowa and Missouri have emerged as the dominant growth areas in beef brood cow herds. The Plains states and the Desert Southwest have consistently lost ground to these areas.

To illustrate the impact of pasture improvement, Eastern Oklahoma is annually converting about a quarter of a million acres to the tame, fertilized grasses. This represents an annual growth potential of about

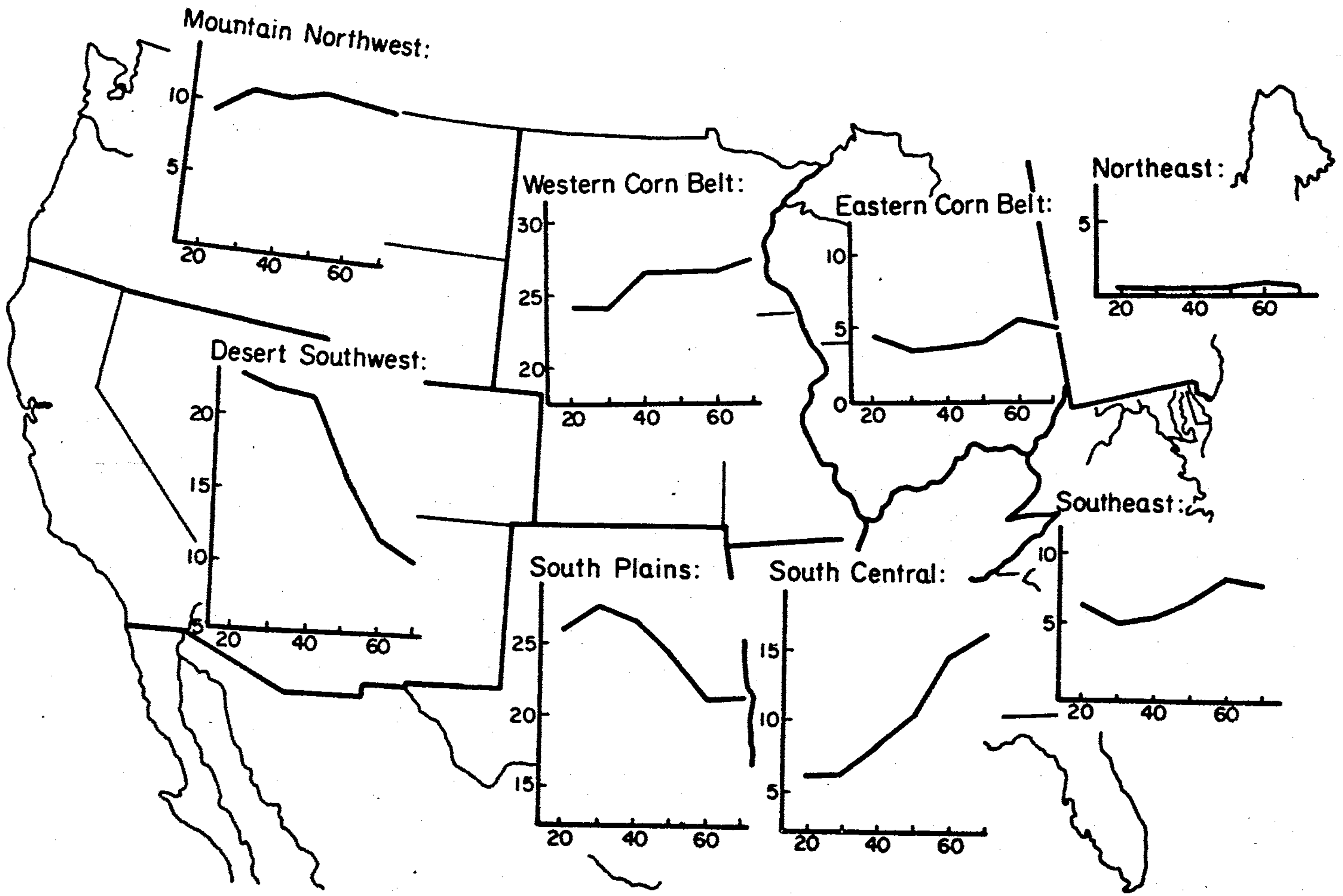

Figure 2. Percent of National Beef Brood Cow Herd, by Region, Decennial Years, 1920-70

Source: John W. Goodwin, "Quo Vadis for the Beef Industry," Agricultural Economics, Paper 7027, Oklahoma State University, Stillwater, Oklahoma.

87,000 brood cows in Eastern Oklahoma alone. This same pattern is being repeated across the South but most especially in Mississippi, Alabama, Kentucky and Tennessee.

A second factor which has become extremely important to the growth in the beef industry is feed grain supplies. Fed beef has been of increasing importance as a proportion of American food expenditures. Of the 113.7 pound per capita consumption in 1970, 74 percent was from animals sold through feedlots. The location of these feed grain supplies is of critical importance in the location of beef production. Since it is generally cheaper to move cattle to feed grain than it is to move feed grains to cattle, cattle have typically been fed where the grains have been available. As late as 1955, the Corn Belt states fed almost all of the nation's cattle. During the 1950's, California and Arizona began to feed large numbers of cattle with imported feed grain, but feeding in these states has since declined. During the 1960's, there was a tremendous surge of cattle feeding in the South Plains. Through the latter 1960's the Plains became the dominant growth area (Figure 3).

In 1960, the South Plains fed eight percent of the nation's cattle. By 1965, this had increased to 14 percent. In 1969, the Plains fed 24 percent of the 24 million head of cattle market from United States feedlots. Just where any future growth in the beef industry will develop will depend on the interaction of beef production, slaughter, consumption, and transportation activities.

Problem and Justification

A rapidly changing economic environment has resulted in significant changes in the beef industry. Factors such as population, growth,

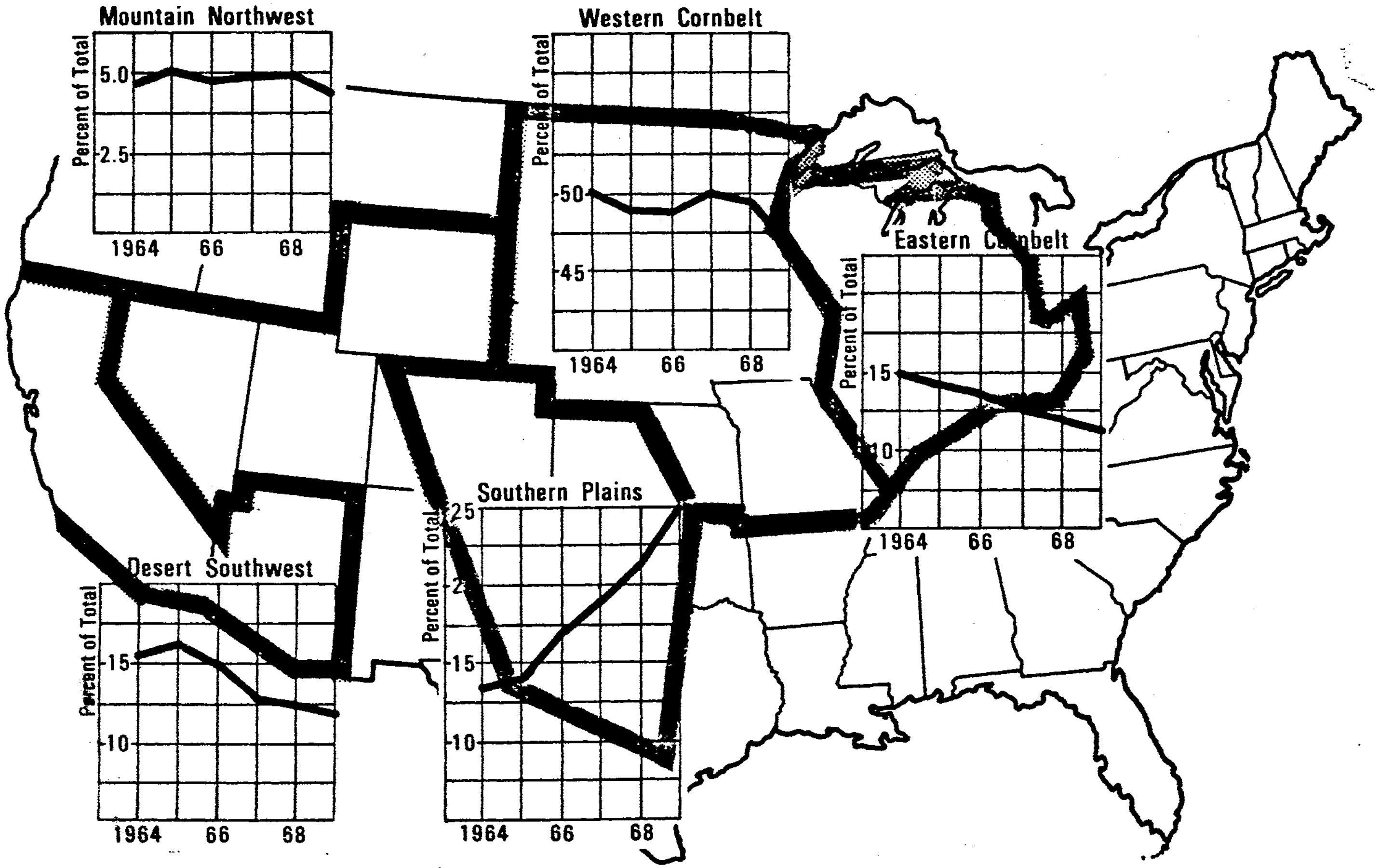

Figure 3. Regional Shares of Cattle Feeding, Percentage of 23 States Total, 1964-1969

Source: John W. Goodwin, "Quo Vadis for the Beef Industry," Agricultural Economics, Paper 7027, Oklahoma State University, Stillwater, Oklahoma.

changes in regional distributions of population, increased per capita income, increased preference for beef, technology, and government agricultural policy have altered regional patterns of beef production, finishing, and marketing. Technological changes at all levels have altered cost structures and volume potentials for all regions of the United States.

Since beef accounted for 26.5 percent of the total income to farmers in 1969, and is the single largest contributor to farm income,[2] information concerning long term competitive positions in the production, finishing, and marketing of beef is of utmost importance. The growth of the feeding industry has brought great development to some areas. Information concerning this growth is needed for defining the potential for future growth in all sections.

Knowledge concerning the optimal flows of cattle and the competitive positions for different regions is of prime importance to decision makers of the beef industry. These decision makers may be cow-calf producers, small grain producers, feedlot owners, meat packers, transportation companies, or others involved in the marketing of beef products. Such knowledge could be useful in determining the locations for the various installations that would minimize costs of production and/or distribution cost. Such information could also be useful to marketing firms in suggesting which markets should be investigated or where facilities should be located.

Although an optimum organization* (one which minimizes the cost of providing beef to the consumer) may never be attained in a dynamic

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*For this study, an "optimum" organization is defined to be that organization which minimizes the cost of providing beef to the consumer.

economic environment, a partial equilibrium analysis may provide the direction and magnitude for desirable changes. The analysis of an optimum market organization should provide: (1) guidelines to enable individual firms to reduce unnecessary inefficiencies in existing organization and future growth, and (2) guidelines to enable those involved in public policy formulation to better facilitate the needs of producers, processors, and consumers.

Objectives

The purpose of this study is to evaluate the interregional aspects and competitive structure of the beef industry. The specific objectives are:

(1) To specify optimum locations for brood cow herds, stocker operation, feedlots, and slaughter plants subject to existing production constraints of feed grain, wheat, grass capacity, feedlot capacity, and slaughtering capacity.

(2) To examine the effects of removing the constraints of feedlot capacity and slaughtering capacity on the optimum locations of brood cow herds, stocker operations, feedlots, and slaughter plants.

(3) To postulate probable future changes in regional production patterns when the total demand for beef increases.

Procedures

To satisfy or fulfill the objectives, fourteen broad competitive regions were defined on the basis of similarity of resource base, production, and marketing patterns. Representative points within these regions were specified as origins of production with major population centers designated as consumption points.

Regional consumption estimates were synthesized from work completed at Oklahoma State University,[3, 4] along with secondary information from the Household Food Consumption Survey.[5] Regional differences in consumption were obtained by adjusting the annual national consumption of beef for regional differences in income, prices of beef, and the prices of pork. The adjusted beef consumption figure was then multiplied by regional population figures to give an estimate of the total demand of beef for a region. Projection for 1975 and 1980 used projected estimates of population[6] and income[7] to arrive at consumption of beef in those years.

Regional constraints on grass availability, cow herds, feedlot capacity, slaughter capacity, feed grain availability, and wheat availability were collected from secondary sources. The production within a region depends on availability of these resources. To expand the production possibility of both the region and the economy as a whole, mobility of resources is extremely important.

In the analysis, all cattle and feed concentrates are free to move to any other region for the transportation cost. Present feeding, slaughtering, and grass facilities are not movable to other regions. If a region needs additional facilities, they must purchase such facilities before using them in production operations.

Costs of activities associated with each of the constraints in the model were determined from secondary sources.

Cost differences among regions may be explained by differences in scales of plants. This may be brought about because of factors such as a larger consumer market, a greater rate of technical adaptation, climate, lower factor costs or greater specialization of labor.

Transportation costs of stockers, feeders, fat cattle, dressed beef, feed grain, and wheat were provided by rate information from common carriers. So far as grain rail rates were concerned, rates for moving domestically consumed grain were used. Rail rates for carcass beef were rail carload freight rates on domestic shipment of fresh meat. Similar rates for truck transportation were also obtained for least cost transportation comparisons.

Truck rates for the movement of live cattle were based on a rate of 70 cents per load mile which was the common rate at the time of the programming of this study. A 44,000 pound load limit, which is the highest legal weight a truck can carry, was used. Therefore, for this study, 110 400-pound stocker calves may be hauled in one truck load. Seventy-three feeder cattle weighing six hundred pounds each may be trucked in a single load. For fat cattle, the truck could legally haul only 44 animals at one time.

The basic data were integrated in a transhipment model. Four models were programmed to look at different alternatives. Model I was based on production costs, demands for beef, and production facilities as they exist today. Model II considered the organization of the beef industry when the feedlot and slaughtering constraints were removed from Model I. Models III and IV examined resource adjustments as the consumption of beef was expanded to expected 1975 and 1980 levels, respectively. The location of calf production, stocker operations, feeding and slaughtering facilities and interregional flow patterns for stocker cattle, feeder cattle, fed cattle, processed beef and concentrates were obtained for each of the models.

Organization of the Study

The remainder of this study is divided into five chapters. Chapter II contains the theoretical considerations of location and the mathematical presentation of the model. Chapter III contains a specification of the regional demarcation used in the study and a description of the regional data is presented. These data are related to current estimates of supplies, demands, capacities, transportation costs, and feeding costs.

Chapter IV contains the analysis of optimum location for brood cow herds, feedlots and slaughter plants, under conditions approximating the 1970 situation and the location of enterprise with production constraints removed. The results of the postulated probable future changes in regional patterns are presented in Chapter V.

Finally, Chapter VI contains a summary of the study and a discussion of the conclusions and implications of the analyses. The limitations of the study are also considered as well as some suggestions for future research.

FOOTNOTES

[1]U. S. Department of Agriculture, Livestock and Meat Statistics, Economic Research Service, Statistical Bulletin 333, Supplement for 1970 (Washington, D. C., 1971), p. 138.

[2]U. S. Department of Agriculture, Agriculture Statistics 1969, Economic Research Service (Washington, D. C., 1969), pp. 449-451.

[3]John W. Goodwin and Reuven Andorn, The Irreversible Demand Function for Beef, Technical Bulletin T-127, Oklahoma State University, Agricultural Research Experiment Station (June, 1968).

[4]Richard Crow and John W. Goodwin, "The Demand for Beef, an Irreversible Demand Function" (Unpub. journal article, Dept. of Agricultural Economics, Oklahoma State University). This paper was a revision of the Goodwin-Andorn work.

[5]U. S. Department of Agriculture, Household Food Consumption Survey, 1965-66, Reports Nos. 1-5 (1968).

[6]U. S. Department of Commerce, Population Estimates, Series P-25, No. 375 (Washington, D. C., October, 1967), p. 34.

[7]National Planning Association, State Economics and Demographic Projection, Regional Projection Series, Report 70-R-1 (Washington, D.C., 1970), p. S-6.

CHAPTER II

THEORETICAL CONSIDERATIONS

Location analysis is directed toward discovering the economically optimum means for adapting to the geographic separation of sellers from buyers and of resources from consumers.[1] The theory of location first became of interest to a German, von Thunen, in the nineteenth century. Von Thunen was an agriculturalist with large real estate holdings. He became interested in the question of where production of agricultural products should be located to increase his rent from land. Von Thunen focused attention on transportation costs, adopting the position that reducing the total cost of transporting the various products would increase rents.

Von Thunen started his analysis by assuming that the price of grain at any point in the isolated state, for example, would be the town price less the cost of transportation to the town. Since the city was assumed to be the only market, and all grain (except that used on the farm) was marketed in the city, this was bound to be the case.

The absolute outward boundary for any crop or method would be where Value of Marginal Product was equal to zero. With the value of marginal product being the additional production from the last unit of input multiplied by the price of the output, where price is equal to market price minus transportation cost, the farther the product is produced from the central market the lower the value of marginal product. This results because the net price of the output declines as the distance from the market increases. Where two or more alternative products would yield a positive Value of Marginal Product at the same point in space, the most profitable of the alternatives would be chosen. Outward and inward boundaries of the various concentric circular zones of differing production, therefore, were precisely determined by the model.

Figure 4 illustrates von Thunen's situation. Let O be the market for different products. One product--potatoes--yields economic rent in the amount of OA per acre when raised in the immediate vicinity of O. A second product--corn--yields economic rent in the amount of OB in that vicinity. As the distance from O increases, the relative amounts of economic rent generated by the two products change. Since the harvested weight of an acre of potatoes exceeds the harvested weight of an acre of corn, the per acre transportation charge for shipping these yields to the market place at point O will be greater for potatoes. As distance increases, the transportation charge absorbs the per acre economic rent from potatoes more quickly than it absorbs that from corn. At distances greater than OD, only corn will be produced since the net return to the producer is greater for corn. If the analysis is enlarged to include the cultivation of the various crops, the result is a concentric configuration as shown in Figure 5. Perishable products would be expected to be produced near the market, while the less perishable products would be expected to occur further out in the periphery.[2]

Von Thunen emphasized the competition among various types of agriculture and their relative ability to pay land rent, thus determining the pattern of land use. A later school of thought, as presented by Alfred Weber, placed major emphasis on the location of the individual

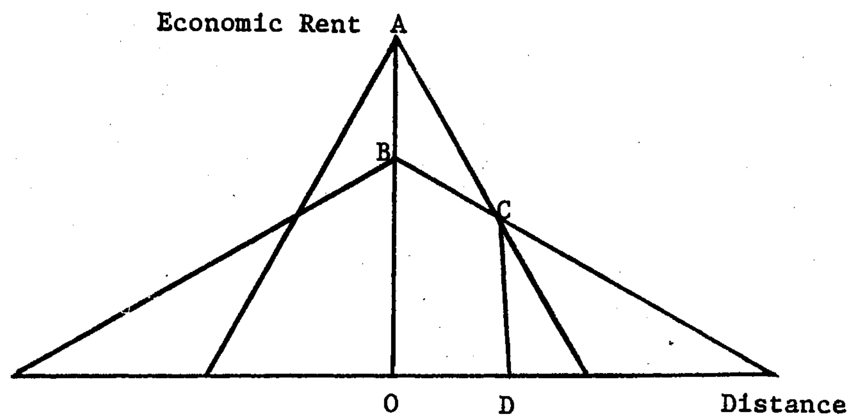

Figure 4: Location of Production Due to Harvest Weight in von Thunen Production

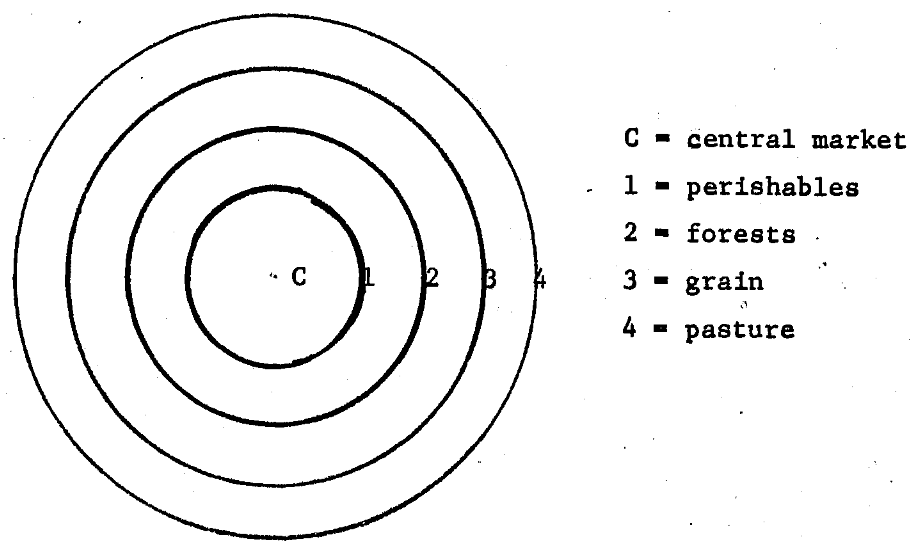

Figure 5: Concentric Circles of von Thunen Location of Production

firm.[3] Weber is credited with being the first to attempt the analysis of the choice of industrial location in terms of transport costs, wages, and raw materials prices, a significant departure from von Thunen's use of transportation costs as the only important variable.

Weber's formulation was based upon the availability and processing properties of the raw materials.* His major objective was to show where processing should be located in order to minimize total transfer cost of raw materials and finished products plus labor costs involved in processing. The solution can be seen by visualizing these consumption areas as apexes of a triangle. Just where a production center to serve these areas will be established depends upon the availability of the raw materials and the weight-losing characteristics of raw materials and the weight-losing characteristics of raw materials during processing. For example, if equal quantities of two raw materials are required, but one loses more weight when combined into the finished product, the production point will be located nearer the material which loses the greater weight. On the other hand, if absolute weight losses are equal but one material is used in greater quantities than the other, the two will be brought together for production nearer the material used in greatest quantity.

It was not until 1937 that E. M. Hoover combined the relevant Weberian analysis with the contemporary notions embodied in the theory of the firm and partial equilibrium analysis.[4] However, August Losch

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*The raw materials were classified as to availability and processing characteristics. In terms of availability, "ubiquities" were available in all locations; materials found only in certain localities were said to be "localized." Materials which did not lose weight during processing were called "pures" while those losing weight during processing were referred to as "gross material."

is generally credited as being the first writer to present a general equilibrium system describing the interrelationships among locations. He was critical of the cost orientation to location expressed by earlier writers. Losch maintained that cost alone could not be used to determine actual location and that net profit would be the final and sole determining factor in location.[5]

Profits are stated to be the ultimate in economics. Richardson, however, discusses different location decision criteria in his work on regional economics.[6] Industries at one time tended to locate near supplies of raw materials and fuel. Today, many firms exhibit a market orientation by locating near large, high-income population centers. Even though certain industries appear to be free to relocate, and even though substantial tax inducements have been offered, there has still been considerable location inertia so far as interregional transfers of industry are concerned. One reason for this inertia has been that locations no longer possessing direct cost advantages have frequently continued to be preferred because they offer large external economics such as well developed transportation facilities. Apart from the external economies, the most plausible explanation for location inertia, market orientation, and agglomeration in certain regions is that the location decision may be determined by criteria other than profit maximization.[7]

The theoretical basis combining location and transportation into a spatial general equilibrium model and incorporating it into a programming framework was completed by Louis Lefeber in 1958.[8] Drawing upon previous work of economists and location theorists such as Samuelson,[9] Baumol,[10] Koopmans,[11] and Beckman,[12] Lefeber combines spatial theory and general equilibrium analysis to form a neoclassical general equilibrium theory for the spatial allocation of factors, distribution of goods, and the choice of industrial location with respect to transport costs, wages and prices of raw materials.

Since the initial development of the transportation model for use in analytical work relating to decisions on location, various applications and studies have been completed. Henry and Bishop[13] used a transportation model to determine the best possible adjustments of national broiler markets. Price differences between markets and a least-cost broiler shipping pattern between supply areas and consuming centers were estimated by minimizing transportation costs.

One of the earliest spatial models in the livestock field was developed by Karl Fox.[14] Fox divided the United States into 10 regions and a demand for feed is estimated for each. Using 1949-1950 regional production of feed, numbers and prices of livestock and their demand equations, he derives equilibrium consumption, price, and shipments of feed for each region. The effect of alternative transportation rates and production levels are considered.

Further development was made by Judge and Wallace in 1959.[15] The Judge-Wallace model was concerned with analyzing the beef and pork marketing sectors of the economy. Their studies did not take into consideration the different forms of beef. Regions, therefore, may have been classified as surplus with respect to total beef when they could have been deficit, for example, in fed beef.

Another study which used a spatial equilibrium model was completed by King and Schrader.[16] They were concerned with determining the optimum location of feedlots under specified conditions as to feeder cattle location, feed supplies, non-feed costs and feed conversion efficiency by regions. A similar study was conducted by Malone with special reference to Oklahoma's role in interregional trade.[17]

As the entire family of models improved, approaches developed which allowed for regions to be both origin and receiving points. Such a model, called the "transhipment model," was first used in a major application by King and Logan in 1964.[18] An iterative procedure was used to incorporate economies of scale in processing and transport costs to find the optimum locations for processing plants and the optimum shipping patterns of raw materials and final products. The model was applied only to the California area.

Besides being only a formulation of a single product model involving inelastic raw product supply and product demand functions, King and Logan's formulation required subtraction of artificial variables from the estimated shipments once the minimum cost solution was found in order to determine the actual level of shipments. In 1965, Hurt and Tramel reformulated the King and Logan problem, such that the subtraction of artificial variables was not necessary.[19] They also extended this simple product model to include a multiproduct commodity space and multiproduct processing plants.

Leath and Martin extended the Hurt and Tramel model to include the capability of solving multifactor, multiproduct, multiregion, and multistaged problems of a spatial nature for the grain industry.[20] The model was formulated to allow five different grains to compete for the limited regional capacities in storage as they flowed through the system. Hard and soft wheat moving to the milling sector were allowed to compete for the limited milling capacity. Multiproduct storage was introduced into the model in addition to the multiproduct processing. Further, the model considered demands for intermediate as well as final products. Optimum solutions to the Leath-Martin formulation specified least-cost locations for processing and storage. Thus, the efficient location of economic activity was determined rather than assumed.

An extension of the above Leath-Martin model was made in 1967 when it was extended to a time-staged transhipment model capable of considering several time periods simultaneously.[21] This model allowed for the consideration of highly seasonal products where requirements for the commercial storage were not uniform through the marketing year. The model could be modified to contain minimum capacity restraints to insure that a minimum percentage of the capacity was used. Further, restrictions could be placed on the total quantity that could be shipped from a specified group of supply points, and minimum and maximum restraints on a particular supply or demand could be incorporated. The model was used by Leath to study the optimum utilization of regional storage capacities and determine optimum quarterly interregional flows of grain that were consistent with the available regional storage capacity.[22]

Another recent application of the general transhipment models have been by Langemeier and Finley in a study to estimate optimal location of cattle feeding.[23] They attempt to divide the demand for beef into fed and non-fed beef and to include existing slaughter capacities in the model framework. Their models showed improvements over most previous work in terms of consistency with recent trends in the location of cattle feeding.

To permit consideration of the size economies, Kloth and Blakley extended the production distribution model to include a separable programming routine.[24] Their work revolved from a study to determine the optimum market organization of the fluid milk industry. The transport-separable model was developed utilizing the various cost functions to determine the number, size and location of fluid milk plants that would give a minimum market cost under alternative assumptions.[25] They were then able to obtain an optimum plant location with economies of size and market-share restrictions incorporated in the model.

The Model

The model used in this study was developed to study the different segments of the beef industry as an entire system. The overall and generalized objective was to determine the competitive positions of different regions at the various levels and to examine how interrelationships among the various segments affect regional competitive positions. A model considering the production activities of the cow-calf, stocker, and feeder enterprises was incorporated with slaughtering and transportation activities to fulfill the objectives. The flow diagram in Figure 6 gives more insight to the movement of a beef animal through a multiregion, multifactor, and multistage transhipment model used in this study.*

As noted in Figure 6, the starting point for the entire system is the cow herds. Pasture availability in a given region may be used for the production of calves or the production of stockers, depending upon which activity helps to minimize the total costs of beef production. If a calf is produced in a region, it has the alternative of staying in the region where produced or to be transferred to a second region for

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*The model used in this work is in essence the Leath-Martin model.

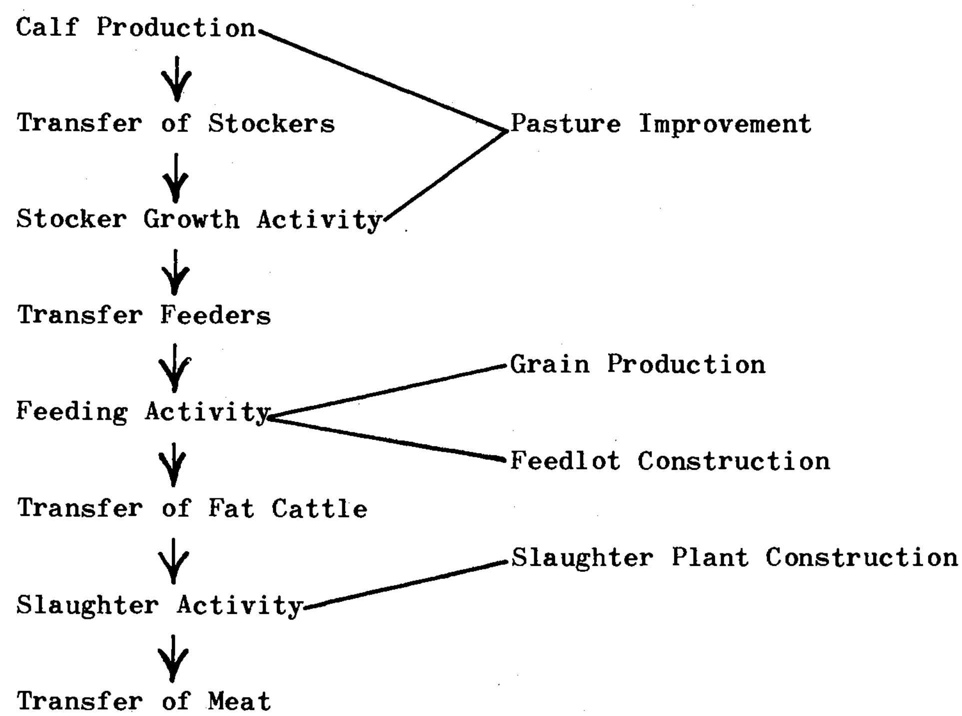

Figure 6. Flow Diagram Showing the Movement of a Beef Animal Through the Transhipment Model

stocker growing. Each stocker activity is assumed to produce a 600 pound feeder animal.

The same alternatives are available at the stocker level, i.e., the feeder animal may remain in its growing region or be moved to a second region for feeding. Feeding activities are assumed to produce an 1100 pound animal. The fat cattle may be slaughtered in the region in which they are fed or moved to some other region having surplus slaughter capacity. If the animal is slaughtered in the region where fed, the meat is transported in carcass form. Each animal was assumed to produce 682 pounds of meat.

Similar to the movements of cattle are the movements of feed grains. Each region has the alternative of using its own grain or purchasing it from other regions. Wheat is treated as a feed grain in the study given recent increases in the use of wheat in cattle feeding operations.

Given the production restriction for each region, the above activities were incorporated into a transhipment model with the objective of minimizing the combined production and transportation costs for the United States beef economy. A matrix of a two-region problem is shown in Figure 7.

Following the format of the matrix in Figure 7, the -1 in row four indicates that one stocker calf is produced in region one. This calf may be retained in region one as indicated by the 1 and -1 under TST 1, 1, or transferred to region two as shown by the 1 and -1 under TST 1,2. The stockers which arrive in region one become available for the stocker growth activity in the region as shown by the 1 in row six, column seven. This stocker animal will utilize A AUM's of grass, row 24, and B therms of concentrates, row 34, before it becomes a feeder calf ready

	Rows		1 CC1	2 CC2	3 TST1,1	4 TST1,2	5 TST2,1	6 TST2,2	7 SG1	8 SG2	9 TF1,1	10 TF1,2	11 TF2,1	12 TF2,2	13 F1	14 F2	15 TFC1,1	16 TFC1,2	17 TFC2,1	18 TFC2,2	19 KILL1	20 KILL2	21 TM1,1	22 TM1,2	23 TM2,1	24 TM2,2	25 TFG1,1	26 TFG1,2	27 TFG2,1	28 TFG2,2	29 TW1,1	30 TW1,2	31 TW2,1	32 TW2,2	33 AS1	34 AS2	35 AFC1	36 AFC2	37 RHS1
1	COST	N	C	B	A	B	B	A	B	B	A	B	B	A	C	C	B	B	B	B	B	B	A	B	B	A	B	B	B	B	B	B	B	B	A	A	B	B	
2	COW1	L	A																																				F
3	COW2	L		A																																			F
4	SSTOCK1	E	-1		1	1																																	
5	SSTOCK2	E		-1			1	1																															
6	STCCKR1	E			-1		-1		1																														
7	STCCKR2	E				-1		-1		1																													
8	SFCER1	L							-1		1	1																											
9	SFDER2	L								-1			1	1																									
10	FDERR1	E									-1		-1		1																								
11	FDERR2	E										-1		-1		1																							
12	FLCTC1	L													1																						-1		G
13	FLOTC2	L														1																						-1	G
14	SFATC1	L													-1		1	1																					
15	SFATC2	L														-1			1	1																			
16	RFATC1	E															-1		-1		1																		
17	RFATC2	E																-1		-1		1																	
18	KILLC1	L																			1														-1				G
19	KILLC2	L																				1														-1			G
20	SMEAT1	E																			-T		1	1															
21	SMEAT2	E																				-T			1	1													
22	DMEAT1	G																					1		1														G
23	DMEAT2	G																						1		1													G
24	STOKC1	L	B						A																														G
25	STCKC2	L		B						A																													G
26	SFGRA1	L																									1	1											G
27	SFGRA2	L																											1	1									
28	RFGRA1	N																									1		1										
29	RFGRA2	N																										1		1									
30	SWHT1	L																													1	1							G
31	SWFT2	L																															1	1					
32	RWHT1	N																													1		1						
33	RWHT2	N																														1		1					
34	ENGT1	E							B		A		A		C												-1		-1		-1		-1						
35	ENGT2	E								C		A		A		C												-1		-1		-1		-1					
36	WHTC1	L																									-1		-1		1		1						
37	WHTC2	L																										-1		-1		1		1					
38	NKILL1	L																																	1				F
39	NKILL2	L																																		1			F
40	NLCT1	L																																			1		F
41	NLOT2	L																																				1	F

Figure 7. Matrix Format of Transhipment Model

Figure 7 (Continued)

Where

Columns

CC	is	Calf Production
TST	is	Transfer Stockers
SG	is	Stocker Growth
TF	is	Transfer Feeders
F	is	Feeding Activity
TFC	is	Transfer Fat Cattle
KILL	is	Slaughter Activity
TM	is	Transfer Meat
TFG	is	Transfer Feed Grain
TFW	is	Transfer Wheat
AS	is	Acquire New Slaughter
AFC	is	Acquire New Feeding Facilities

Rows

COW	is	Cow Constraint
SSTOCK	is	Supply of Stocker
STOCKR	is	Stockers Received
SFDER	is	Supply of Feeders
FDERR	is	Feeders Received
FLOTC	is	Feedlot Capacity
SFATC	is	Supply of Fat Cattle
RFATC	is	Receive Fat Cattle
KILLC	is	Slaughter Capacity
SMEAT	is	Supply of Meat
DMEAT	is	Demand of Meat
STOCK	is	Grass Capacity
SFGRA	is	Supply of Feed Grains
RFGRA	is	Receive Feed Grains
SWHT	is	Supply of Wheat
RWHT	is	Receive Wheat
ENGT	is	Energy Transfer
WHTC	is	Wheat Control
WKILL	is	New Slaughtering Facilities
NLOT	is	New Feeding Facilities

for shipment to the next activity as shown by the -1 in row eight, column seven. This feeder animal is available for shipment to either region one or region two as shown by the 1's in row eight. For an animal going to region one, a -1 indicates a feeder has been received and available for feeding in the region as shown by the 1 in row 10, column 13. The 1 in row 12 indicates that a unit of the feedlot capacity is utilized to feed this animal. Feeder calves are transformed into fat cattle as represented by the -1 in column 13. To accomplish this, C therm of concentrates are transported to the region.

The animals fattened in region one are available for transfer to region one itself or to region two as the 1's indicate in row 14. For animals shipped to 1 a -1 appears in row 16, column 15. Therefore, this animal becomes available for slaughter in region one as the 1 in row 16, column 19 indicates. To slaughter this animal a unit of slaughter capacity is utilized as shown by 1 in row 18. The -T in row 20 shows that the slaughter animal will produce T among of animal equivalent meat. The 1's in row 20 symbolize that this 1 unit of meat can be transported to either region one or region two. Of the TM 1,1, the 1 in row 22, column 21 indicates a unit of meat is utilized to help fulfill the demand in region one. Activities through column 24 show the steps an animal can go through to fill the demands in rows 22 and 23.

Columns 25 through 31 show the movement of feed concentrates to feed the cattle. For an animal fed in region one, it may pull wheat therms or feed grains therms from region one or region two as shown by the 1's in row 26, column 25; row 27, column 27; row 30, column 29; row 31, column 31. The 1's in row 28 symbolize that feed grain trerms are received in the region while the 1's in row 32 symbolize the receiving of wheat in region one. The -1 and +1 in row 36 limits the feed concentrate ration to a maximum of 50 percent wheat. The -1's in row 34 provides the therm transfer to the region as drawn through by the B, A, or C in the different activities which utilize concentrates.

The last four rows and columns allow for each region to buy new feeding and slaughtering facilities. If region one needs to purchase new slaughter facilities, the 1 in row 38 indicates that 1 unit of new slaughter facilities is being used and made available by the -1 in row 18. Similar discussion may be used for the feeding capacity.

Mathematical Model

The mathematical definition of the production-transhipment model may be stated as follows:

Minimize:

$$(6) \quad A = \sum_i B_{Ki} U_i + \sum_i \sum_j C_{Pij} S_{ij} + \sum_i I_i U_i + \sum_i \sum_j C'_{ij} M_{ij} + \sum_i \sum_j C_{Tij} G_{ij} + \sum_i C_{Zi} Q_i$$

Subject to the contraints,

$$(7) \quad St_i \leq St_i + \Sigma\, St_{ji} - \Sigma\, St_{ij}$$

$$(8) \quad F_i \leq F_i + \Sigma\, F_{ij} - \Sigma\, F_{ij}$$

$$(9) \quad Fa_i \leq Fa_i + \Sigma\, Fa_{ji} - \Sigma\, Fa_{ij}$$

$$(10) \quad FG_i \leq FG_i + \Sigma\, FG_{ji} - \Sigma\, FG_{ij}$$

$$(11) \quad W_i \leq W_i + \Sigma\, W_{ji} - \Sigma\, W_{ij}$$

$$(12) \quad \sum_i FG_{ij} \geq \sum_i W_{ij}$$

$$(13) \quad SC_i \geq \sum_i SA_i$$

(14) $FC_{ij} \geq \sum_i FA_i$

(15) $GC_i \geq \sum_i AUM_i$

(16) $\sum_i DM_i = \sum_i SM_i$

where:

A is the cost of the industry.

K is the kind of production activity.

P is the kind of animal transferred.

T is the kind of grain transferred.

Z is the kind of new facilities acquired.

B_{ki} is the cost of producing K in region i.

C_{pij} is the cost of transporting animal p from i^{th} region to j^{th} destination.

I_i is the cost of slaughtering in region i.

C_{ij} is the cost of transporting carcass meat from region i to region j.

C_{Tij} is the cost of transporting grain T from region i to region j.

N_{Zi} is the cost of acquiring facility Z in region i.

U_i is the quantity of K produced in i.

S_{ij} is the quantity of P shipped from region i to destination j.

U'_j is the number of animals slaughtered in region i.

M_{ij} is the number of carcasses shipped from region i to region j.

G_{ij} is the amount of therms of grain T shipped from region i to region j.

Q_i is the quantity of new facilities built in region i.

St_i is the number of stockers used in region i.

F_i is the number of feeders used in region i.

Fa_i is the number of fat animals used in region i.

FG_i is the quantity of feed grains used in region i.

W_i is the quantity of wheat used in region i.

SC_i is the slaughter capacity of region i.

SA_i is the number of animals slaughtered in region i.

FC_i is the feeding capacity in region i.

FA_i is the number of animals fed in region i.

GC_i is the grazing capacity utilized in region i.

AUM's is the quantity of grazing utilized in region i.

DM_i is the demand for beef in region i.

SM_i is the supply for beef in region i.

Equation 6 is a total beef industry cost function which is to be minimized within the constraints of the model. Equations 7, 8, 9, 10, and 11 are the quantities of factors used in any region and are equal to or less than the resource availability within the region, plus resource inshipments and less resource outshipments. Equation 12 limits the feeding of wheat to one-half the energy of the total ration fed in any region.[26] The capacity restraints are shown in equations 13, 14, and 15. Equation 16 requires that the supply of beef in each region be equal to the final consumption.

Assumptions made to allow a workable model were:

(1) Production and consumption are assumed to take place at particular points in each region.

(2) Quantities of resources supplied in each region and of beef demanded are preassigned.

(3) Only that quantity of beef required for meeting total consumption needs is moved through the system.

(4) Resources available in any region can be used in any other region, i.e., resource homogeneity is assumed.

(5) Feed grains and wheat are measured in therms, and a therm of any grain is perfectly substitutable for a therm of any other grain.

Alternative Versions of the Model Used In the Study

The analysis of the location of beef enterprise from a complete systems approach is based on the model previously described with some versions that differ as to constraints and beef demand projections. These models may be described briefly as follows:

Model I: The supply of intermediate products of feed grain and wheat are given. Constraints on the numbers of cows available, feedlot capacity, grazing capacity, and slaughter capacity which various regions face at the present time are used. Feeding efficiency for each region is assumed to be the same; therefore, the same number of therms required to finish an animal will be the same for all regions. Transfer functions are specified for the intermediate products and for dressed meat using the least cost mode of truck, rail, barge, or combination of modes. Costs of the various activities differ among regions due to the difference in cash costs of operation. Prices of concentrates differ among regions depending on the price received by farmers. Each region has the opportunity of purchasing new feeding and slaughter facilities. The demand for beef relates to the quantity of fed beef demanded to price and income differentials of the region.

Model II: Differs from Model I in that available slaughter and feeding constraints were removed from the model. Each region had to purchase and operate the facilities as they were used.

Model III: Differs from Model I in that each region has the opportunity to purchase additional grazing capacity. Cow numbers were removed as a constraint in the model. Demand for fed beef were increased in each region based on their projected increase in population and income.

Model IV: Differs from Model I the same as Model III except the demand is projected to 1980 consumption.

The production-transhipment programming method offers the following information:

1. Optimum locations of cow herds, stocker operations, feeding activity, slaughter activity, and the optimum combinations of wheat and feed grains used in fattening rations in the various regions.

2. Optimum shipment patterns for stockers, feeders, and feed grains.

3. Optimum shipment patterns for carcass beef.

Further, the costs associated with introducing activities not in the optimum solution are obtained. An analysis of the results of the four major models are presented in Chapters IV and V following a discussion of the data required for the model.

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CHAPTER III

DATA NEEDS IN RELATIONS TO THE ANALYTICAL MODEL

The massive data needs for this study were obtained primarily from secondary sources. Some basic data were obtained from surveys of representative feedlots throughout the United States, and transportation rates were obtained through the cooperation of railroads, grain companies, national marketing associations, food processing companies, and trucking firms.

Regional Demarcation

This study encompasses the forty-eight contiguous states. The regional demarcations were made on the basis of similarity of operations for the different segments of the industry. States are generally the smallest entity for which data are available. However, through the use of state reporting services, most states have information available on a smaller scale. In this study, Kansas and Nebraska have been internally divided because of structural differences in the beef industry between the western and eastern limits of the states.

Fourteen separate regions were defined as shown in Figure 8. The same regional demarcations are used for cattle production, feeding activities, and consumption. Regional production and consumption are assumed to center around particular points within each region. Major population centers within the demarcated regions were used as

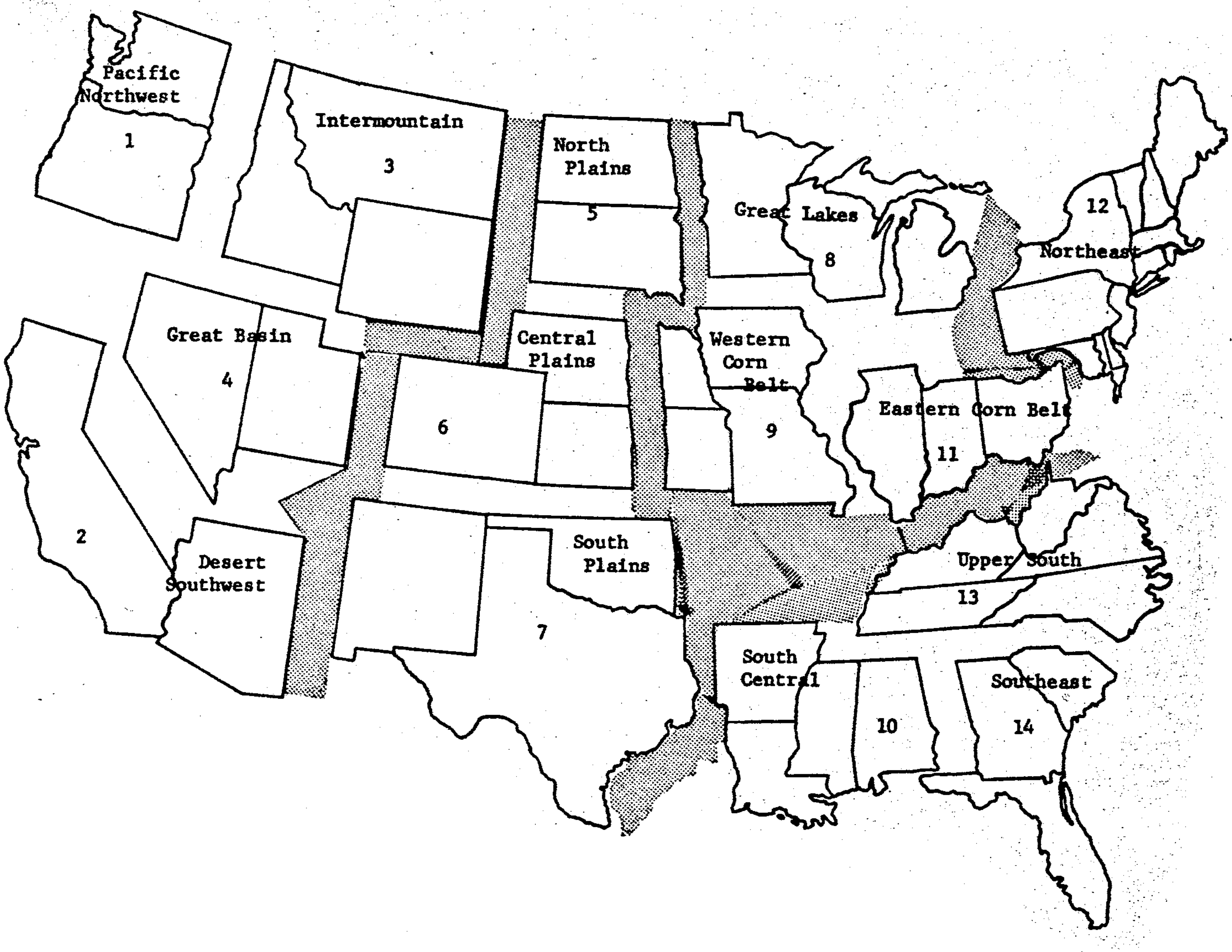

Figure 8. Regional Demarcation of the United States

consumption points to make the model more realistic. Production points were designated largely on the basis of proximity to the feed grain production within the regions. Grain was assumed to originate at the same points as was fed cattle production. Production points (origins) and consumption points (destinations) are shown in Table I.

Regional Constraints

Cow Herds

Cow herds were taken as given in the regions. An average number of beef cows for the years 1968, 1969, and 1970 were used to indicate the number of cows available.[1] The average of this three year period was used to soften the impact of an unusual condition that might exist within any given region at any one point in time. Further, one-half of the dairy cows for this time period were treated as beef cows, their calves being assumed to be available for feeding use. As an indication of the calving rates, calves born as a percent of cows and heifers two years and older were used.[2] The percentage of calves born were used to ascertain the number of cows required to produce a living calf. Only those animals which competed for the available resources were allowed to move through the model. Calves were assumed to be homogenous in quality and weight. While the quality of animals may vary both within and among areas, the data are not available to quantify this quality differential. Therefore, the model was designed under the assumption each region would be able to supply any other region. The number of cows regionally available are shown in Table II.

TABLE I

REGIONAL BASING POINTS FOR BEEF PRODUCTION AND CONSUMPTION

Region		States Included	Origin	Consumption
1	Pacific Northwest	Washington, Oregon	Portland	Portland
2	Desert Southwest	California, Arizona	Brawley	Los Angeles
3	Intermountains	Montana, Wyoming, Idaho	Helena, Montana	Helena, Montana
4	Great Basin	Utah, Nevada	Wells, Nevada	Salt Lake City
5	North Plains	North Dakota, South Dakota	Aberdeen, S. Dakota	Sioux Falls, S.D.
6	Central Plains	Colorado, West Nebraska, West Kansas	Holyoke, Colorado	Denver
7	South Plains	Oklahoma, Texas, New Mexico	Guymon, Oklahoma	Dallas
8	Lake States	Wisconsin, Michigan, Minnesota	St. Paul	St. Paul
9	Western Corn Belt	Iowa, Missouri, East Nebraska, East Kansas	Omaha	Omaha
10	South Central	Arkansas, Louisiana, Mississippi, Alabama	Jackson, Mississippi	New Orleans
11	Eastern Corn Belt	Illinois, Indiana, Ohio	Fort Wayne, Indiana	Chicago
12	Northeast	New England, New York, Pennsylvania, Maryland, New Jersey, Delaware	Albany	New York City
13	Upper South	West Virginia, Virginia, Kentucky, Tennessee, North Carolina	Knoxville	Richmond, Virginia
14	Southeast	South Carolina, Georgia, Florida	Thomasville, Georgia	Atlanta

TABLE II

ESTIMATED SUPPLY OF COWS BY REGIONS

Region		Number of Cows ('000 head)
1	Pacific Northwest	1217
2	Desert Southwest	1613
3	Intermountains	3032
4	Great Basin	647
5	North Plains	2865
6	Central Plains	3772
7	South Plains	8910
8	Lake States	2737
9	Western Corn Belt	5640
10	South Central	4383
11	Eastern Corn Belt	2104
12	Northeast	1616
13	Upper South	3745
14	Southeast	2218
	Total	44449

Feedlot Capacity

There are no published data giving the feeding capacities of individual states. Regional feeding capacity was estimated by adding the largest quarterly totals for each of the four quarters during the 1968-1970 period.[3] That is, the largest of the first quarter placements during this period was added to the largest of the second quarter placements, etc. This procedure gave an indication of the annual feeding capacity available in each region. The procedure does, perhaps, underestimate the feeding capacity in areas that do not typically feed cattle the year around. However, the structure of the feeding industry in these regions is such that any other method of estimation based on available data would most likely overstate the feeding potential.

Quarterly placement data were not available for states in the South Central, Northeastern, Upper South and Southeastern regions (Regions 10, 12, 13 and 14). Feedlot capacity was estimated for these regions by using the numbers of cattle on feed January 1 and July 1. This procedure most likely tends to underestimate the total feeding capacity since cattle are not likely to be on feed for a full 180 days. However, these regions have not historically put many resources into feeding and are unlikely to do so unless substantial increases in grain production occur. Therefore, any errors that result from this assumption are likely to be small. The estimated annual feeding capacity by regions is shown in Table III.

TABLE III

ESTIMATED FEEDLOT CAPACITY BY REGIONS

Region		Level of Capacity (000 head)
1	Pacific Northwest	548
2	Desert Southwest	3064
3	Intermountains	720
4	Great Basin	157
5	North Plains	776
6	Central Plains	4247
7	South Plains	3964
8	Lake States	1540
9	Western Corn Belt	8675
10	South Central	191
11	Eastern Corn Belt	2332
12	Northeast	149
13	Upper South	195
14	Southeast	212
	Total	26770

Slaughter Capacity

Even though the total numbers of cattle slaughtered (including both cow slaughter and steer and heifer slaughter) are reported monthly by states, the slaughter capacity for individual states is not reported as such. To estimate the total cattle slaughter capacity, the largest total monthly slaughter of cattle, both federally inspected and non-federally inspected for the years of 1968, 1969, and 1970, was multiplied by twelve.[4] Although this may underestimate the total United States potential slaughter capacity since numerous plants that were closed during the 1968-1970 period might potentially be reopened, the procedure does yield an estimate of the maximum capacity effectively available in any given locale.

The slaughter capacity estimate for any given region includes the capacity available for processing both fed cattle and cull cows. A method separating the two forms of slaughter was devised since cow beef and fed beef are really different products. Cows were assumed to be slaughtered within the region in which they originate. The regional estimates of cow slaughter were based on the proportion of total cows two years old and older that were present in each region. For example, if a region had 12 percent of the total cow population of the United States, that region was assumed to slaughter 12 percent of the cows which were slaughtered during the base period. The estimate of regional cow slaughter was deducted from the original estimate of regional slaughter capacity. The resulting difference was defined to be the regional capacity for steer and heifer slaughter or for the slaughter of cattle coming from feedlots. The estimated total slaughter capacity for each region is shown in Table IV.

TABLE IV

ESTIMATED SLAUGHTERING CAPACITY FOR STEERS AND HEIFERS BY REGIONS

Region		Estimated Slaughtering Capacity (000 head)
1	Pacific Northwest	952
2	Desert Southwest	3774
3	Intermountains	277
4	Great Basin	226
5	North Plains	549
6	Central Plains	4224
7	South Plains	3289
8	Lake States	3766
9	Western Corn Belt	8402
10	South Central	441
11	Eastern Corn Belt	3043
12	Northeast	1608
13	Upper South	876
14	Southeast	539

Demand for Meat

Various analysts have estimated regional consumption patterns using one of three general approaches:

1. Use of consumer panels.
2. Use of household consumption reports.
3. Estimation of some regional mathematical function.

The major problem encountered in any estimation of regional beef demand is the lack of data concerning regional beef consumption.

The demand for any product reflects the influences of consumer income, the commodity price, and prices for substitute goods. Built into these are consumer tastes and preferences for the particular commodity. Population is the key variable in the aggregation of the demand for the commodity.

Goodwin and Andorn have shown that the demand for beef tends to be an irreversible function.[5] This concept suggests that consumers exhibit one pattern of behavior under a given set of conditions which prevails for some period of time, and then change their behavior when circumstances change. When the consumers are again confronted with conditions approximating those they originally faced, their behavior differs from that exhibited during the initial period. This suggests that beef consumption depends not only upon the price of beef, income, and prices for substitute goods, but also upon the level of beef consumption to which consumers are accustomed. For example, a consumer with an income of $4,000 per year will form a certain behavorial pattern spending perhaps $3,000 on consumption. If his income rises to $5,000 per year and remains at this level long enough for him to adjust his consumption pattern, he will behave differently and spend, say $4,000 on consumption.

If his income should return to \$4,000, rather than his consumption expenditure returning to \$3,000 it would stay at some higher level of perhaps \$3,500. Thus, his reaction is irreversible--that is, he does not return to his original point. Based on the hypothesis of an irreversible demand, a model was developed to measure the effects of not only prices and income but also the lagged effects during periods of increasing and decreasing consumption periods. The estimated income and price elasticities from this model were used in calculating the regional consumption estimates.[6]

To estimate the regional consumption, the following equation was used.

$$(1) \quad C_i = Z_K + Z_K (I_E)(\Delta I_i) + Z_K (P_E)(\Delta P_B i) + Z_K (P_X)(\Delta P_X i)$$

where

C_i = consumption in region i.

Z_K = national average per capital consumption.

I_E = elasticity of demand for beef with respect to income.

ΔI_i = the percentage difference in per capita disposable income in region i and the national average per capita disposable income.

P_E = elasticity of demand for beef with respect to beef price.

$\Delta P_B i$ = the percentage difference in the retail price of beef in region i and the national average price.

P_X = cross-price elasticity of demand for beef with respect to the price of pork.

$\Delta P_X i$ = percentage difference in average price of pork in region i and the national average pork prices.

The equation estimates regional beef consumption in pounds per capita. Since the resulting value contains both cow beef and steer and heifer beef, adjustments were necessary to get an estimate of the beef consumption which actually comes from grain finished cattle.

To adjust the total meat consumption for non-fed beef, the 1965 Household Consumption Report* estimates were adjusted based upon the increased consumption of "lesser meats" between 1965 and 1970. Since the lesser meats can come from both cows and fed beef, it was calculated that 64 percent of all lesser meats come from cows and imports.** This percentage was applied to the adjusted consumption estimates derived from the 1965 Household Consumption Report to obtain an estimation of cow and import meat consumption for the four regions reported. Final results were that the West consumed 35.38 pounds, South 33.03 pounds, North Central 41.45 pounds, and the Northeast 25.23 pounds of cow and import meats per capita. These values were distributed to the fourteen regions of this study depending upon which of the four regions reported in the 1965 Household Consumption Report included the region in question. Subtracting the per capita consumption of lesser beef from the per capita consumption of total beef consumption as estimated by equation 1 yielded an estimate of grain finished steer and heifer beef. These regional consumption estimates are shown in Figure 9.

Grazing Capacity

The proximity of grazing to the other resources necessary for cycling beef through the system plays an important part in determining the size of the beef industry in a state or region. Grass may be

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*The 1965 Household Consumption Report lists consumption for four general regions: West, South, Northeast, North Central.[7]

**Through information provided in Livestock and Meat Statistics, the portions of beef consumption made up of cows, imports, fed beef and calves were calculated. Considering cows, imports and hamburger meat from steers as lesser meats, it was calculated that 64 percent of this meat was from cows and imports.

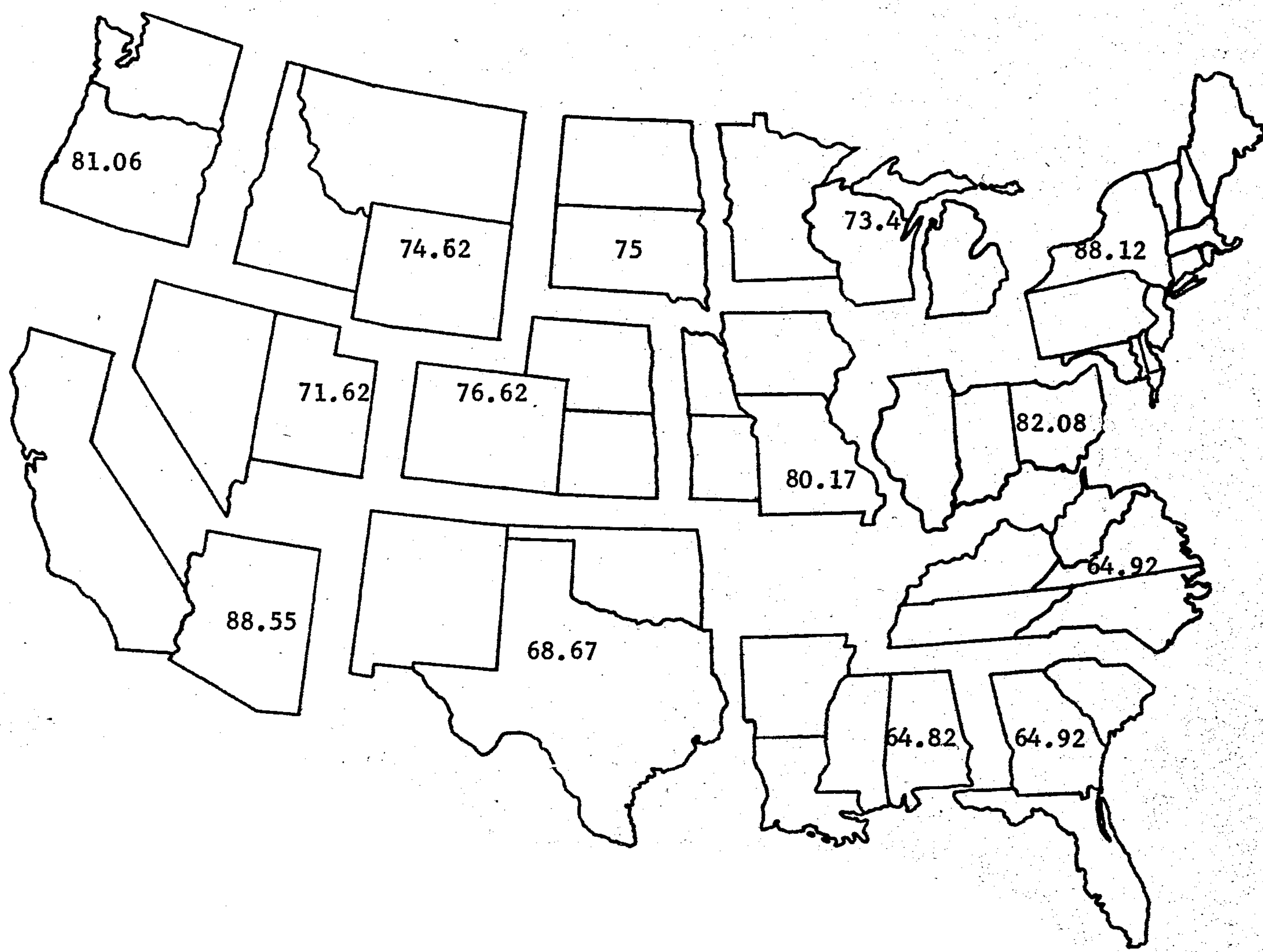

Figure 9. Estimated Annual Consumption of Fed Beef by Regions

utilized by either the cow herds or by stockers depending on the other conditions in the system.

A 1955 U.S.D.A. study reporting the available AUM's* of grazing on permanent pasture for each state provided the basis for defining the regional grazing potential.[8] Data from the 1955 study were increased for permanent pasture improvement brought about through the cooperative efforts of the Soil Conservation Service.[9] Published research results suggest that pasture improvement increases carrying capacity by about half.[10] Further information from the 1964 Census of Agriculture was used to determine the acreage of cropland converted to pasture.[11] Also, temporary pasture from small grain and feed grain stubble was included in the estimates of pasture availability.[12] The total regional availability of grazing was generated, converting acreages to AUM's, through the use of estimated pasture carrying capacity for various types of pasture.[13] For the different operations a cow-calf operation was defined to require thirteen AUM's of grazing per cow unit, while a stocker animal required six AUM's.[14]

Feed Grain Availability

Feed grains are defined to be corn, grain sorghum, barley and oats. The net-energy values of livestock feeds in therms from these grains were assumed to be perfect substitutes for each other.

All states produce some combination of these four grains. Some feed grains are used in manufacturing and some are exported. The

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*An AUM (animal unit month) is defined to be roughly equivalent to 450 pounds of total digestible nutrients, i.e., the grazing necessary to maintain a 1,000 pound cow and her calf for a period of one month.

manufactured and exported feed grains as well as those used for seed were withheld from the feed grain supply, with the residual feed grains defined to be available for livestock feed.

Total feed grain availability was estimated by averaging the production of each grain for the 1968, 1969, and 1970 crop years in each state, and then aggregating these estimates for the various regions.[15] The quantities of feed grains used in industrial manufacturing were not available from published sources. However, Leath estimated industrial use of feed grains for 1967.[16] Since the per capita consumption of these products has not changed significantly the last three years,[17] Leath's estimate of feed grains required for manufacturing were used in this work.

The grain exported from the separate regions to foreign destinations was also taken into account. Using the U.S.D.A. estimates of total value of feed grains exported by states in 1968,[18] bushels of grain exported could be ascertained. By incorporating the optimal exporting flows for fed grain from Leath's work and the actual grain cleared for export through the various ports,[19] estimates of grain exported to foreign markets from different regions were obtained. For example, if Oklahoma has $1,000,000 of feed grain export sales, it was defined to be milo. Milo was the feed grain cleared through the Houston port and Leath's work showed that milo flowed from Oklahoma to the Houston port. The million dollars were then converted to bushels of milo by dividing by the price of milo at the Houston port.

Seed use was determined by multiplying the acreage planted by the seeding rates.[20]

For purposes of this study, it was assumed that cattle would use only residual feed grains. Grain required for other livestock was estimated and withheld.[21] Implicit in the procedure is the assumption that the marginal value product for grain used in other livestock alternatives is greater than that used in cattle feeding. Though this assumption may be somewhat at variance with the facts, the assumption does permit the examination of the beef enterprise assuming all other livestock enterprises to be in equilibrium. The feed grains available for beef feeding were converted to therms using 48 therms per bushel of wheat, 44.868 therms per bushel of corn, 43.568 therms per bushel of milo, 22.024 therms per bushel of oats and 33.84 therms per bushel of barley.[22] Regional availability of feed grains is found in Table V.

Availability of Wheat

Wheat has become a major source of feed for livestock, especially in the High Plains. With the decline in wheat prices, livestock feeders have found it profitable to substitute wheat for feed grains, particularly during the summer and early fall. Research has shown that cattle perform well so long as wheat constitutes no more than half the concentrates in the ration.[23] The feeding activities in this model permit wheat to be used for meeting up to half of the concentrate requirements in any feeding enterprise.

The availability of feed wheat was calculated in a fashion similar to that used for feed grains. The exceptions were (1) no allowance was made for exports, and (2) no allowance was made for use in feeding other livestock. Industrial and human consumption use were withheld.[24] The volume of wheat which can be profitably used in cattle feeding is a

TABLE V

ESTIMATED THERMS OF FEED GRAINS AVAILABLE IN EACH REGION

Region		Therms Available Before Other Livestock Feed Is Removed	Therms Available After Other Livestock Feed Is Removed
		(000 therms)	(000 therms)
1	Pacific Northwest	1,041,719	-0-
2	Desert Southwest	3,799,917	-0-
3	Intermountains	3,366,052	1,233,282
4	Great Basin	280,236	11,820
5	North Plains	11,940,612	5,583,110
6	Central Plains	13,483,698	8,595,874
7	South Plains	13,030,881	5,399,631
8	Lake States	31,119,417	7,756,365
9	Western Corn Belt	53,823,424	25,012,296
10	South Central	1,694,512	-0-
11	Eastern Corn Belt	47,767,437	22,052,828
12	Northeast	6,467,121	-0-
13	Upper South	6,136,578	-0-
14	Southeast	2,571,087	-0-

question of prime concern in the high-risk farming areas of the Plains. Wheat exports were not reserved in order to permit each region to use its wheat for cattle feeding if wheat feeding was profitable since the trend of wheat exports has been consistently downward since 1965.[25] The therms available from wheat for each region are shown in Table VI.

Availability of Roughage

It was determined that roughage would not play a major role in determining the competitive position of any regions. If other necessary resources were regionally available for cattle feeding, the acquisition of roughage was no real problem. Therefore, for the purpose of this study, roughage for feeding was assumed to be unlimited.

Regional Production and Processing Activities

The costs involved in the production and processing activities in the beef industry are those costs associated with stocker growth, cattle feeding activities, and cattle slaughter. These costs vary between regions due to technology, labor costs, the size of operation, and climatic conditions.

Cow-Calf

Beef cow herds are found throughout the United States. In recent years, the cow herds have made the greatest growth in the South and South Plains (see Figure 2 in Chapter I). Since calf production is the basis of the whole beef industry, the location of cow herds potentially plays a large role in the beef system. For this reason, a cow-calf production activity was used in this study.

TABLE VI

ESTIMATED THERMS OF WHEAT AVAILABLE FOR LIVESTOCK FEED BY REGIONS

Region		Therms
		(000 therms)
1	Pacific Northwest	5,674,656
2	Desert Southwest	35,472
3	Intermountains	6,459,696
4	Great Basin	80,400
5	North Plains	10,900,896
6	Central Plains	15,556,224
7	South Plains	8,241,072
8	Lake States	1,009,392
9	Western Corn Belt	47,760
10	South Central	2,896,176
11	Eastern Corn Belt	-0-
12	Northeast	445,056
13	Upper South	-0-
14	Southeast	-0-

The data for this activity was obtained from work completed at Oklahoma State University by Bowser and Goodwin.[26] Their work contained cash cost data for cow enterprises located throughout the United States. These cash cost values were inflated by the index of prices paid by farmers and used in this work.[27] The regional cost estimates for the cow-calf enterprises are shown in Table VII.

Stocker Growth

The stocker growth activity involves growing an animal from 400 to 600 pounds. As with the cow-calf activity, cash costs were the only costs calculated for the stocker growing activity. Among these costs were protein supplement, veterinary expenses, roughage expenses, taxes on cattle, interests on cattle, grain, mineral-salt, miscellaneous costs and death losses. Land cost was not included since the livestock enterprises cannot be charged for the externalities which are typically included in land values. For example, land in California or Florida has speculative value due to the limited land and a large demand for urban and recreational uses. Land in the South Plains and Central Plains frequently has an undeveloped mineral potential that increases its cost. Incorporating these values into a land charge for livestock production burdens the livestock enterprise with a much greater liability than that enterprise could fairly be expected to pay. Since the return to land is normally a residual after all other costs have been paid, the exclusion of a land charge in this analysis should create no problems in the validity of the results. The regional costs for growing stocker cattle were derived from the most recent State Experiment Station publications available.[28] For these studies published prior to

TABLE VII

ESTIMATED NON-LAND COSTS OF
COW-CALF OPERATIONS

Region		Cost/Cow
1	Pacific Northwest	$ 28.13
2	Desert Southwest	21.36
3	Intermountains	11.58
4	Great Basin	18.45
5	North Plains	14.34
6	Central Plains	16.17
7	South Plains	13.41
8	Lake States	20.12
9	Western Corn Belt	22.54
10	South Central	21.28
11	Eastern Corn Belt	25.08
12	Northeast	25.08
13	Upper South	22.65
14	Southeast	21.28

1970, the cost estimates were inflated by the Index or Prices Paid by Farmers.[29] The regional cost estimates for growing stockers are shown in Table VIII.

Feeder Activity

Since World War II the average quality of beef consumed has steadily increased.[30] Increasing population, increasing consumer incomes plus a taste for beef have generated the price relationships that have provided the incentive for increased beef production. The increased total beef production has necessitated a change in the way beef is produced. The available grazing has come to be utilized primarily by cow herds to provide the basic beef production input of stocker calves. Stocker growing has been accomplished through increased utilization of forage crops and grain finishing of feeder cattle. The demand for cattle feeding facilities has expanded enormously in order to meet this new demand for beef. Some regions have gone to the large commercial lots--some of which have as much as 100,000 head one-time capacity. Other regions have maintained a smaller lot size--normally as parts of general farming enterprises.

For the feeding activities, three major costs are involved. These costs include (1) non-feed costs, (2) feed grain costs, and (3) roughage costs. Roughage costs are not considered in this study. Each region is assumed to be feeding a homogeneous feeder from the weight of 600 to 1,100 pounds. That is, each animal is expected to gain 500 pounds in the feedlot.

Non-feed costs include costs for depreciation, labor, management, office expense, veterinary expenses, interest on cattle, interest on

TABLE VIII

PARTIAL COSTS OF GROWING STOCKERS

Region		Cost/Head
1	Pacific Northwest	$ 30.00
2	Desert Southwest	30.00
3	Intermountains	23.20
4	Great Basin	23.20
5	North Plains	17.80
6	Central Plains	22.00
7	South Plains	16.20
8	Lake States	26.00
9	Western Corn Belt	25.60
10	South Central	16.80
11	Eastern Corn Belt	36.00
12	Northeast	26.00
13	Upper South	21.80
14	Southeast	16.32

working capital, taxes on cattle and miscellaneous costs. Each region must pay this expense for the full 500 pounds of gain if they feed. No provisions are made for feeding to weights other than 1,100 pounds. The data with regard to feeding costs were obtained from State Experiment State publications listed in the Bibliography. Data were inflated to 1970 standards by the Index of Prices Paid by Farmers.[31] Regional non-feed costs are shown in Table IX.

Feed costs per pound of gain depend upon the level of efficiency and the cost for feed grains in each region. Four levels of efficiency were considered in this study. Gains of 2, 2.5, 3, and 3.4 pounds of gain per day were used. The therm requirement for each rate of gain was obtained from nutritional research conducted at Oklahoma State University.[32] For the rations, concentrates were assumed to make up 70 percent, 75 percent, 80 percent, and 85 percent of the rations yielding daily gains of 2, 2.5, 3, and 3.4 pounds per day.

Each region was allowed to purchase its feed concentrates from any other region. These concentrates could be made up of either feed grains or wheat. Feed concentrates were priced in cents per therm, f.o.b. point of origin, using the weighted average price received by farmers for the 1968, 1969, and 1970 crop years.[33] If grain was moved from one region to another for feeding, the cost of using that grain included the price at point of origin plus the cost of transportation and handling. Prices for feed grains and wheat, free of transportation costs, are shown in Table X.

TABLE IX

NON-FEED COSTS FOR FEEDING ACTIVITY

Region		Costs ($ for 500 lb. gain)
1	Pacific Northwest	$ 26.75
2	Desert Southwest	21.94
3	Intermountains	26.75
4	Great Basin	26.75
5	North Plains	27.29
6	Central Plains	21.40
7	South Plains	21.40
8	Lake States	48.15
9	Western Corn Belt	32.10
10	South Central	27.29
11	Eastern Corn Belt	37.45
*12	Northeast	37.45
13	Upper South	26.75
*14	Southeast	26.75

*Values of nearest region of same general characteristic were used because no actual costs were located.

TABLE X

COSTS OF FEED GRAINS AND WHEAT, FREE OF TRANSPORTATION COSTS BY REGION IN CENTS PER THERM

Region		Cost per Therm of Feed Grain	Cost per Therm of Wheat
1	Pacific Northwest	.029	.0282
2	Desert Southwest	.0325	.0294
3	Intermountains	.0243	.0257
4	Great Basin	.0315	.0275
5	North Plains	.024	.0294
6	Central Plains	.0245	.0253
7	South Plains	.0249	.0263
8	Lake States	.0257	.0279
9	Western Corn Belt	.0256	.0253
10	South Central	.0316	.0247
11	Eastern Corn Belt	.0267	.0256
12	Northeast	.031	.0259
13	Upper South	.029	.0264
14	Southeast	.03	.0262

Slaughter Activity

Cost information for the beef slaughter activity was taken from a forthcoming Southern Cooperative Series publication.[34] Slaughter costs include (1) wages and salaries, (2) annual investment allowances, (3) utilities. From the regions defined in the Southern Cooperative study, the points nearest the production origins used in this study were used. The regional costs specified in Table XI are the costs associated with slaughtering an eleven hundred pound animal.

Transportation Charges

The largest data class for this problem was transportation costs. Transportation costs required were (1) transportation costs for shipment of feed grains, (2) transportation costs for shipment of wheat, (3) transportation costs for shipment of stocker cattle, (4) transportation costs for shipment of feeder cattle, (5) transportation costs for shipment of fat cattle, and (6) transportation costs for shipment of carcass beef. In each case both rail and truck rates were considered. Where applicable, barge rates were also considered in moving grain.[35] Point-to-point rates were obtained for all modes of transportation except the truck movement of grain. A functional relationship was utilized in the case of truck movement.[36]

Shipment of Cattle

In each case, the rates used for transporting cattle included the total cost of moving one complete animal. Shrinkage costs were incorporated into the movement of animals by charging the cost for bringing the animal back to the original weight.[37] For example, a 400 pound

TABLE XI

COSTS OF SLAUGHTERING AN 1100 POUND ANIMAL

Region		Cost/Head
1	Pacific Northwest	$ 11.66
2	Desert Southwest	12.43
3	Intermountains	10.89
4	Great Basin	11.99
5	North Plains	11.77
6	Central Plains	12.21
7	South Plains	10.67
8	Lake States	13.20
9	Western Corn Belt	12.76
10	South Central	10.34
11	Eastern Corn Belt	11.77
12	Northeast	9.46
13	Upper South	9.68
14	Southeast	10.34

Source: Irving Dubov, University of Tennessee, Knoxville, Tennessee, Southern Cooperative Publication in process.

stocker calf transported for 100 miles was charged a three percent shrinkage loss. The cost of putting the 12 pounds back on the animal was charged the region to which he was shipped along with the cost of transportation. Each animal in the system was assumed to be of uniform weight. Stocker cattle were assumed to weigh 400 pounds, feeder cattle were assumed to weigh 600 pounds, and fat cattle were assumed to weigh 1,100 pounds. The appropriate shrinkage charges are found in Table XII.

For the movement of stocker calves, point-to-point movement was assumed except in the case of the South Plains region. McAlester, Oklahoma, was used as the origin of stocker calves while Vernon, Texas, was used as the receiving point. This was done for two reasons: (1) the geographically disparate distributions of different types of cattle operations in the various regions, and (2) the very large distances potentially involved in moving cattle within this region.

The transportation charges for the movement of each class of cattle are found in Tables XIII, XIV, and XV. These costs represent the minimum costs of shipping cattle by truck or railroad modes.

Transfer of Grain

Truck rates, rail rates, and barge rates were all considered in this study. Actual rates between points were collected for rail and barge movement. These were furnished by railroad and barge companies and contain the most recent rail rate increases of January, 1971.

Truck rates used were estimated through regression analysis by the Texas Transportation Institute and Marketing Economics Division of ERS.[36] The functional equations estimating truck rates for wheat, corn, oats, barley and sorghum are presented below.

TABLE XII

SHRINKAGE OF FEEDER AND FAT CATTLE AS RELATED TO HOURS IN TRANSIT

Hours in Transit	Fat Cattle			Feeder Cattle			Average All Cattle		
	No. of Shipments	No. of Head	Percent Shrink	No. of Shipments	No. of Head	Percent Shrink	No. of Shipments	No. of Head	Percent Shrink
1 Hour	7	615	1.70	11	563	1.85	18	1,178	1.77
2 Hours	24	1,138	4.24	23	2,261	3.74	47	3,399	3.95
3 Hours	42	1,415	4.98	16	1,733	3.57	58	3,148	4.33
4-6 Hours	24	1,001	5.42	23	1,496	3.77	47	2,497	4.66
7-9 Hours	50	2,132	5.81	12	1,735	5.98	62	3,867	5.90
10-17 Hours	852	29,769	6.20	27	1,983	8.20	879	31,752	6.27
18-35 Hours**	97	5,531	9.63	80	12,702	7.18	177	18,233	8.08
36-59 Hours**	85	3,610	7.53	93	9,180	10.14	178	12,790	9.18
60-83 Hours	39	2,470	8.60	66	8,540	10.44	105	11,010	9.91
84 Hours and over	22	1,078	10.81	82	12,970	12.44	104	14,048	11.99

**Feed, water, and rest period during journey.

Source: Neff Tippets, Ira M. Stevens, C. B. Brotherton, and Harold Abel, In-Transit Shrinkages of Cattle, Mimeograph Circular No. 78, Agricultural Experiment Station, University of Wyoming, February, 1957.

TABLE XIII

MINIMUM COST IN SHIPPING 400 POUND STOCKER CALVES IN DOLLARS PER HEAD BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-	7.62	5.86	3.98	8.52[R]	8.68[R]	10.24	9.12[R]	9.76[R]	13.92[R]	14.00[R]	18.64[R]	16.00[R]	16.16[R]
2	7.62	-	10.43	4.65	9.80	8.28	5.91	10.16	8.84	None	None	None	None	None
3	5.86	10.43	-	4.01	4.27	4.08	7.08	5.04	5.33	None	None	None	None	None
4	3.98	4.65	4.01	-	7.59	5.65	7.60	8.24[R]	7.40[R]	None	11.06	None	None	None
5	8.52[R]	9.80	4.27	7.59	-	3.12	5.68	1.44	2.19	None	4.91	9.10	None	None
6	8.68[R]	8.28	4.09	5.65	3.12	-	5.04[R]	4.12	2.16	None	6.05	10.28	None	None
7	10.63	7.69	7.48[R]	8.52[R]	5.57	5.04[R]	1.54	5.20	3.63	3.04	5.51	10.27	5.70	6.76
8	9.12[R]	10.16[R]	5.04	8.24[R]	1.44	4.12	4.54	-	2.28	6.69	3.69	7.88	5.39	8.24
9	9.76[R]	8.84[R]	5.33	7.40[R]	2.19	2.16	2.70	2.28	-	5.52	3.86	8.34	6.02	7.82
10	14.00[R]	9.11	11.00[R]	11.74	7.80	7.60	4.14	6.69	5.52	-	4.86	8.20	3.81	2.68
11	14.00[R]	13.40[R]	11.00[R]	11.06	4.91	6.05	6.87	3.69	3.86	4.86	-	4.49	1.30	5.22
12	18.64[R]	18.00[R]	12.99	15.55	9.10	10.28	11.66	7.88	8.34	8.20[R]	4.49	-	4.76[R]	6.97
13	16.00[R]	12.75	11.59	12.98	8.38	8.62	7.00	5.39	6.02	3.81	1.30	4.76[R]	-	3.00
14	16.16[R]	13.32[R]	12.68[R]	13.92[R]	10.16	9.96[R]	6.74	8.24	7.82	2.68	5.22	6.97	3.00	-

[a]R denotes rail rates; others are truck rates.
[b]None designates that these shipments were assumed not to exist.

TABLE XIV

MINIMUM COST FOR TRANSPORTING 600 POUND FEEDER CATTLE IN DOLLARS PER HEAD BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		11.48	8.83	6.00	12.78[R]	13.02[R]	15.36[R]	13.68[R]	14.64[R]	20.88[R]	21.00[R]	27.96[R]	24.00[R]	24.24[R]
2			15.72	7.01	16.70[R]	12.42[R]	16.80[R]	15.24[R]	13.26[R]	15.60[R]	20.10[R]	27.00[R]	19.22[R]	19.98[R]
3				6.04	6.43	6.16	8.94	7.59	8.03	15.36[R]	12.25	19.57	17.47	19.02[R]
4					11.44	8.51	10.14	12.36[R]	11.10	17.04[R]	16.67	23.43	19.55	20.88[R]
5						7.14[R]	8.40	2.17	3.30	12.06	7.39	13.71	12.62	15.30
6					4.70		3.69	6.20	3.26	11.34	9.11	15.49	13.0	14.94
7		8.90				7.56	0	6.85	4.07	6.23	13.0	17.57	10.65	10.15
8							7.83		3.44	10.08	5.56	11.88	8.12	12.42
9							4.51			8.32	5.81	12.57	9.07	11.78
10		13.72	14.94[R]	16.74[R]			7.76				7.32	12.30	5.73	4.04
11	19.86[R]	19.20[R]					10.52					6.76	1.97	7.86
12	25.32[R]	23.88[R]	19.38[R]	22.44[R]			17.66						7.96	10.51
13	23.58[R]			19.44[R]			10.81							4.57
14			18.66[R]	20.52[R]			12.61							

[a]R denotes rail rates; others are truck rates.
[b]Costs from region 7 were from Vernon, Texas, while costs "in" were to Guymon, Oklahoma.
[c]Blank spots mean that the costs are the same as the above diagonal.
[d]Some costs differ to and from regions because of rail rate structures.

TABLE XV

MINIMUM COST FOR TRANSPORTING 1100 POUND SLAUGHTER CATTLE IN DOLLARS PER HEAD BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-	20.95	16.12	10.96	26.92	25.97	29.23	29.37[R]	29.75	43.19	40.30	None	None	None
2	20.95	-	28.68	12.79	30.15	23.73	22.44[R]	32.78[R]	28.49[R]	None	None	None	None	None
3	16.12	28.68	-	11.03	11.74	11.24	16.31	13.86	14.65	None	24.19	None	None	None
4	10.96	12.79	11.03	-	20.88	15.52	18.50	24.71	23.76[R]	None	30.42	None	None	None
5	26.93	30.15	11.74	20.88	-	8.58	15.33	3.96	6.02	None	13.49	25.03	None	None
6	25.97	23.73	11.24	15.52	8.58	-	6.74	11.32	5.95	20.91	16.63	28.26	None	None
7	29.33	23.43	16.31	18.50	15.33	6.74	-	14.30	8.23	14.16	19.20	32.17	19.72	23.01
8	29.75	32.78[R]	13.86	24.71	3.96	11.32	14.30	-	6.28	18.39	10.15	21.68	14.82	22.66
9	29.75	29.21	14.65	26.39	6.02	5.95	8.23	6.28	-	15.19	10.61	22.94	16.56	21.51
10	43.19	19.47[R]	30.40	32.29	22.02	20.91	14.16	18.39	15.19	-	13.35	24.65	10.47	7.37
11	40.30	None	24.19	30.42	13.49	16.63	19.20	10.15	10.61	13.35	-	12.34	3.59	14.35
12	51.81[R]	48.07[R]	35.72	42.75	25.03	28.26	32.17	21.68	22.94	22.55[R]	12.34	-	14.53	19.18
13	45.64	35.07	31.89	35.68	23.03	23.71	19.72	14.82	16.56	10.47	3.59	14.53	-	8.26
14	50.70	38.36	36.07	40.62	27.93	28.46	23.01	22.66	21.51	7.37	14.35	19.18	8.26	-

[a] R denotes rail movement; others are truck rates.
[b] None designates that these shipments were assumed not to exist.

Wheat

$$Y = 3.6987165 + 0.0871990X + 0.0000139X^2 - 0.000000067X^3$$

$$s = 2.178501$$

$$r^2 = 0.966191$$

$$n = 272$$

Corn

$$Y = 1.8593640 + 0.1250674X = 0.0001984X^2 + 0.000000216X^3$$

$$s = 2.314911$$

$$r^2 = 0.952412$$

$$n = 246$$

Oats

$$Y = 5.6934370 + 0.1679232X = 0.0004285X^2 + 0.000000469X^3$$

$$s = 4.898500$$

$$r^2 = 0.854819$$

$$n = 83$$

Barley

$$Y = 4.1490884 + 0.0883299X - 0.0000211X^2$$

$$s = 1.793721$$

$$r^2 = 0.973186$$

$$n = 173$$

Sorghum

$$Y = 4.190913 + 0.11452X - 0.000162X^2 + 0.000000179X^3$$

$$s = 2.024156$$

$$r^2 = 0.978988$$

$$n = 62$$

where

Y = transportation rate in cents per 100 pounds,

X = miles,

s = standard deviation in cents per hundredweight,

r^2 = coefficient of determination, and

n = number of data points.

Truck shipments were not permitted for distances greater than 700 miles for wheat nor greater than 600 miles for other grains since greater distances were beyond the levels to which the regression equations presented above were applicable. The Texas Transportation Institute has recommended that the calculated rates from the equations be increased six percent for all grains except corn, and that rates for corn be increased by ten percent to reflect 1970 conditions. Since the various feed grains were combined in this study, the rates for the feed grain predominant within any region were applied to all feed grain shipments from that region.

Included in the cost of transferring grain are the handling costs associated with receiving and shipping grain by the difference modes. Handling costs are shown in Table XVI. Transportation costs for feed grain and wheat, handling costs included, are shown in Tables XVII and XVIII.

Transfer of Carcass Beef

Carcass beef may be moved either by rail or truck. Each is under government regulation and published tariffs are available. Packing companies furnished much of the data for motor carriers on a point-to-point basis. Rail companies furnished the rail rates. Separate destinations

TABLE XVI

ESTIMATED COSTS OF HANDLING GRAIN IN COMMERCIAL ELEVATORS BY GEOGRAPHIC AREA, TYPE OF FACILITY AND MODE OF TRANSPORTATION, 1967-1968

Area and Facility	Received by Truck	Received by Rail	Received by Water	Shipped by Truck	Shipped by Rail	Shipped by Water
			Cents Per Bushel			
North Plains[a]						
Inland elevators	1.95	4.81	--	3.50	2.71	1.00
Port elevators	--	--	--	--	--	--
Mid-Plains[b]						
Inland elevators	2.28	2.87	--	2.36	3.56	--
Port elevators	--	--	--	--	--	1.00
South Plains[c]						
Inland elevators	3.07	10.50	--	3.38	4.19	--
Port elevators	1.60	1.20	1.20	2.30	3.10	0.80
West[d]						
Inland elevators	2.64	7.55	--	3.45	3.15	--
Port elevators	2.00	2.30	1.20	2.00	4.20	1.50
Great Lakes[e]						
Inland elevators	2.47	6.75	--	2.49	3.08	--
Port elevators	1.30	3.00	1.10	4.30	2.60	1.40
South and East[f]						
Inland elevators	1.95	3.86	2.00	3.20	2.18	--
Port elevators	1.30	1.80	4.00	3.90	2.40	1.00

[a]North Dakota, South Dakota, and Minn. (excluding port facilities).

[b]Nebr., Kansas, Colorado, Wyoming, Iowa, and Missouri.

[c]Oklahoma, New Mexico, and Texas, plus all gulf port facilities.

[d]Wash., Oregon, Idaho, Montana, Calif., Ariz., Nevada, and Utah.

[e]Wis., Illinois, Indiana, Ohio, Mich., and Minn. port facilities.

[f]Arkansas, Mississippi, S. C., Tenn., Kentucky, New York, Va., Pa., New Jersey, Maryland, Del., La., Alabama, Georgia, West Virginia, North Carolina, and New England (excluding port facilities).

Source: Mack Leath, "An Interregional Analysis of the United States Grain Marketing Industry" (unpub. Ph.D. dissertation, Oklahoma State University, Stillwater, Oklahoma, May, 1970).

TABLE XVII

MINIMUM COSTS OF SHIPPING FEED GRAIN IN CENTS PER THERM BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3	.0103	.0136		.0082	.0081	.0082	.0105	.0094	.0097					
4	.0090	.0112	.0090		.0196[R]	.0129[R]	.0145[R]	.0219[R]	.0129[R]					
5	.0717	.10202	.0098	.0337		.0069	.0138	.0044	.0054	.0124	.0390	.0570	.0143[R]	.0161[R]
6	.0215[R]	.0215[R]	.0091	.0160	.0068		.0057	.0091	.0051	.0139	.0341	.0827	.0153[R]	.0165[R]
7	.0216[R]	.0216[R]	.0162	.0214	.0143[R]	.0057		.0129	.0065	.0135	.0127	.0298	.0236[R]	.0165[R]
8	.0213[R]	.0213[R]	.0138	.0213[R]	.0041	.0091	.0134		.0053	.0042[B]	.0237	.0371	.0050[B]	.0064[B]
9	.0215[R]	.0215[R]	.0141	.0214[R]	.0053	.0051	.0066	.0054		.0037[B]	.0151	.0438	.0057[B]	.0077[B]
10														
11					.0388	.0335	.0133	.0237	.0151	.0032[B]		.0543	.0042[B]	.0055[B]
12														
13														
14														

[a]R denotes rail movement; B denotes barge movement; others are truck movement.

[b]Costs above and below the diagonal may differ because of handling costs difference between the regions.

[c]No transportation costs were charged for intraregional movements. The other blanks indicate that the activities were assumed not to exist prior to programming.

TABLE XVIII

MINIMUM COST FOR SHIPPING WHEAT IN CENTS PER THERM BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		.0088	.006	.0077	.0714	.0233^{R}	.0249^{R}	.0255^{R}	.0233^{R}					
2	.088		.0137	.0079	.1017	.0233^{R}	.0249^{R}	.0268^{R}	.0233^{R}					
3	.9967	.0135		.0076	.0075	.0075	.0071	.0077	.0075					
4	.0075	.0078	.0076		.0196	.0233^{R}	.0249^{R}	.0268^{R}	.0233^{R}					
5	.0716	.1019	.0077	.0335		.0068	.0248^{R}	.0268^{R}	.023^{R}	.0140	.0388	.057	.0143	.0162^{R}
6	.0215^{R}	.0205^{R}	.0075	.0215^{R}	.0067		.0057	.0053	.0051	.0139	.0341	.0827	.0154	.0165
7	.0216^{R}	.0216^{R}	.0216^{R}	.0216^{R}	.0185	.0059		.0128	.0066	.0135	.0127	.029	.0236	.0165
8	.021^{R}	.021^{R}	.021^{R}	.021^{R}	.0059^{R}	.0053	.0133		.0053	.0041^{B}	.0236	.037	.0049^{B}	.0049^{B}
9	.0215	.0215	.0215	.0215	.0054	.0053	.0066	.0055		.0037^{B}	.0151	.0437	.0056^{B}	.0076^{B}
10								.0071	.0072		.0076^{B}	.0074^{B}	.0039	
11					.0387	.0335	.0132	.0236	.015	.0031		.0054	.0044	.0059
12														
13										.0039	.0074			.0065
14														

[a]R denotes rail movement; B denotes barge movement; others are truck movement.

[b]Costs above and below the diagonal may differ because of handling costs difference between the regions.

[c]No transportation costs were charged for intraregional movements. The other blanks indicate that the activities were assumed not to exist prior to programming.

were used for the shipment of carcasses. Large population centers were designated as delivery points for the meat. The origin and destinations are presented in Table XIX with the least cost mode for shipping 682 pounds of carcass beef--that is, the carcass weight of an 1,100 pound live animal to these destinations in Table XX.

TABLE XIX

REGIONAL BASING POINTS FOR CARCASS MEAT
ORIGINS AND DESTINATIONS

Regions		Origin	Destination
1	Pacific Northwest	Portland, Oregon	Portland, Oregon
2	Desert Southwest	Brawlay, California	Los Angeles, California
3	Intermountains	Helena, Montana	Billings, Montana
4	Great Basin	Wells, Nevada	Salt Lake City, Utah
5	North Plains	Aberdeen, South Dakota	Sioux Falls, S. Dakota
6	Central Plains	Holyoke, Colorado	Denver, Colorado
7	South Plains	Guymon, Oklahoma	Dallas, Texas
8	Lake States	St. Paul, Minnesota	St. Paul, Minnesota
9	Western Corn Belt	Omaha, Nebraska	Omaha, Nebraska
10	South Central	Jackson, Mississippi	New Orleans, Louisiana
11	Eastern Corn Belt	Fort Wayne, Indiana	Chicago, Illinois
12	Northeast	Albany, New York	New York City, New York
13	Upper South	Knoxville, Tennessee	Richmond, Virginia
14	Southeast	Thomasville, Georgia	Atlanta, Georgia

TABLE XX

MINIMUM COST FOR TRANSPORTING CARCASS BEEF IN CENTS
PER POUND BY MODE OF TRANSPORTATION

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		1.82		2.06	3.32	2.23	3.32^R	3.32	3.32	3.32^R	3.62	5.55	5.51	5.06
2	1.98	.79	2.25	1.45	3.32^R	1.81	3.15	3.32^R	3.17	3.32^R	3.29	5.14	3.39	3.16
3		1.88		1.84	1.79	1.87	3.46	1.50	2.28	3.68	2.08	4.73	3.97	3.52
4	1.24	2.02	1.35		3.32^R	1.65	3.24	3.32	2.58	2.39	3.46	4.35	5.08	3.85
5	2.71	2.53	2.53	2.67		1.375^R	2.96^R	.935^R	1.10^R	1.92	1.12	2.338^R	2.48^R	1.93
6	1.38^R	1.35^R	1.34^R	1.38^R	1.42	.35	1.60	1.99	.90	1.82	1.39	2.61^R	2.96	2.31
7	1.76^R	1.54^R	1.76^R	1.54^R	1.35	.94	1.08	1.54	.98	1.55	1.65	2.76	2.65	2.01
8	2.67	2.85	2.67	2.85	.76	2.03^R	1.81		.70	1.84	.74	2.26^R	2.095^R	1.74
9	2.67	2.63	2.67	2.63	.56	1.03	1.45^R	.82		1.67	.85	2.26^R	2.095^R	1.69
10					2.55^R	2.425^R	2.005^R	2.235^R	1.97^R	0^R	1.15^R	1.76^R	.43^R	.49^R
11	2.04^R	3.10	3.14	3.10	1.78	1.74	2.25	1.222^R	1.519^R	1.27^R	.50	1.72	1.77	1.34
12							2.51^R			1.76^R			1.25^R	1.55^R
13					2.48^R	2.68^R	2.48^R	2.095^R	2.095^R	.49^R	.79^R	1.25^R		.49^R
14					2.99^R	2.917^R	2.63^R	2.63^R	2.483^R	.43^R	.76^R	1.55^R	.49^R	R

[a]R denotes rail transportation.

[b]No transportation costs were charged for intraregional movements. The other blanks indicate that the activities were assumed not to exist prior to programming.

FOOTNOTES

[1]U.S. Department of Agriculture, Livestock and Meat Statistics, Economic Research Service, Statistical Bulletin 333, Supplement for 1967, 1968, 1969 (Washington, D. C., 1968, 1969, 1970).

[2]Ibid.

[3]Ibid.

[4]Ibid.

[5]John W. Goodwin and Reuven Andorn, The Irreversible Demand Function for Beef, Technical Bulletin T-127, Oklahoma State University, Agricultural Research Experiment Station (June, 1968).

[6]J. Richard Crow and John W. Goodwin, "The Demand for Beef, an Irreversible Demand Function" (Unpub. journal article, Department of Agricultural Economics, Oklahoma State University). This paper was a revision of the Goodwin-Andorn work.

[7]U.S. Department of Agriculture, Household Food Consumption Survey, 1965-66, Reports Nos. 1-5 (1968).

[8]U.S. Department of Agriculture, Relative Use of Feeds for Livestock Including Pasture by States, Statistical Bulletin No. 153 (Washington, D. C., February, 1955), p. 52.

[9]U.S. Department of Agriculture, Agriculture Conservation Programs Accomplishments, Agriculture Stabilization and Conservation Service (1956-1970).

[10]Consult various references listed in the Bibliography.

[11]U.S. Bureau of the Census, "Farms and Land in Farms," Census of Agriculture, 1964, Vol. 11, Chapter 1 (Washington, D.C., 1967).

[12]The wheat pasture AUM's pertained only to the South and Central Plains. The values were obtained by linking the number of acres of wheat planted in these states and multiplying by .7 which is the quantity of AUM's which an acre of wheat provides. For stubble, the number of acres of corn and milo planted in a region was multiplied by .6.

[13]Various State Experiment Station publications were used, a complete list of which may be found in the Bibliography.

[14]Ibid.

[15]U.S. Department of Agriculture, Crop Production, Economic Research Service, Statistical Reporting Service Crop Production 2-3 (Washington, D.C., December 23, 1970).

[16]Mack Leath, "An Interregional Analysis of the United States Grain Marketing Industry" (Unpub. Ph.D. thesis, Oklahoma State University, May, 1970).

[17]U.S. Department of Agriculture, Food Consumption, Prices and Expenditures, Supplement to Agricultural Economic Report 138 (Washington, D.C., January, 1971), p. 33.

[18]U.S. Department of Agriculture, Export Shares by Region and State, Fiscal Year 1968, Economic Research Service-Foreign 241 (November, 1968).

[19]U.S. Department of Agriculture, Grain Market News, Consumer and Marketing Service (Hyattsville, selected issues consulted).

[20]U.S. Department of Agriculture, Field and Seed Crops, Usual Planting and Harvesting Dates, by States in Principle Producing Areas, Statistical Reporting Service, Agricultural Handbook 283 (Washington, D.C., March, 1969).

[21]The numbers of different livestock in a region were taken from the 1968, 1969, and 1970 issues of Livestock and Meat Statistics with the required grain for each calculated using Frank Morrison, Feeds and Feeding, 22nd edition (Clinton, Iowa, 1959).

[22]Frank Morrison, Feeds and Feeding, 22nd edition (Clinton, Iowa, 1959).

[23]J. R. Brethour, Feeding Wheat to Beef Cattle, Kansas Agricultural Experiment Station Bulletin 487 (February, 1966).

[24]Leath, p. 76.

[25]U.S. Department of Agriculture, Agriculture Statistics, 1970 (Washington: U.S. Government Printing Office, 1970), p. 10.

[26]Max Bowser and John W. Goodwin, Optimum Distribution Patterns for Feeder Cattle, Technical Bulletin T-123 (Stillwater: Oklahoma State University, Oklahoma Agricultural Experiment Station, June, 1968).

[27]Index of prices paid by farmers which included taxes, interest, and wages was used as the inflator 1957-58 = 100.

[28]The complete list of state publications is found in the Bibliography.

[29]Index of prices paid by farmers which included taxes, interest, and wages was used as the inflator, 1957-58 = 100.

[30]U.S. Department of Agriculture, Livestock and Meat Statistics, Economic Research Service, Statistical Bulletin 333, Supplement for 1970 (Washington, D.C., 1971), p. 138.

[31]Index of prices paid by farmers which included taxes, interest, and wages was used as the inflator, 1957-58 = 100.

[32]Don Gill, How to Use Net Energy Tables for Cattle Feeding, Oklahoma State University Extension, Leaflet L-167 (Stillwater, 1968).

[33]U.S. Department of Agriculture, Crop Values, Statistical Report Service, Cr Pr 2-1-1 (Washington, D.C., December, 1969 and 1970).

[34]Irving Dubov, "Area Differences in Slaughter Costs," Southern Cooperative Publication in process.

[35]Waterways Freight Bureau, Local, Joint, Proportional, Import and Export All-Water Commodity Rates on Grain and Products, and Related Articles in Bulk, Freight Tariff No. 7 (Washington, D.C., 1968).

[36]Hoy A. Richards and Jack T. Lamkin, "An Empirical Analysis of Motor and Inland Carrier Grain Rate Structures for the North Central Region of the United States" (Unpub. research report, Texas Transportation Institute in cooperation with the U.S. Dept. Agriculture Economic Research Service, Texas A. & M. University, April, 1967).

[37]Neff Tippets, Ira M. Stevens, C. B. Brotherton, and Harold Abel, In-Transit Shrinkage of Cattle, Mimeograph Circular No. 78 (Laramie: University of Wyoming Agricultural Experiment Station, February, 1957).

CHAPTER IV

LOCATION OF BEEF ENTERPRISES UNDER PRESENT CONDITIONS USING RESTRICTIVE AND NON-RESTRICTIVE MODELS

The results of this research will be discussed for four different models. Model I was designed to approximate an optimal solution for the beef industry under current conditions. Constraints on numbers of cows available, feedlot capacity, grazing capacity, feed grain supplies, wheat supplies, and slaughter capacity were used to represent the estimated capacity limitations which the various regions face at the present time. Model II was designed to define the optimal situation in the beef industry if no feeding and slaughtering constraints were in the model. The results of Model II would give indications of which regions could be expected to become commercial producing areas if the "fixed" resources were not fixed. This model suggests the directions and the magnitudes of the incentive for change in today's beef industry.

Models III and IV analyze the probable adjustments in the beef industry as it strives to serve the demand for beef projected for 1975 and for 1980. These results will be examined in Chapter V. Other situations such as changing feeding efficiency and changing interest rates were examined. The results of these models are shown in tabular form presented in the appendices.

For each model, the optimal locations for calf production, cattle production, feeding activities, and slaughtering activities will be discussed, and optimal patterns of movement examined. The regional volumes of production and the patterns of product flows should be interpreted as the manner in which the marketing system should function given the supply, demand, and the competitive conditions of 1968-1970 in order to minimize the cost of supplying the estimated regional requirements of beef from the available beef supply. Given the basic data no other patterns of production would result in a lower total cost for the system as a whole.

Model I

Model I was based on the regional demarcations shown in Figure 9 in Chapter IV. For this model each region was assumed to be equally efficient in cattle feeding. Each region was further assumed to have resource constraints similar to those present in 1970. Least-cost distribution patterns and locations of major enterprises were determined within these constraints.

The results of Model I are discussed in terms of the operation of all sectors in the beef industry within five major aggregated regions:

(1) The West (regions 1, 2, 3, 4)

(2) The Plains (regions 5, 6, 7)

(3) The Corn Belt (regions 8, 9, 11)

(4) The Northeast (region 12)

(5) The South (regions 10, 13, 14)

Following this, beef industry sectors (i.e., cow-calf, stocker growing, feeding, etc.) are discussed across regions. Finally, the degree of resource utilization and the efficiency of the beef industry are defined.

The Regional Industries

The West

The beef industry in the four Western regions is largely independent of the industry in other areas, at least through the feeding stage. The major movements of cattle occur among the four Western regions. Limited numbers of cattle do leave the Intermountain area to move into the Plains (Figure 10)*. Within the West, the Desert Southwest exports excess calves to the Pacific Northwest and the Great Basin. Calf production is non-existent in the Pacific Northwest because of the high costs involved in maintaining cow herds. Cattle operations in the West were constrained because of the lack of available facilities, lack of grass, and a market for finished products limited to the Western regions because of location.

The Pacific Northwest completely utilized its feeding facilities and received additional beef supplies from its Eastern neighbor. Feeding in the Intermountain area was limited because of the lack of extra-regional market outlets other than the Pacific Northwest.

The Great Basin region of Utah and Nevada served as a "balancing center" for the other three Western regions. All available Great Basin grass was utilized in cow-calf and stocker operations. Small numbers of calves were imported for growing out to feeder weights. The Great Basin retained only those feeder cattle necessary for filling local feedlots and shipped the remaining production to the Intermountain area for feeding.

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*For all maps, the solid lines represent the movements of stocker cattle while the dashed lines represent the movements of feeder cattle.

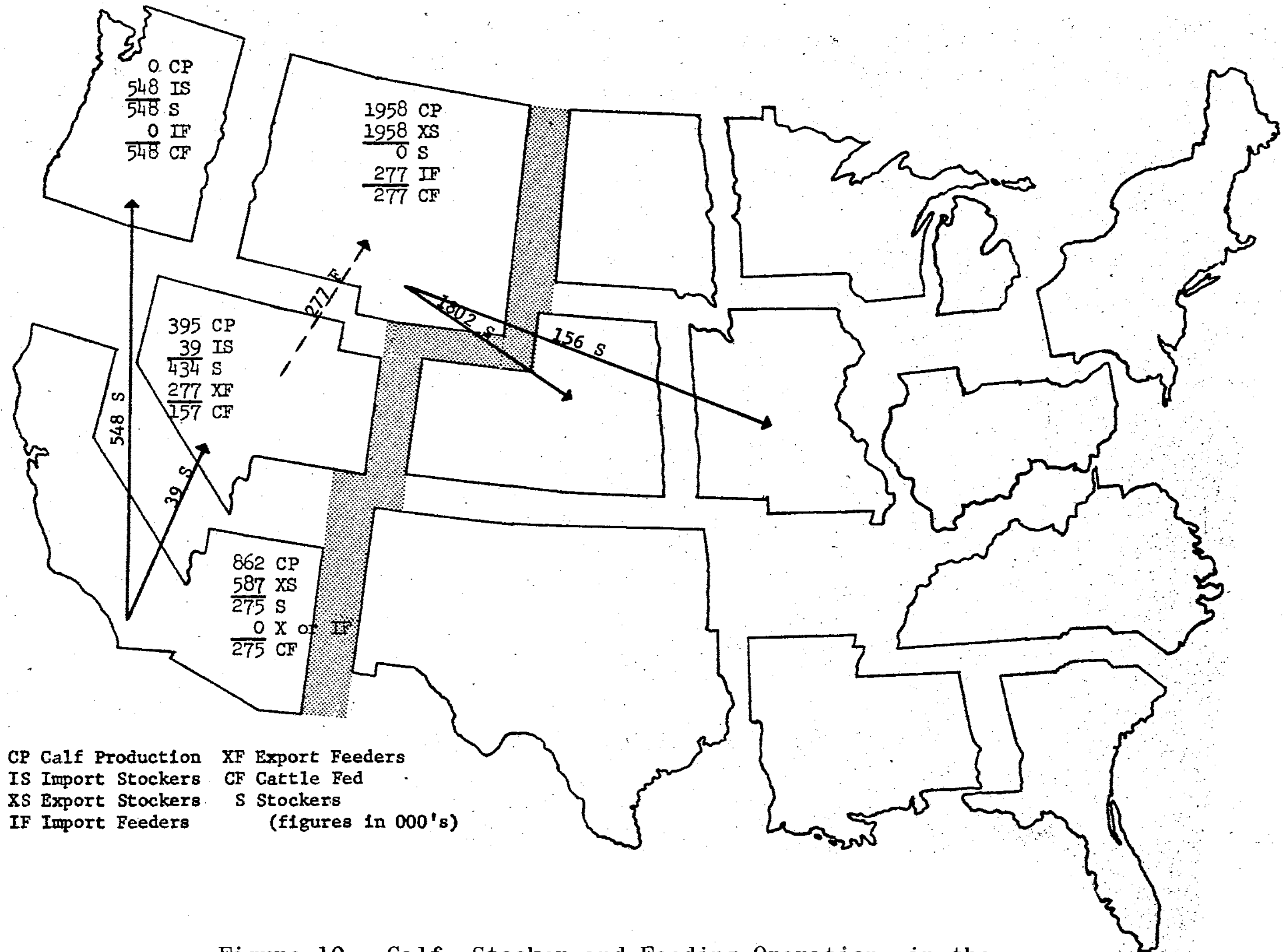

Figure 10. Calf, Stocker and Feeding Operations in the Western Regions, Model I

The Desert Southwest contains 73 percent of the ultimate demand for beef in the four Western regions. Because of lack of feed concentrates, beef operations were limited to those numbers which could be fed using available wheat and imported feed grains. Feeding beyond this magnitude was not feasible because of the great cost involved in transporting grain and the close competitive position of the three Plains regions.

The lack of feed concentrates in any region limits all phases of beef production. Calf production in the Desert Southwest is limited to the numbers of calves which can be feasibly grown out in the West, since the costs for moving grains in or calves out to grain producing regions are prohibitive.

The Plains

Unlike the West, the Plains regions rely on other regions for supplies of stockers and/or feeders in addition to the major supplies produced locally. The market outlets for all classifications of cattle are readily available within the Plains and adjacent regions. Each of the Plains regions is located such that it can potentially supply deficit regions with stocker calves and feeder cattle in addition to meeting its own demands for each class of cattle.

The Plains states are the predominant calf producing regions as shown in Figure 11. Each of these regions ranks among the lowest cost regions for calf production. Consequently, vast projections of their pasture capability are allocated to the cow-calf enterprises. The North Plains is a major supplier of stockers for the Western Corn Belt because of proximity to the area. Having produced more calves than can be carried through to feeding weights on the available grass, the South

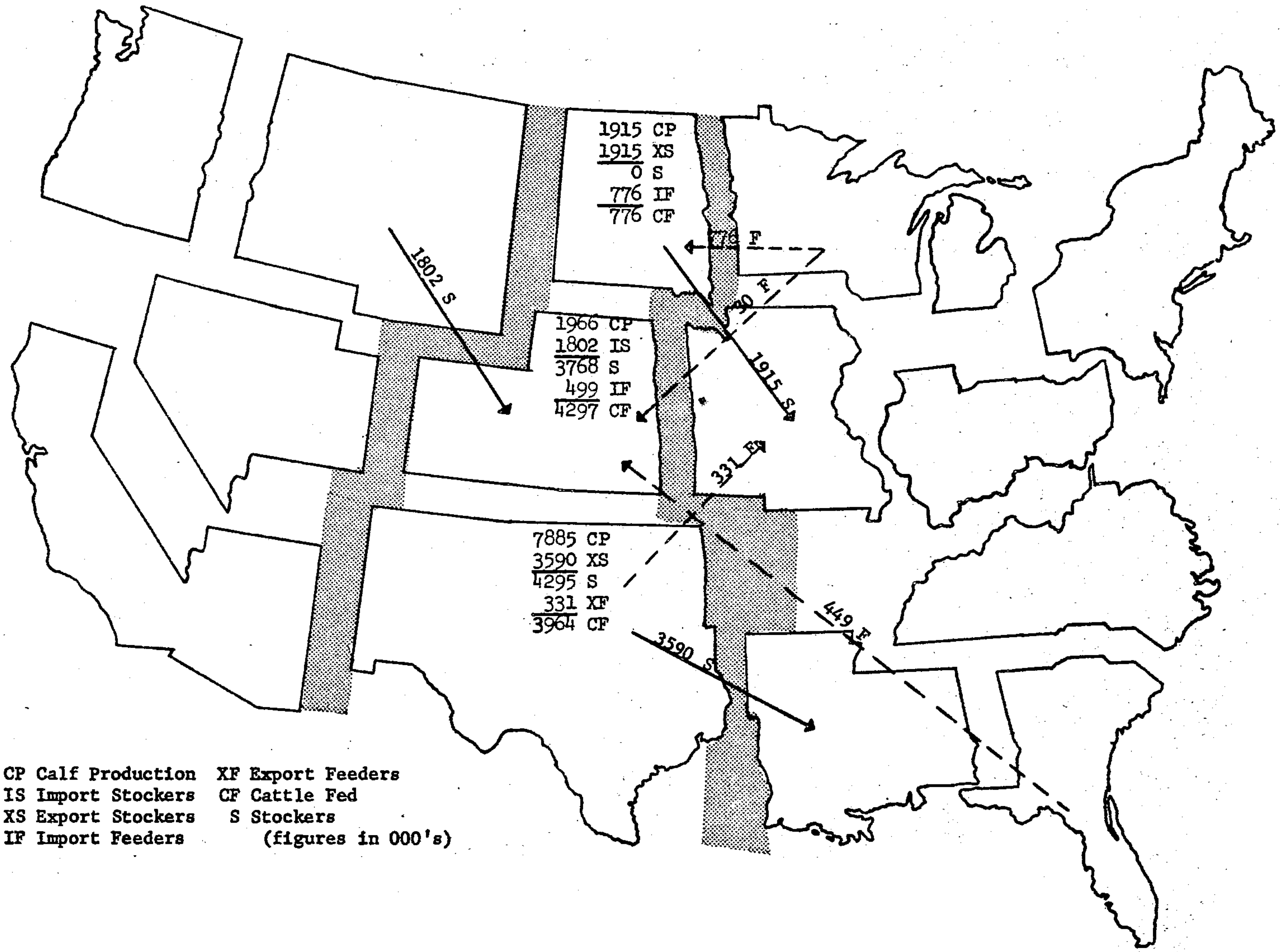

Figure 11. Calf, Stocker and Feeding Operations in the Plains Regions, Model I

Plains exports stockers to the South Central area. The Central Plains is the only Plains region which imports stocker calves receiving them from the Intermountain area. This balance of calf production and stocker growing for the Central Plains occurred since grass is not available in sufficient quantities for carrying all calves required by the region through to feeder weight. Further, the Intermountain area is the only area from which the Central Plains can feasibly import calves. The Intermountain area utilized all available grass in the cow-calf enterprise. Grass in the Central Plains is divided between local calf production and stocker growing operations that utilize the Intermountain calves.

Stocker growing operations are important in both the South and Central Plains areas. Since the North Plains utilized available pasture solely for calf production, North Plains calves were grown to feeding weight in the Western Corn Belt. Feeder calves were imported for feeding in the North Plains from the Lake States. The Central Plains received additional feeders from the Lake States and from the Southeast.

The Plains regions utilized their own feed grains and wheat for fattening cattle. Both the Central and North Plains areas utilized only feed grains for feeding cattle. The South Plains used large amounts of wheat in their rations, although feed grains were the predominant concentrate. Without wheat, the South Plains would have been forced either to import feed grains or to reduce feeding by 1.2 million head.

Corn Belt

Calf production in the Corn Belt occurs only in the Lake States (Figure 12). Efficient utilization of the available grass was the major factor controlling calf production in these regions. Because of the large acreages of grass required per beef cow, the Western Corn Belt gets its required levels of feeder cattle at lower cost by utilizing grass for stocker growing. The cost of shipping the heavier feeder animals into the region would increase the total cost of fed beef production. Stocker calves for the Western Corn Belt were imported from the Northern tier of states between Michigan and Idaho. Since the quantity of grass produced in the Western Corn Belt is insufficient for meeting the total needs for feeder cattle, additional feeder cattle were imported from the Southern regions and the South Plains.

The Eastern Corn Belt utilized no grass in the production of calves or in stocker growing. Feeder cattle could be supplied by the Upper South at a lower total cost than these cattle could be produced in the Eastern Corn Belt.

Feed grains were the primary feed concentrate in all Corn Belt regions. Less than one percent of the concentrate was made up of wheat in any Corn Belt region.

Northeast

Under the assumptions of Model I, the Northeast did not produce calves, feeders or fat cattle.

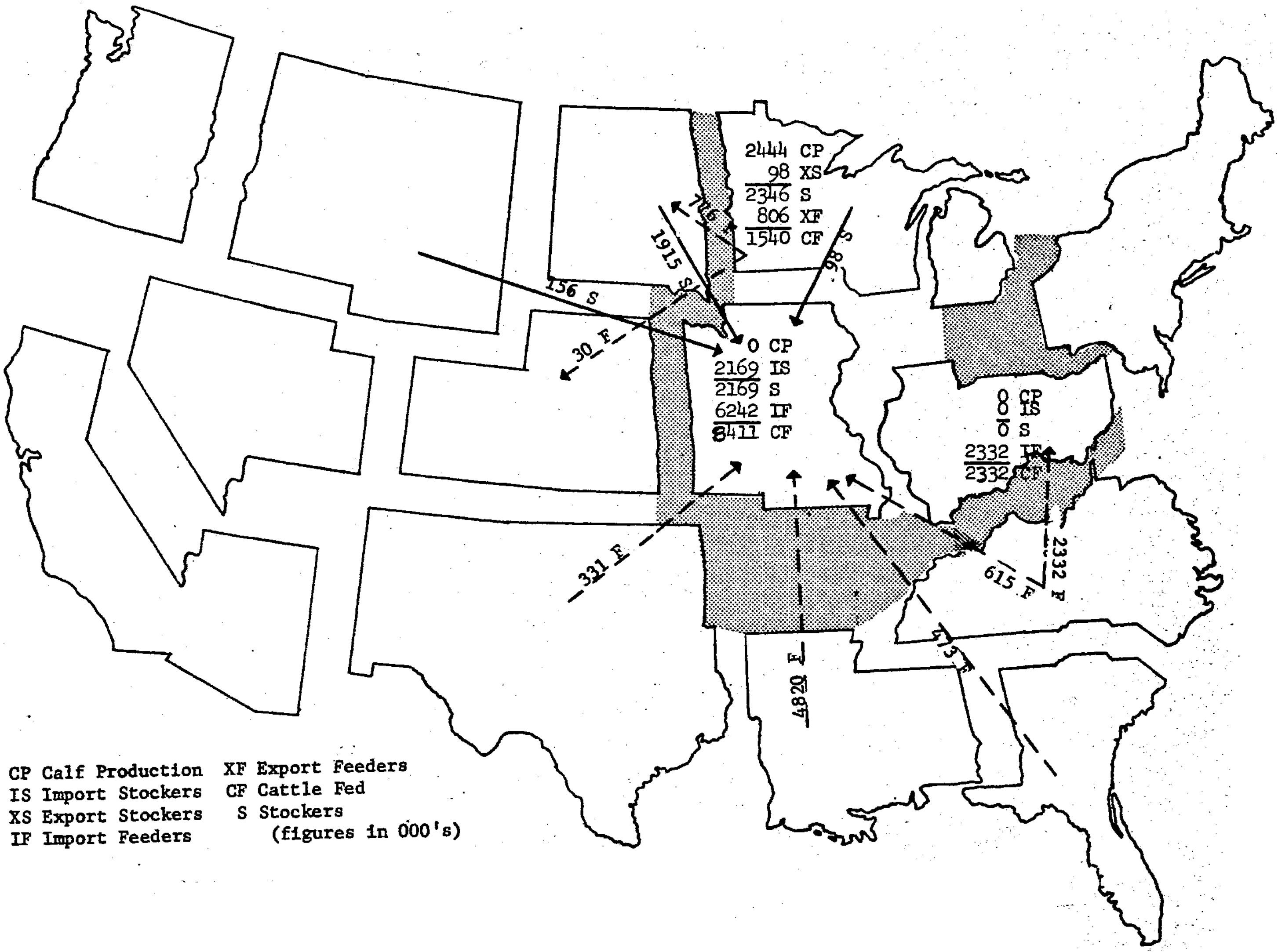

Figure 12. Calf, Stocker and Feeding Operations in the Corn-Belt Regions, Model I

The South

The second largest general calf producing area was composed of the three Southern regions. Figure 13 shows that the Southern regions were major suppliers of feeder cattle for both the Corn Belt and the Central Plains. The South Central area was the only region importing cattle of any kind. While calf production was an important sector in this region, most of the grass was utilized in stocker activities and growing calves originating in the South Plains. The South Central region was the growing area for 21 percent of all stocker cattle in the nation with South Central feeder cattle making up the lion's share of the cattle fed in the Western Corn Belt.

Cattle shipped from the other two Southern regions originated locally and were grown to feeding weights on locally available grass. The proximity of Corn Belt feedlots was a major factor encouraging large volumes of calf production and stocker growing activities in these regions.

Feeding in the South was limited to the facilities which were already present. Cattle resources were readily available but feed grains were lacking. Although low-cost barge transportation could be used to move feed concentrates into the South, the combined costs of feeding and grain transportation placed the South at a disadvantage compared with the South Plains.

Beef Industry Sectors

Calf Production

Optimal calf production for each individual region is shown in Table XXI. The vast majority of these calves originated in the three

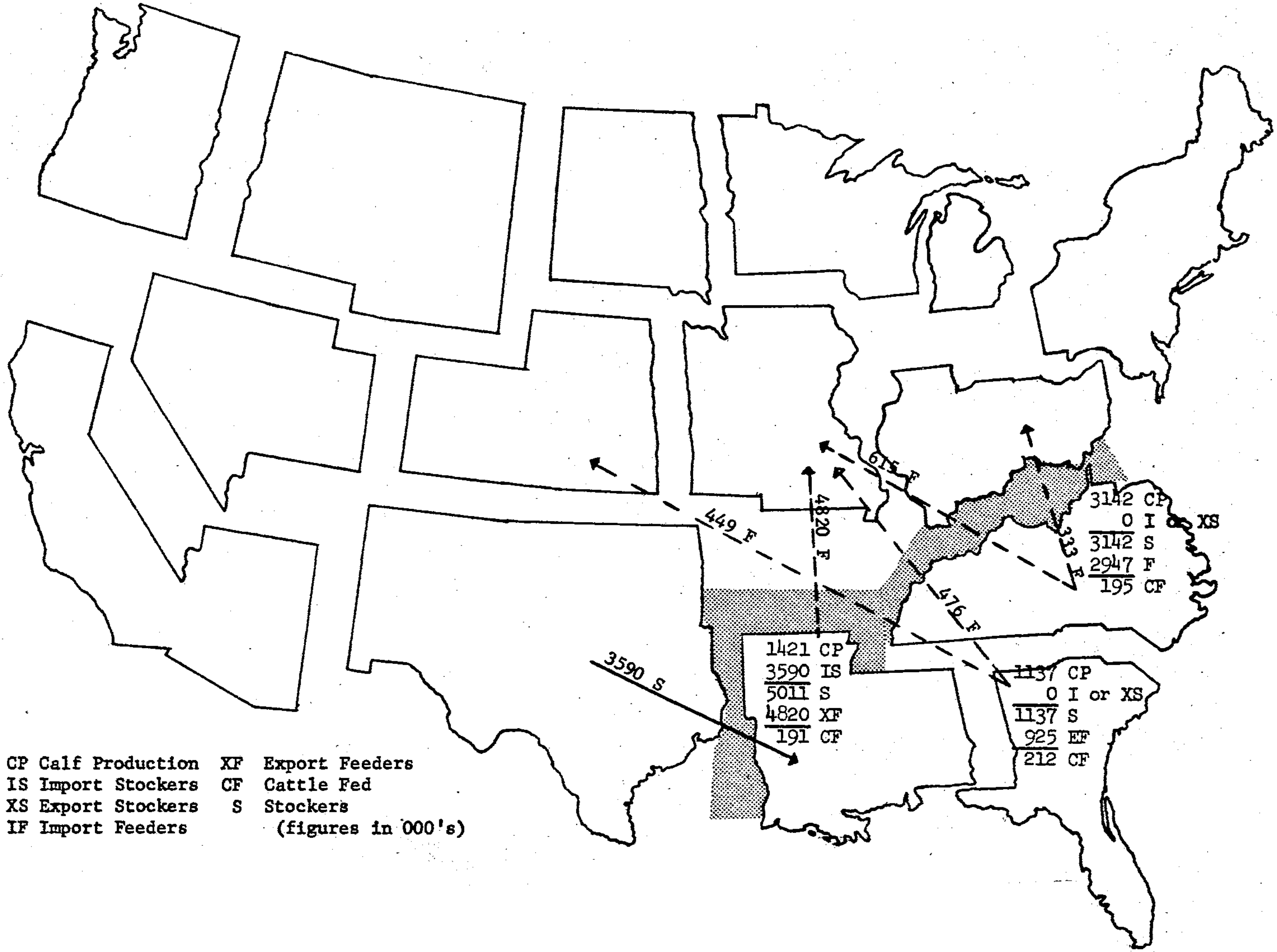

Figure 13. Calf, Stocker and Feeding Operations in the Southern Regions, Model I

TABLE XXI

OPTIMAL REGIONAL DISTRIBUTION OF CALF PRODUCTION IN MODEL I

Region		Production
		(000 head)
1	Pacific Northwest	-0-
2	Desert Southwest	862
3	Intermountains	1958
4	Great Basin	395
5	North Plains	1915
6	Central Plains	1966
7	South Plains	7885
8	Lake States	2444
9	Western Corn Belt	-0-
10	South Central	1421
11	Eastern Corn Belt	-0-
12	Northeast	-0-
13	Upper South	3142
14	Southeast	1137
	Total	23125

Southern regions and the Plains regions. These regions were favorably located with respect to large feeding areas and abundant feed grains. Consequently, large markets existed for their calves.

Stocker Operations

Stocker cattle were grown to feeding weights in the same general geographic pattern as were calves (Table XXII). The areas adjacent to large feeding concentrations and those regions which enjoyed abundant grass capacity were major suppliers of feeders. The West produced only for the relatively small Western feeding industry.

Feeding

Feeding hinges upon the regional capability to assemble feeder cattle and feed concentrates at minimum cost, and upon low cost access to beef consuming markets. In the model, each region had the option of purchasing additional feeding facilities. However, this option was not utilized under the assumptions approximating current conditions. All cattle were fed in existing facilities. Optimal feeding for each region is shown in Table XXIII.

Feeding centered around the abundant feed grain suppliers of the Plains and Corn Belt. These regions were located such that the beef could be readily distributed to large consumer markets. The West and South did feed cattle but on very limited scale, since these regions lacked the feed grains to compete with the Plains and Corn Belt areas except within their own local markets.

TABLE XXII

OPTIMAL RECEIVING OF STOCKERS AND STOCKER GROWING IN MODEL I

Region		Received Stockers From	Quantity Received	Total Number Grown
			(000 head)	
1	Pacific Northwest	2	548	548
2	Desert Southwest	2	275	275
3	Intermountains	None	None	None
4	Great Basin	2	39	
		4	395	434
5	North Plains	None	None	None
6	Central Plains	3	1802	
		6	1966	3768
7	South Plains	7	4295	4295
8	Lake States	8	2346	2346
9	Western Corn Belt	3	156	
		5	1915	
		8	98	2169
10	South Central	7	3590	
		10	1421	5011
11	Eastern Corn Belt	None	None	None
12	Northeast	None	None	None
13	Upper South	13	3142	3142
14	Southeast	14	1137	1137

TABLE XXIII

OPTIMAL FEEDING NUMBERS FOR EACH
REGION UNDER MODEL I

Region		Number
		(000 head)
1	Pacific Northwest	548
2	Desert Southwest	275
3	Intermountains	277
4	Great Basin	157
5	North Plains	776
6	Central Plains	4247
7	South Plains	3964
8	Lake States	1540
9	Western Corn Belt	8411
10	South Central	191
11	Eastern Corn Belt	2332
12	Northeast	-0-
13	Upper South	195
14	Southeast	212
	Total	23125

Movement of Fat Cattle and Slaughtering

The cattle slaughtering activity was heavily production orientated since carcasses could be moved at much lower cost than could fat cattle. The only movement of fat cattle that occurred was a very limited movement from the North Plains into the Lake States. North Plains slaughter capacity was insufficient for slaughtering the cattle produced in North Plains feedlots, but it was cheaper to move the surplus cattle to surplus slaughter capacity in the nearby Lake States than to build new local slaughter capacity.

Of the Western regions, only the Intermountain area used all available slaughtering capacity. Excess capacity for about four million animals was unused in the other Western regions.

The Plains regions utilized all of their available slaughter. Two of these regions--the Central Plains and the South Plains--bought additional capacity. The South Plains bought capacity to slaughter 675,000 additional cattle. This would be equivalent to about three new plants, each having the annual capacity of 225,000 head of cattle. The Central Plains built 23,000 head of additional capacity.

The Corn Belt regions had ample slaughtering facilities. Only the Western Corn Belt fully utilized its existing capacity, and built 9,000 head of additional capacity in order to kill the animals fed locally. The other Corn Belt regions had 2.7 million head of unused capacity. Slaughter in the Southern regions was limited to locally fed animals, leaving 1.2 million head of unused capacity in the South.

Of the 23,125,000 head of cattle fed, less than one percent of the fat cattle were transported live. All regions (except for the North

Plains) with insufficient slaughter capacity for the cattle fed built new facilities.

Distribution of Beef

The optimal flows of beef shown in Figure 14 illustrate the optimal concentration of feeding in the central part of the United States with shipments from the heartland to outlying coastal areas. Almost three-fourths of all cattle are fed and slaughtered in the major feeding regions of the South and Central Plains and the Corn Belt regions. Beef produced in the Western regions is consumed in the West. The Plains are located near the geographic center of the United States. Consequently, these areas are able to move either direction with great efficiency as shown in Figure 14. A cost change of a fraction of a cent on eastbound shipments would pull large volumes of Central Plains beef to the East. The resulting slack in the West Coast market would be picked up by the South Plains and the Intermountain area.

For the South Plains, the major market was the Southern part of the United States. The rapidly growing population in the Gulf Coast and Atlantic seaboard areas encourages a rapidly growing beef industry in the South Plains. These Southern markets were not sensitive to any reasonable transportation cost changes. That is, Gulf Coast and South Atlantic markets are likely to be dominated by the South Plains regardless of transportation rate structure.

Beef in the Corn Belt flows to the heavy beef consuming areas of the East. A strong market advantage is enjoyed by these regions for selling beef in the Northeast market due to the favorable transportation cost structure.

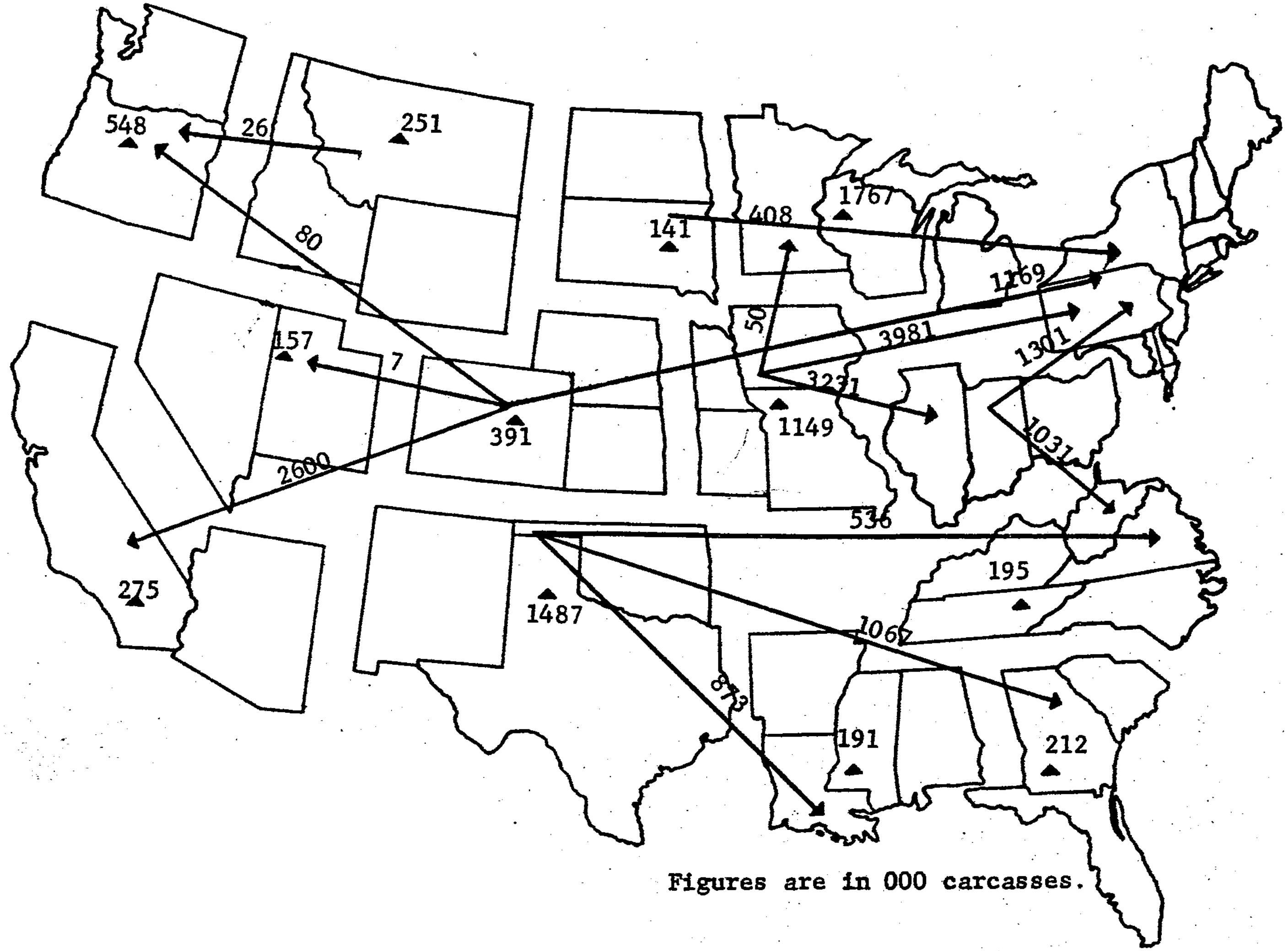

Figure 14. Optimal Flows of Dressed Beef, Model I

Feed Grains and Wheat

Feed grains and wheat movements were limited mainly to intra-regional moves as shown in Tables XXIV and XXV. Feeding in the West was totally dependent on feed grains produced in the Intermountain area. The Intermountain area supplied each of the Western regions with the feed grains necessary to balance the wheat used in their concentrate ration.

The only other interregional movement of feed grains or wheat occurs by barge transportation from various points in the Corn Belt to the Southern regions.

Transporting the Products

In the movements of the different beef animals, all of the movements of the live animals were handled by truck. This was true of stocker cattle and feeder cattle as well as of the fat cattle that were shipped. Rail movements were not competitive unless cattle were moved for very long distances. In the optimal flow patterns, movements of this type were not present.

In the transportation of meat, trucks tended to dominate the shorter interregional moves as well as the moves within regions. Railroads handled the longer hauls except for the meat movements to the Southern regions from the South Plains. The sensitivity of the transfer activities for all models is found in Appendix D.

Capacity Constraints

The production constraints were placed in the model in order to describe current conditions as realistically as possible. For the most

TABLE XXIV

OPTIMAL SHIPMENT OF FEED GRAINS

Origin		Destination		Quantity (000,000 therms)
3	Intermountains	1	Pacific Northwest	546
		2	Desert Southwest	274
		3	Intermountains	269
		4	Great Basin	145
4	Great Basin	4	Great Basin	12
5	North Plains	5	North Plains	1558
6	Central Plains	6	Central Plains	8502
7	South Plains	7	South Plains	5400
8	Lake States	8	Lake States	3069
		13	Upper South	194
		14	Southeast	211
9	Western Corn Belt	9	Western Corn Belt	16167
		10	South Central	190
11	Eastern Corn Belt	11	Eastern Corn Belt	2397

TABLE XXV

OPTIMAL SHIPMENT OF WHEAT

Origin		Destination		Quantity (000,000 therms)
1	Pacific Northwest	1	Pacific Northwest	546
		2	Desert Southwest	239
2	Desert Southwest	2	Desert Southwest	35
3	Intermountains	3	Intermountains	269
		4	Great Basin	76
4	Great Basin	4	Great Basin	80
7	South Plains	7	South Plains	2500
9	Western Corn Belt	9	Western Corn Belt	1009
10	South Central	10	South Central	48
11	Eastern Corn Belt	10	South Central	143
		11	Eastern Corn Belt	2397
		14	Southeast	211
13	Upper South	13	Upper South	194

part, the beef industry utilized the facilities which were currently available rather than constructing new facilities. Grass capacity was completely utilized in all regions except for the Pacific Northwest, Desert Southwest, Eastern Corn Belt, Northeast, and Upper South. Any additional growth in the beef industry in other regions will require substantial grassland improvements.

Slaughter capacity was completely utilized in the Intermountain region in the North, Central and South Plains and in the Western Corn Belt. Of these, only the North Plains and Intermountain areas purchased no additional capacity.

Feedlot capacity was exhausted in all regions except for the Desert Southwest, Intermountain, and Western Corn Belt regions. Feed grain supplies were depleted in the Intermountain, Great Basin and South Plains regions. All other regions have substantial volumes of surplus feed grains. Wheat supplies were completely consumed in the Desert Southwest, Great Basin, Western Corn Belt and South Central regions. Ample wheat remained available in other regions. The shadow prices for the grazing of slaughter and feedlot contraints are shown in Appendix E.

Efficiency of the Industry

Economic efficiency is often discussed as the law by which managers must live. For the beef industry, economic efficiency may be defined to be getting the carcass animal to the consumer at the lowest possible cost. The analysis of Model I showed lowest marginal cost for supplying a carcass to be that of providing an additional carcass to the Intermountain region. This minimum marginal cost was $234.75. Additional beef moved to the Richmond, Virginia, area would be the most expensive at $252.98. The rank of the regions from lowest to highest marginal cost is shown in Table XXVI. These marginal costs given an indication that as population shifts just how costly it may become to provide beef to population growth areas.

Following the optimal flow and production patterns, the average cost of supplying a carcass animal was $199.19. If the animal is converted to the 1969 average price, the carcass would be valued at $334.00.[1] This leaves $114.81 as a return to land, management, roughages and profits for all the different segments of the beef industry.

Model II

Model II was designed to determine the effects of removing the capacity constraints upon the feedlot and slaughtering activities. Under the assumptions of Model II, each region was required to invest in facilities as they were used. The objective of Model II was to suggest where different beef enterprises might be expected to locate if no fixed facilities were present. The results of Model II were expected to suggest the direction and the intensity of the incentives for change from the optimum specified in Model I. Other than in the areas of the capacity restraints on feeding and slaughtering facilities, Model I and Model II were based on the same assumptions.

The Regional Industries Under Model II

The West

The cattle industries in the Western regions shifted almost entirely to calf production as viewed in Figure 15. Except for the

TABLE XXVI

MARGINAL COSTS OF SUPPLYING THE LAST CARCASS
TO EACH REGION UNDER MODEL I

Region		Cost
3	Intermountains	$ 234.75
9	Western Corn Belt	237.24
6	Central Plains	237.24
5	North Plains	238.20
7	South Plains	242.20
8	Lake States	242.83
11	Eastern Corn Belt	243.03
2	Desert Southwest	244.05
4	Great Basin	244.26
1	Pacific Northwest	244.26
10	South Central	245.49
14	Southeast	248.63
12	Northeast	252.65
13	Upper South	252.99

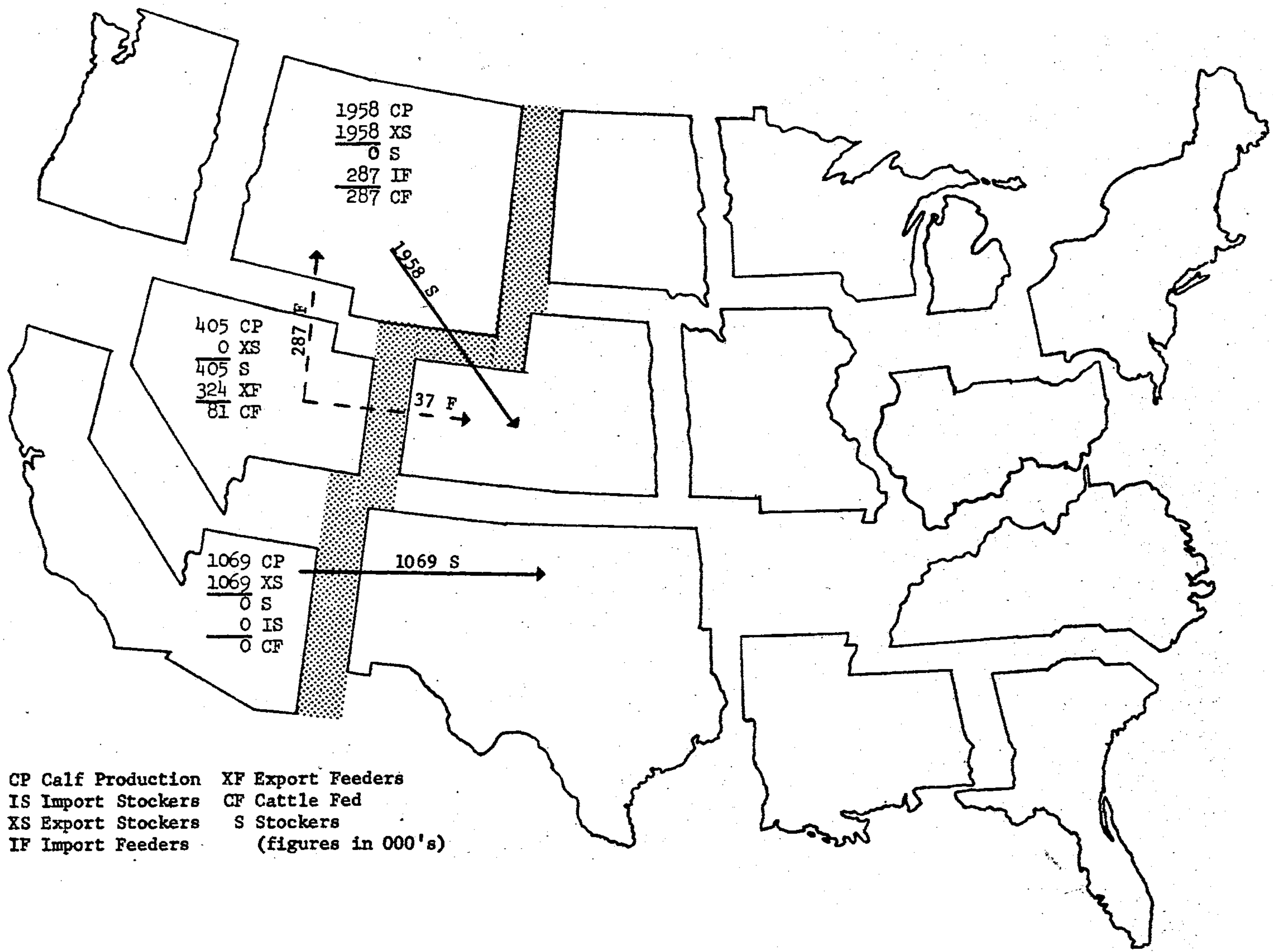

Figure 15. Calf, Stocker and Feeding Operations in the Western Regions, Model II

Great Basin, stocker calves produced in the West were grown to feeder weights in the Plains area.

The Great Basin was the only Western region to hold calves beyond weaning. Limited numbers of Great Basin feeder cattle were fed in local feedlots, with the remainder being fed in the adjacent Intermountain area. The Great Basin and Intermountain regions were the only Western regions which had feed grain available for feeding.

The Plains

The Plains dominated the cattle feeding industry in Model II (Figure 16). Some of the grass in the Plains was used to grow stocker calves produced in other regions to feeding weights. This meant that the Plains regions produced about 15 percent fewer calves in Model II than in Model I. By substituting stocker growing enterprises for cow-calf operations, the Plains were able to reduce the total cost of producing beef. This saving was due to the different levels of costs involved in transporting stocker cattle versus feeder cattle.

The Plains regions are characterized by relatively low calf production costs, the lowest non-feed cost for feeding, and relatively low costs of slaughtering. Of the calves produced in the three Plains regions, all are grown out to feeder weights within the region of origin. The Central Plains receives additional stocker calves from the Intermountain area, and the South Plains imports additional stockers from the Desert Southwest.

Additional feeder cattle are drawn into the South and Central Plains from the South Central area. The Central Plains acquires feeder cattle from the Western Corn Belt, the Lake States, and the Great Basin

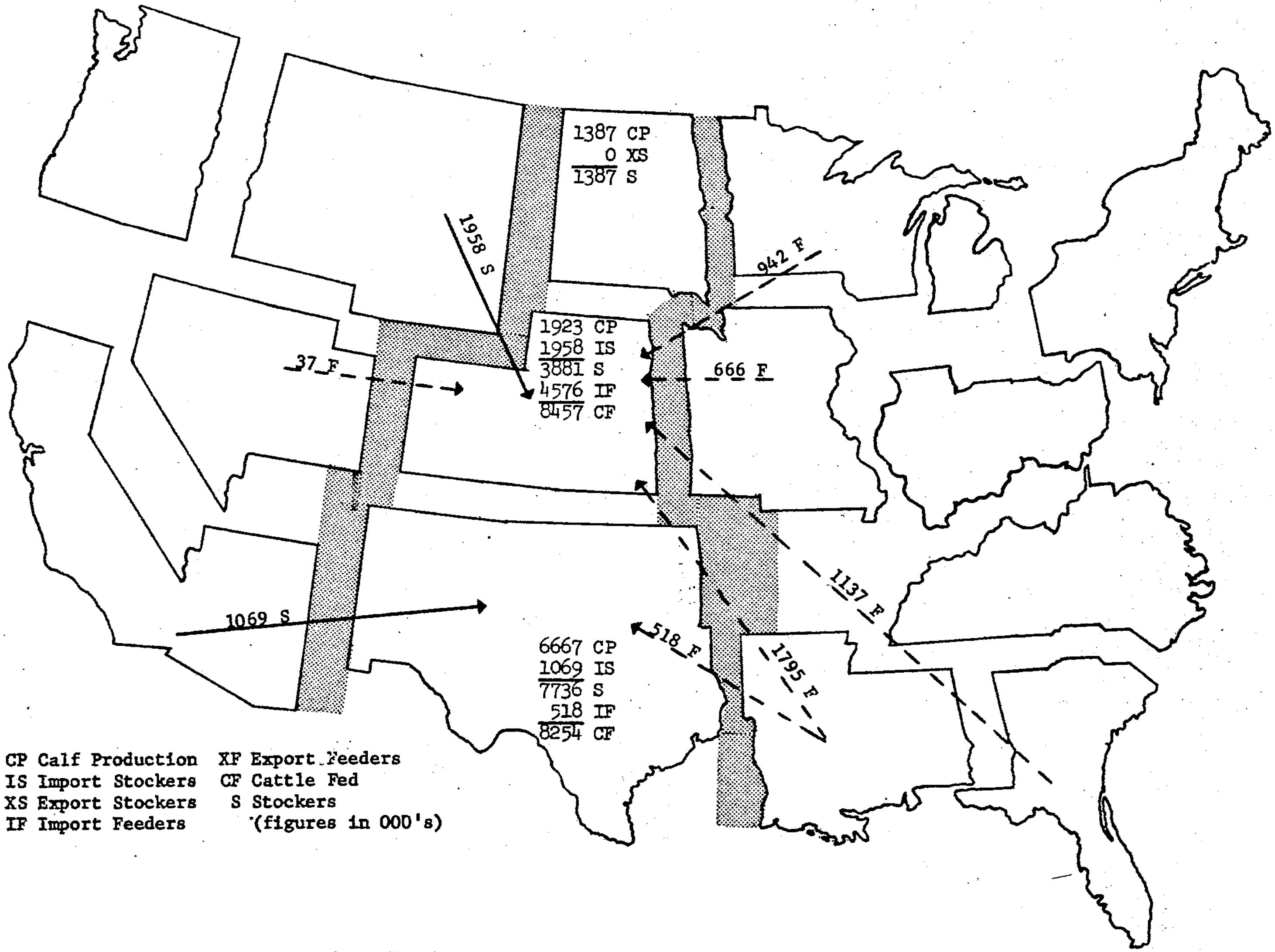

Figure 16. Calf, Stocker and Feeding Operations in the Plains Regions, Model II

areas, as well as from the South Central region. Vast quantities of feed grain were drawn from the Western Corn Belt to the South Plains in order to supplement the large surplus of South Plains wheat. Both the South and Central Plains utilized equal proportions of wheat and feed grains as concentrates in their rations. Feeding in the North Plains used only feed grains in their cattle feeding activity.

Corn Belt

Even though the three Corn Belt regions are located near large consumer markets, these regions experienced a major disadvantage as a result of their inability to supply large quantities of feeder cattle and their relatively high non-feed costs. Two of the Corn Belt regions became suppliers of feeders for the Plains region in Model II (Figure 17). Feeding in the Corn Belt was carried out only in the Eastern Corn Belt. This region received feeder calves from the Upper South for their feeding operations. All beef produced from Eastern Corn Belt lots was marketed internally to the region. The cost structure was such that Eastern Corn Belt beef could not carry any additional cost in the form of transportation and still compete effectively in any other region.

Northeast

Again in Model II, the Northeast was strictly a beef consuming region and did not figure in the beef production patterns of the United States.

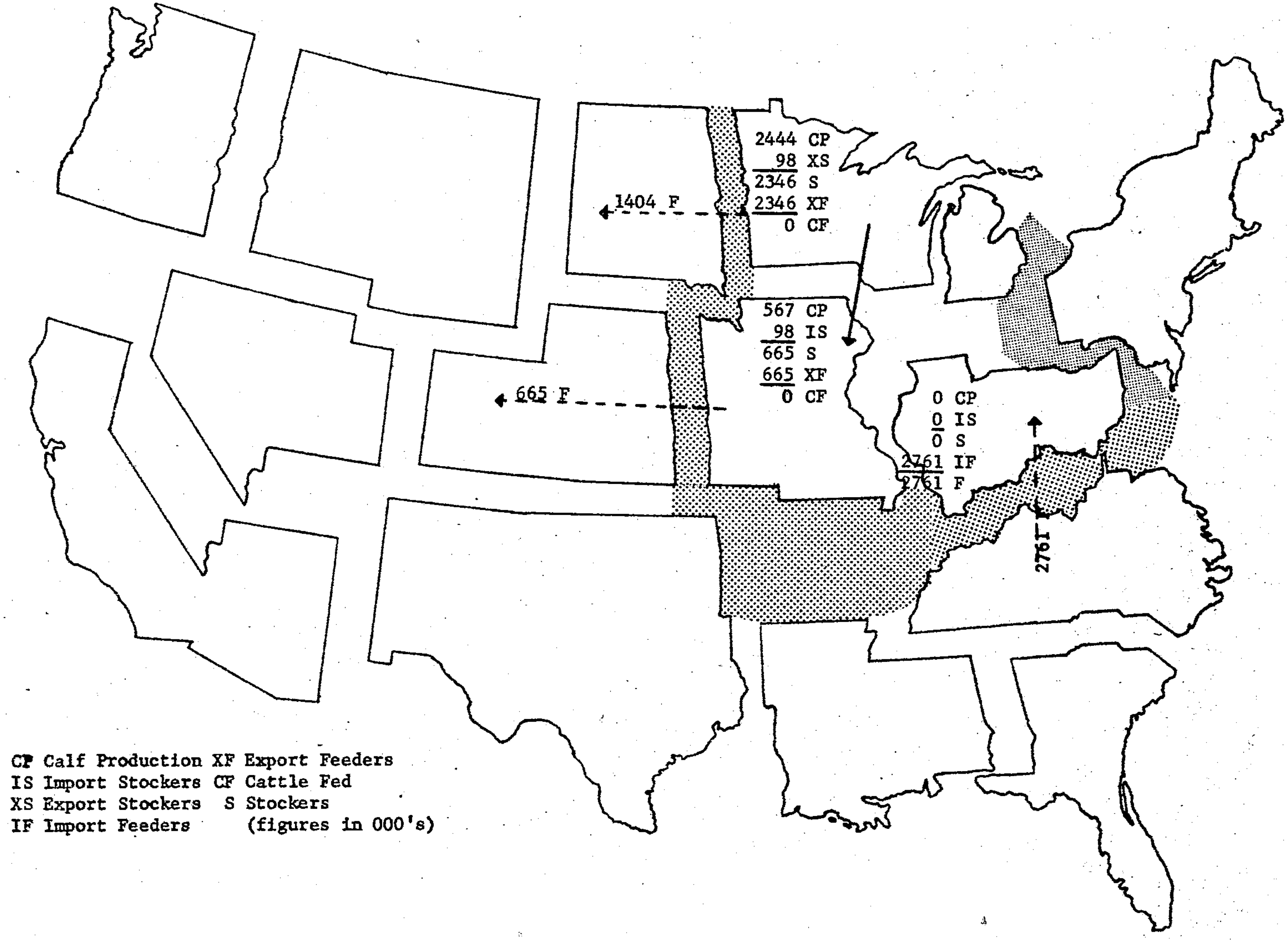

Figure 17. Calf, Stocker and Feeding Operations in the Corn-Belt Regions, Model II

The South

Beef industries in the South centered mainly on calf and feeder cattle production (Figure 18). Only the Upper South was involved in cattle feeding. Feeder cattle from the South Central and Southeast areas were shipped to the South and Central Plains. These two Southern regions found themselves facing the same limitations as did the Corn Belt plus the added disadvantage that the regions were both heavily deficit in feed grains.

Beef Industry Sectors--Model II

Calf Production

Optimal calf production for each individual region is shown in Table XXVII. Calf production was more widely distributed among regions in Model II than in Model I. However, the majority of the calves were still produced in the Plains. The major market for the calves produced outside of the Plains was in the Plains region since this is where the lion's share of feeding eventually took place.

Stocker Production

Stocker calves were mainly grown out in the regions where they originated. Some stocker calves were shipped out of the Western region and some interregional movement took place from the Lake States. Other than these isolated movements, feeder cattle were the ones which were eventually transported.

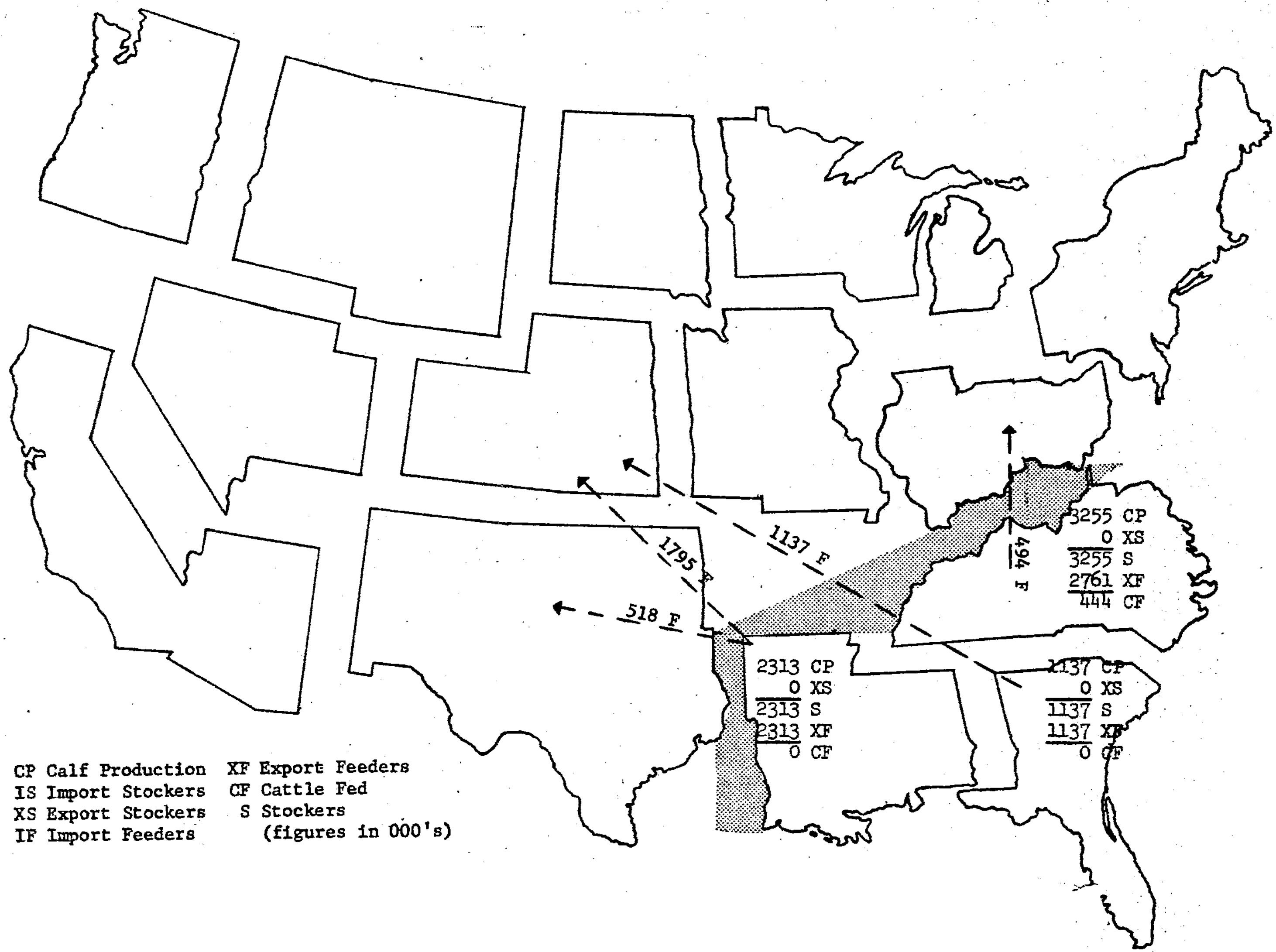

Figure 18. Calf, Stocker and Feeding Operations in the Southern Regions, Model II

TABLE XXVII

OPTIMAL PRODUCTION LEVELS OF CALVES IN MODEL II

Region		Production Level (000 head)
1	Pacific Northwest	-0-
2	Desert Southwest	1069
3	Intermountains	1958
4	Great Basin	405
5	North Plains	1387
6	Central Plains	1923
7	South Plains	6667
8	Lake States	2444
9	Western Corn Belt	567
10	South Central	2313
11	Eastern Corn Belt	-0-
12	Northeast	-0-
13	Upper South	3255
14	Southeast	1137
	Total	26125

Feeding Activity

The location of the major inputs plays a large role in locating the feeding activities. Also, the levels of non-feed costs, slaughtering costs, and costs of carcass beef transportation help in the final analysis to determine the location of feeding activities. The results of Model II suggested that if all facilities had to be built anew, feeding would concentrate in the South and Central Plains (Table XXVIII). The balance of the feeding would be centered in the North Plains, and the Eastern Corn Belt with minor areas in the Intermountain region and the Upper South. Feeding was not carried on in the Western Corn Belt--the largest single feeding region under current conditions. Thus, the locational inertia resulting from fixed investments in feeding facilities is substantial.

The Plains regions, with large commercial lots, enjoy low per head costs of non-feed items in the feeding activity. Costs for feed grains were as low in these regions as in any region except for the Intermountain area. Also, the abundant numbers of feeder cattle produced in the immediate vicinity of the large feed supplies further reduced production costs for fed cattle. The Central and North Plains had enough local grains to feed their cattle. The Central Plains used equal amounts of wheat and feed grains, while the North Plains used only feed grains. Feed in the South Plains consisted of home-grown wheat mixed with locally produced feed grains and with feed grain transported into the region from the Western Corn Belt.

The relative advantage of low costs in both non-feed and feed items coupled with slaughter costs that are lower than in the Northern,

TABLE XXVIII

OPTIMAL FEEDING LEVELS IN MODEL II

Region		Feeding Level (000 head)
1	Pacific Northwest	-0-
2	Desert Southwest	-0-
3	Intermountains	287
4	Great Basin	81
5	North Plains	2791
6	Central Plains	8457
7	South Plains	8254
8	Lake States	-0-
9	Western Corn Belt	-0-
10	South Central	-0-
11	Eastern Corn Belt	2761
12	Northeast	-0-
13	Upper South	494
14	Southeast	-0-
	Total	26125

Western and Eastern states allowed the South Plains to produce a chilled beef carcass at lower costs than any alternative region.

While the Intermountain area enjoyed the lowest feed grain price of any region in the United States, non-feed costs for this area were about average for the country. The Intermountain proximity to the Portland and Seattle markets and the distance of these markets from alternative supply areas permitted the Intermountain area to be competitive in feeding to a limited degree.

The Eastern Corn Belt's feeding advantage results from their proximity to the large consuming areas within this region. The short distance to the consumer offset the disadvantages of relatively high non-feed costs and high slaughter costs.

The Desert Southwest is an area of large commercial lots, but their inability to secure grain at competitive costs places them in a poor competitive position so far as cattle feeding is concerned.

Non-feed costs were the item that prevented the Western Corn Belt from feeding cattle in Model II. A reduction in non-feed cost of $5.81 per head would have been necessary to bring the Western Corn Belt into production. (Total non-feed costs per head reported in the Experiment Station Research Bulletins used in this study were $29.25.) At the lower non-feed costs, feeder cattle would be shipped into the region for feeding.

Movement of Beef

Slaughtering facilities were built in conjunction with the feeding facilities under the conditions of Model II. All slaughtering occurred at the point of production. With the major portion of the feeding and slaughtering occurring in the Plains regions, these areas were the major suppliers of dressed meat. The Central Plains shipped largely to the Western regions and the Northeastern market while the South Plains concentrated their shipments to the Southeast. North Plains beef was transported to the Lake States and the Northeast markets.

The other regions are pretty well furnished by the same regions as in Model I. The Intermountain area still provided its own needs of 25,000 carcasses, shipping the remainder of the Intermountain beef to the Pacific Northwest. The optimal meat flows are shown in Figure 19.

Industry Efficiency

The average cost of supplying a carcass animal under Model II was $232.58 versus $199.19 of Model I. This cost increase would be attributed to the greater transportation costs involved in serving the markets and the costs of purchasing all new feeding and slaughtering facilities. Since 83 percent of all cattle were fed in the Plains regions, the distance that the cattle traveled, both live and in the carcass, were substantially increased.

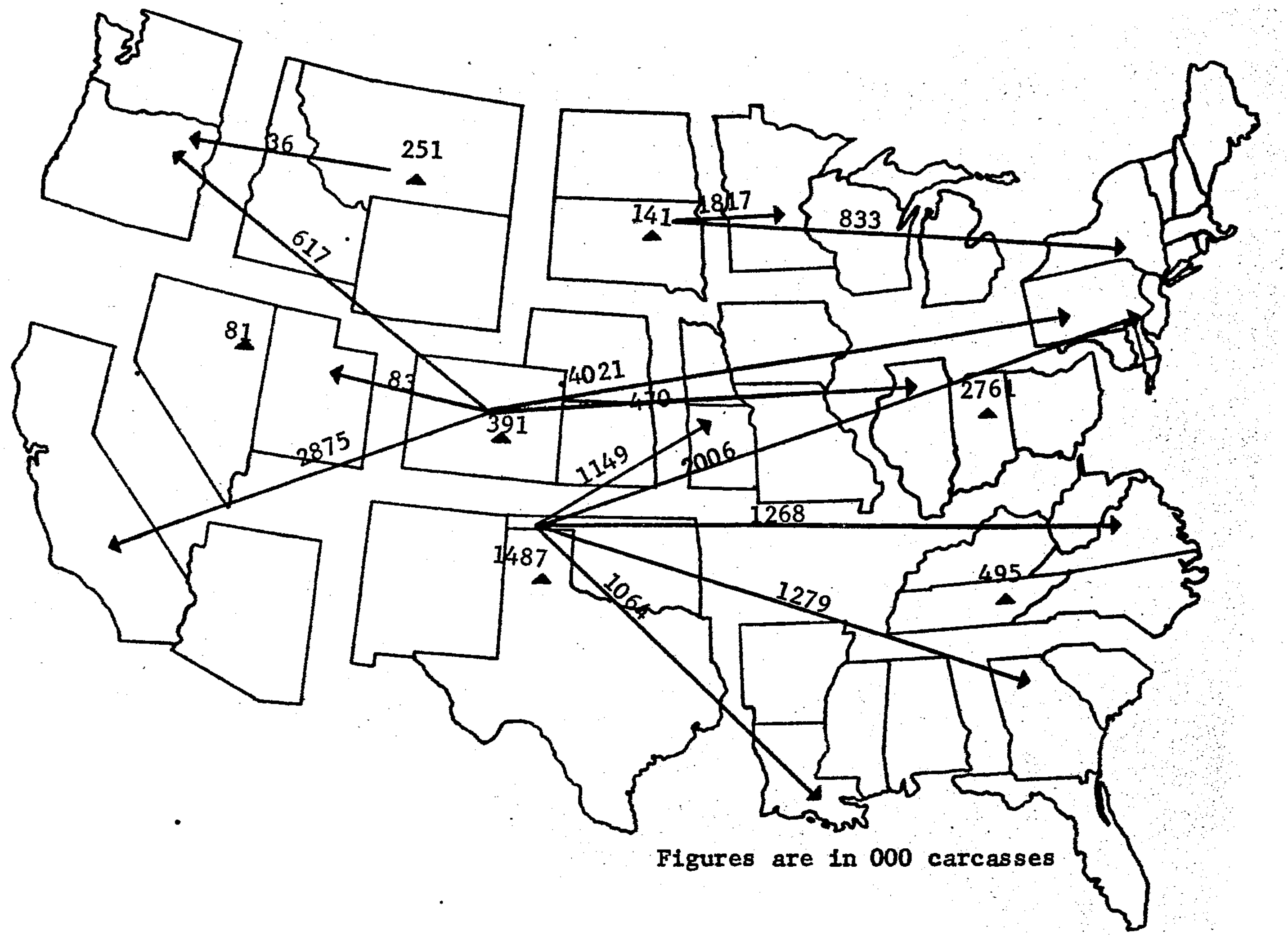

Figure 19. Optimal Flow Pattern of Carcass Meat from Model II

FOOTNOTES

[1]United States Department of Agriculture, Livestock and Meat Statistics, Economic Research Service, Statistical Bulletin 333, Supplements for 1969 (Washington, D. C.), p. 131.

CHAPTER V

PROJECTION PATTERNS ANALYSIS

In order to anticipate future regional growth patterns and to give insight with regard to probable future resource adjustments, the expected impact of the future upon the beef industry has been analyzed. In the process, the expansion of resources needed for meeting the projected future demand has been defined. The model was simulated for income and population changes expected for 1975 and 1980.

Changes for the Projection Models

The primary bases for the expected growth in the beef industry are projected increases in the population of the United States[1] and an expected continued increase in per capita disposable income.[2] To adjust the projected national fed beef consumption, income elasticities (see footnote 4, Chapter III) were used to increase per capita regional consumption estimates based on the projected income increases in footnote 2. These were multiplied by the increase in population for the regions based on the population projections of Model I. These regional per capita estimates of beef demand for 1975 and 1980 are shown in Table XXIX along with the aggregate demand for beef for each region.

Additional grazing capacity was made available to each region through a pasture improving activity. Future regional pasture improvements were projected, based on the average numbers of acres improved

TABLE XXIX

ESTIMATED PER CAPITA FED BEEF CONSUMPTION BY REGIONS AND THE ASSOCIATED ESTIMATED TOTAL FED BEEF CONSUMPTION FOR EACH REGION

Region	Population			Per Capita Disposable Income			Per Capita Consumption			Number of Carcass Animals Demanded		
	1970[a]	1975[b]	1980[b]	1970[c]	1975[d]	1980[d]	1970	1975	1980	1970	1975	1980
	(000 people)											
1 Pacific Northwest	5,500	5,545	6,001	3,170	3,863	4,380	81.66	84.7	92.4	653,766	688,409	813,039
2 Desert Southwest	21,466	25,904	29,480	3,550	4,147	4,622	88.55	92.5	100.9	2,875,304	3,512,993	4,363,515
3 Intermountains	2,312	1,892	2,043	2,640	3,192	3,714	74.62	79.1	86.6	250,936	219,411	259,297
4 Great Basin	1,548	1,829	2,042	2,920	3,065	3,519	71.62	75.9	83.1	163,564	203,596	248,750
5 North Plains	1,283	1,401	1,475	2,690	3,358	3,924	75.0	79.3	87.0	141,122	163,313	188,160
6 Central Plains	3,478	3,196	3,465	2,904	3,590	4,106	76.62	81.2	88.9	390,829	380,568	451,562
7 South Plains	14,771	16,378	17,857	2,750	3,285	3,791	68.67	72.8	79.7	1,487,378	1,748,027	2,085,682
8 Lake States	16,883	16,818	19,220	3,170	3,526	4,070	73.4	77.8	86.3	1,817,127	1,918,534	2,432,091
9 Western Corn Belt	9,793	10,826	11,827	2,878	3,573	4,159	80.17	83.7	91.4	1,148,781	1,329,280	1,584,853
10 South Central	11,198	12,883	13,973	2,230	2,895	3,346	64.82	68.7	75.2	1,064,344	1,297,915	1,540,513
11 Eastern Corn Belt	26,842	28,800	31,139	3,380	4,239	4,823	82.08	85.7	93.6	3,230,539	3,620,692	4,272,253
12 Northeast	52,291	56,169	63,664	3,420	4,144	4,695	88.12	92.05	100.5	6,859,537	7,980,080	9,377,557
13 Upper South	18,517	19,886	21,873	2,490	3,280	3,796	64.92	68.8	75.3	1,762,662	2,006,532	2,415,235
14 Southeast	13,437	15,588	17,358	2,660	2,957	3,436	64.92	68.8	75.3	1,279,034	1,572,742	1,916,506
										23,124,923	26,748,092	31,949,013

[a]U.S. Department of Commerce, 1970 Census of Population (Washington, D. C., 1971). Issues for each state were consulted.

[b]U.S. Department of Commerce, Population Estimates, Series P-25, No. 375 (Washington, D. C., October, 1967), p. 34.

[c]"Per Capita Income by County and State," Sales Management (June 10, 1970), p. B-3.

[d]National Planning Association of Commerce, State Economics and Geographic Projection, Regional Economics Projection Series, Report 70-R-1 (Washington, D. C., 1970), pp. S-6. For 1975 and 1980, the income for the state for which the consumption point is located was used.

through the 1967-1969 period, footnote 9 of Chapter III. The grazing production from the improved acreage was converted to AUM's as discussed in Chapter III.

The increased grazing capability was allocated between cow herds and stocker growing as dictated by the needs of the model. That is, calf production had first claims upon grazing, since the calf had to be produced before it could be grown to feeding weight. These two types of production were allocated among regions such that the total cost of all beef produced was minimum.

Feed grain production was assumed to remain constant except for the South Plains. Continuing development of irrigation in this region has rapidly expanded feed grain production in an area bounded on the north by the Arkansas River and the south by the South Canadian River. Future estimates of feed grain supplies for the South Plains were drawn from the production estimates made by Bekure in a study of the Central Ogallala Formation.[3] The production in this small area was the only expansion of feed grain production allowed in the study.

When the future beef production resulting from expanded facilities for the South Plains is analyzed, the South Plains designation commonly includes those parts of Southwest Kansas and Southeast Colorado which lie south of the Arkansas River. Grain produced in these parts of Colorado and Kansas were grouped with South Plains production due to the inability to specify the quantities of grain produced in each of the sub-state areas within the area.

Many analysts (such as Bekure) group Southwest Kansas and Southeast Colorado with the Oklahoma-Texas High Plains area because of similarities in production and marketing practices.

Model III--1975 Projections

American consumers are expected to demand 2.385 billion more pounds of beef by 1975. The main force behind this 15 percent increase is population growth with some secondary impact from expected increase in average per capita disposable incomes. The increased beef demand can be met either by increased domestic production or through increased beef imports. For the purpose of this study, it was assumed that the additional increase would come from domestic production. The objective of Model III was to define the probable resource adjustments and the regional growth patterns that would be expected to emerge from an increase in domestic production through 1975.

The West

In the aggregate, calf production in the four Western regions was expected to increase by 30,000 head between 1970 and 1975 under the conditions of Model III. This calving increase reflected a large increase in the Desert Southwest with a substantial decrease in the Intermountain area. The decrease in Intermountain calf production was replaced by an increase in the stocker growing activity. The overall beef production pattern in the West, shown in Figure 20, reflected the same general pattern as in Model I; that is, the West produced beef mainly for its own beef markets. The key production region for the West was the Intermountain area. The Intermountain beef industry was geared to supplying stockers for the Pacific Northwest and the Central Plains. Also, the grain production of the Intermountain area supported the feeding industry of all the Western regions.

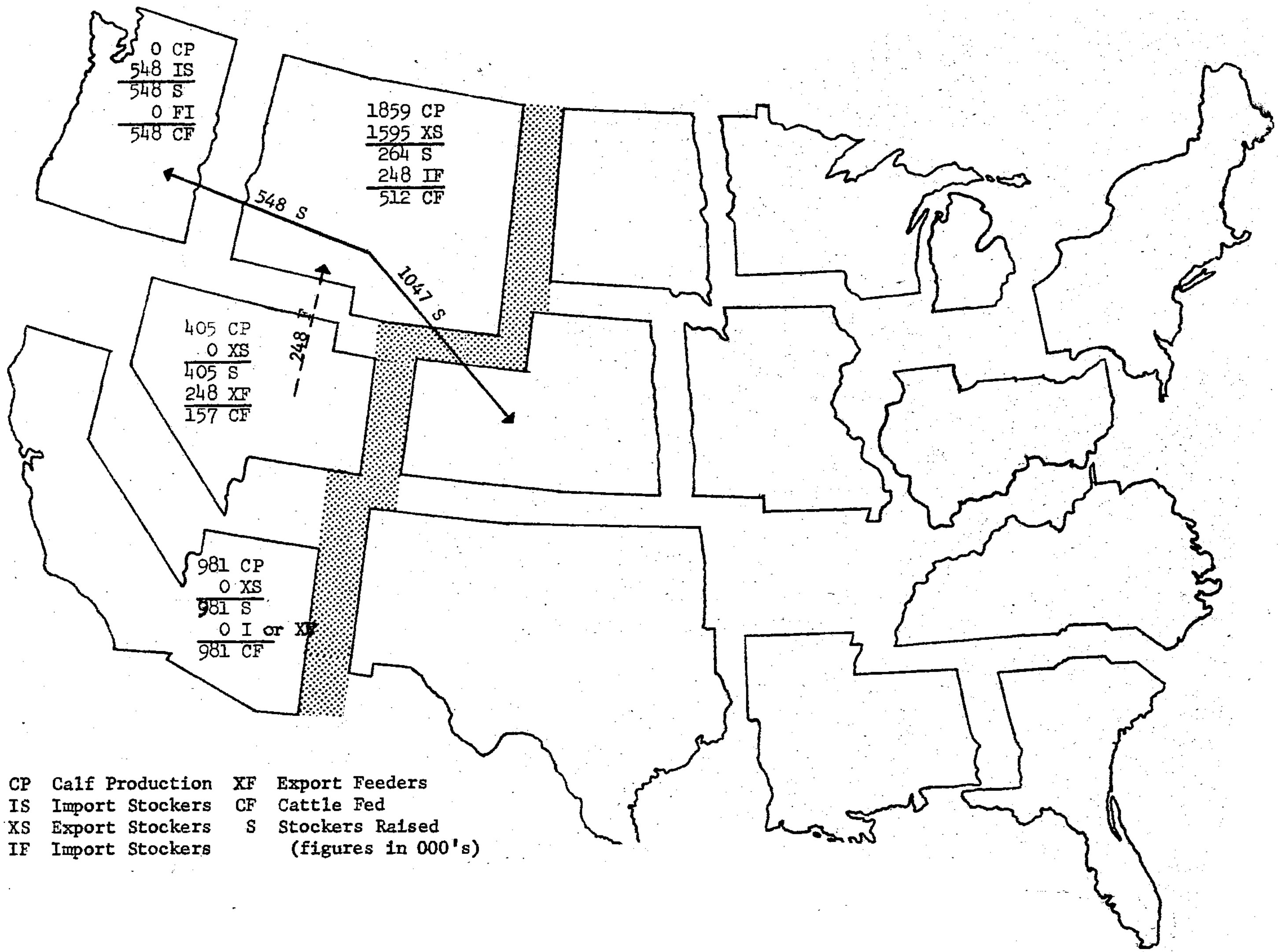

Figure 20. Calf, Stocker and Feeding Operations in the Western Regions, Model III

Stocker calves were exported from the Intermountain area because of the comparative advantage the Intermountain region enjoyed in producing calves as compared with other regions. The Intermountain region was the only feasible source for the calves grown out and fed in the Central Plains. Stocker calves shipped to the Central Plains eventually found their way to the Desert Southwest as carcass beef. This flow pattern occurred since the Central Plains could import stocker calves from the Intermountain region, grow the animals to feeder weight, feed them, and ship the beef cheaper than the combination of operations could be accomplished in any of the Western regions. A small portion of the Desert Southwest market was served through local beef production, but only because resources in the Intermountain and Central Plains areas were exhausted in meeting more favorable beef demands elsewhere.

Even though excess feeding capacity existed in the Intermountain area, a more efficient beef industry resulted from this area being a supplier of basic resources rather than final products.

The Plains

The four Plains regions accounted for nine percent of the increased calf production for 1975. This increase was predominant in the South and Central Plains. Calf production in the North Plains decreased between Models I and III. Stocker calf operations became more important in the North and South Plains while the numbers of stocker calves grown out declined in the Central Plains. The balance sheet for beef production in the Plains is shown in Figure 21.

Each of the Plains regions completely utilized all available grass. The South Plains was the only region to purchase additional

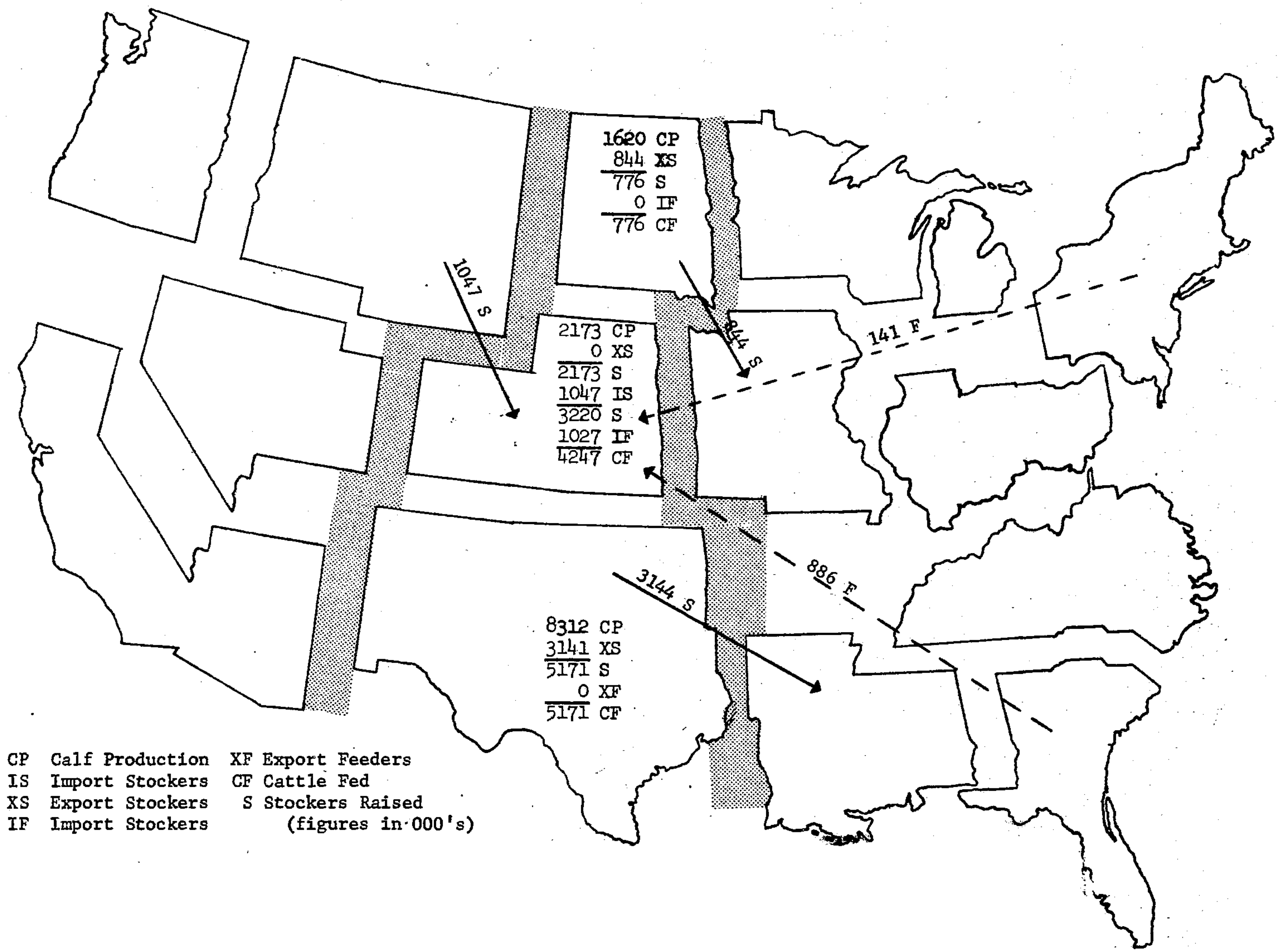

Figure 21. Calf, Stocker and Feeding Operations in the Plains Regions, Model III

grass, purchasing 12.5 million AUM's. This growth means that four million acres of present pasture has to be converted to improved pasture or 1.6 million acres of cropland planted to the high yielding tame pasture grasses.

Both the North and South Plains reserved enough grass to produce the stocker cattle which eventually were fed in these regions. The balance of the grass is utilized in the production of calves. Stocker calves which were in excess supply in the North Plains were shipped to grass in the Western Corn Belt, while the excess stockers in the South Plains were shipped to the South Central region.

Grass capacity in the Central Plains was not sufficient for producing calves and to carry them through to feeding. To make the best use of resources, stocker cattle were shipped from the Intermountain region to the Central Plains, keeping calf production in the Central Plains to a minimum.

While feeding in the South and Central Plains was limited because of feed grain supplies, the North Plains had a large surplus of feed grains. Feeding in the North Plains was limited by the North Plains inability to compete with either the Central or South Plains or the Corn Belt region for the Northeastern beef market. Only after the feed grains in the Central and South Plains areas and after the feeding facilities of the Corn Belt had been exhausted was the North Plains able to expand its feeding operations.

The Corn Belt

The lion's share of the increased numbers of calves required to fill the 1975 consumer's demand for beef was produced in the Corn Belt, particularly in the Eastern Corn Belt. The Corn Belt did not purchase any additional grass; it merely utilized that which had gone unused in Model I.

Grass in the Lake States would be expected to be shifted more toward calf production, with the Lake States retaining only those stocker calves which were used in their local feeding program. Stocker calves were moved from the Lake States to the Western Corn Belt for growing to feeder weights (Figure 22). Under the conditions of Model I, the Lake States have shipped feeder cattle to the Western Corn Belt.

The Western Corn Belt still did not produce calves in Model III. Stocker calves were shipped into the region to utilize the grass available. Although the same numbers of stockers were grown out in the region, the Lake States and the North Plains were joined by the Eastern Corn Belt as the suppliers of these stocker calves rather than the Intermountains area. The Western Corn Belt still imported 74 percent of its feeder cattle from the Southern states as it did in Model I.

The Eastern Corn Belt, producing no calves in Model I, produced 3.13 million calves under the conditions of Model III. Though the Eastern Corn Belt has the second highest calf production cost, the increased calf requirements for 1975 forced the area into production. The Eastern Corn Belt retained none of its calves past weaning, shipping stocker calves to the Western Corn Belt and Upper South for growing purposes. Eventually, the calves shipped to the Upper South return to the feedlots of the Eastern Corn Belt for feeding.

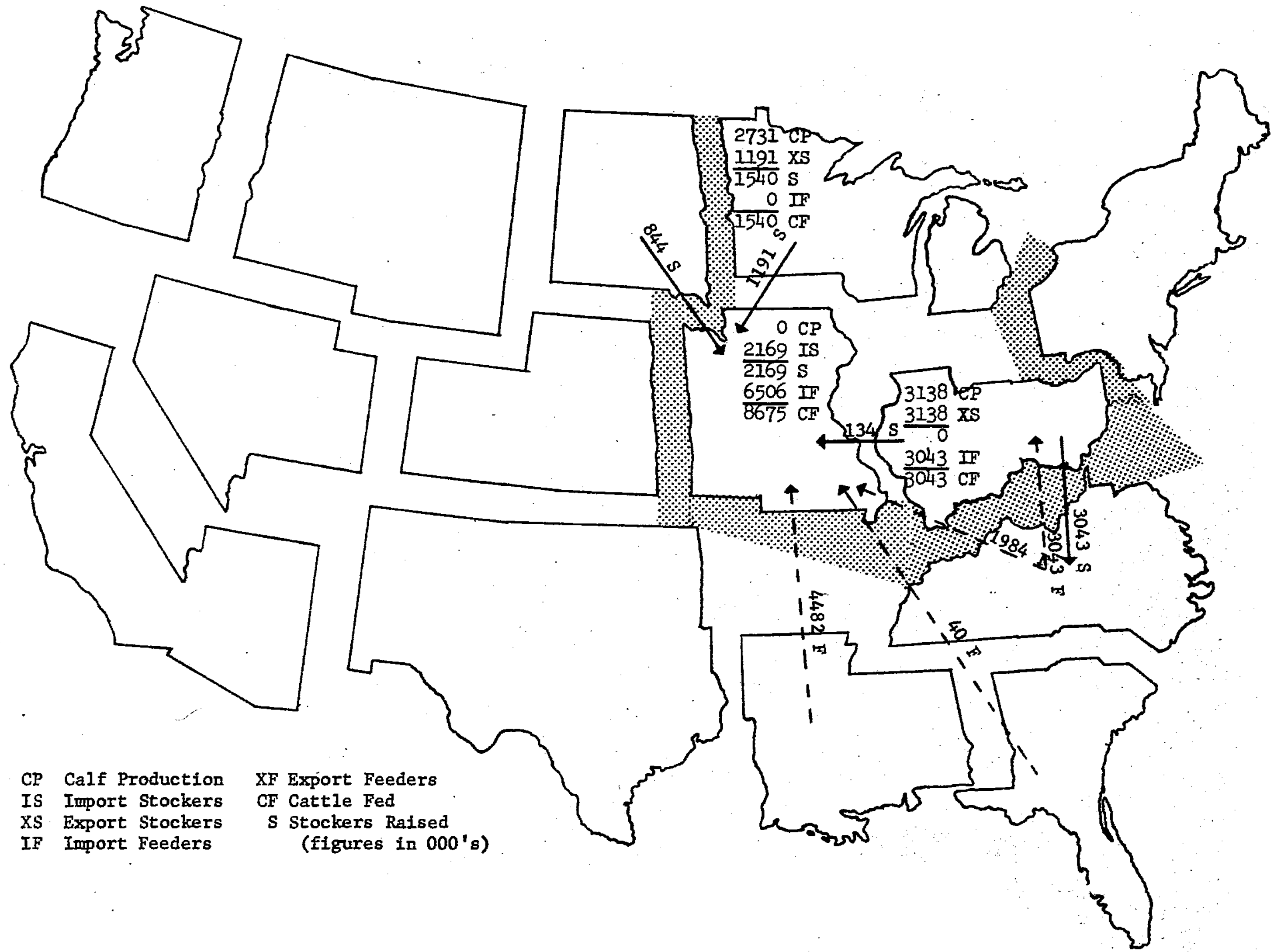

Figure 22. Calf, Stocker and Feeding Operations in the Corn-Belt Regions, Model III

Northeast

Production patterns in the Northeast, shown in Figure 23, showed the Northeast emerging as another marginal beef producing region forced into operation by the expected increase in the total demand for beef. Of the calves produced within this region, all are carried through to feeding weight. Feeder calves in excess of those used for local feeding are transported to the Central Plains.

The South

The Southern beef industry remained a strong cow-calf and stocker production region. Calf production increased in the South Central area, remained the same in the Southeast, and decreased in the Upper South between Models I and III. Calf production in the South Central region increased as the result of reduced stocker inshipments from the South Plains. Having no other inshipments of stocker calves, the South Central area balanced the remaining grass between calf production and the quantity of grass required to grow the stocker calves out. Other than the feeder cattle kept for feeding locally with grain barged in from the Corn Belt, feeder cattle from the South Central area were ultimately fed in the Western Corn Belt (Figure 24).

As the result of increased calf production in the Eastern Corn Belt, grass in the Upper South was shifted toward stocker operations. In an effort to offset high calf production costs in the Eastern Corn Belt, the model used pasture in the Upper South for stockers as a counter balancing force in reducing total beef cost. Consequently, calf production declined in the Upper South to the levels permitted by

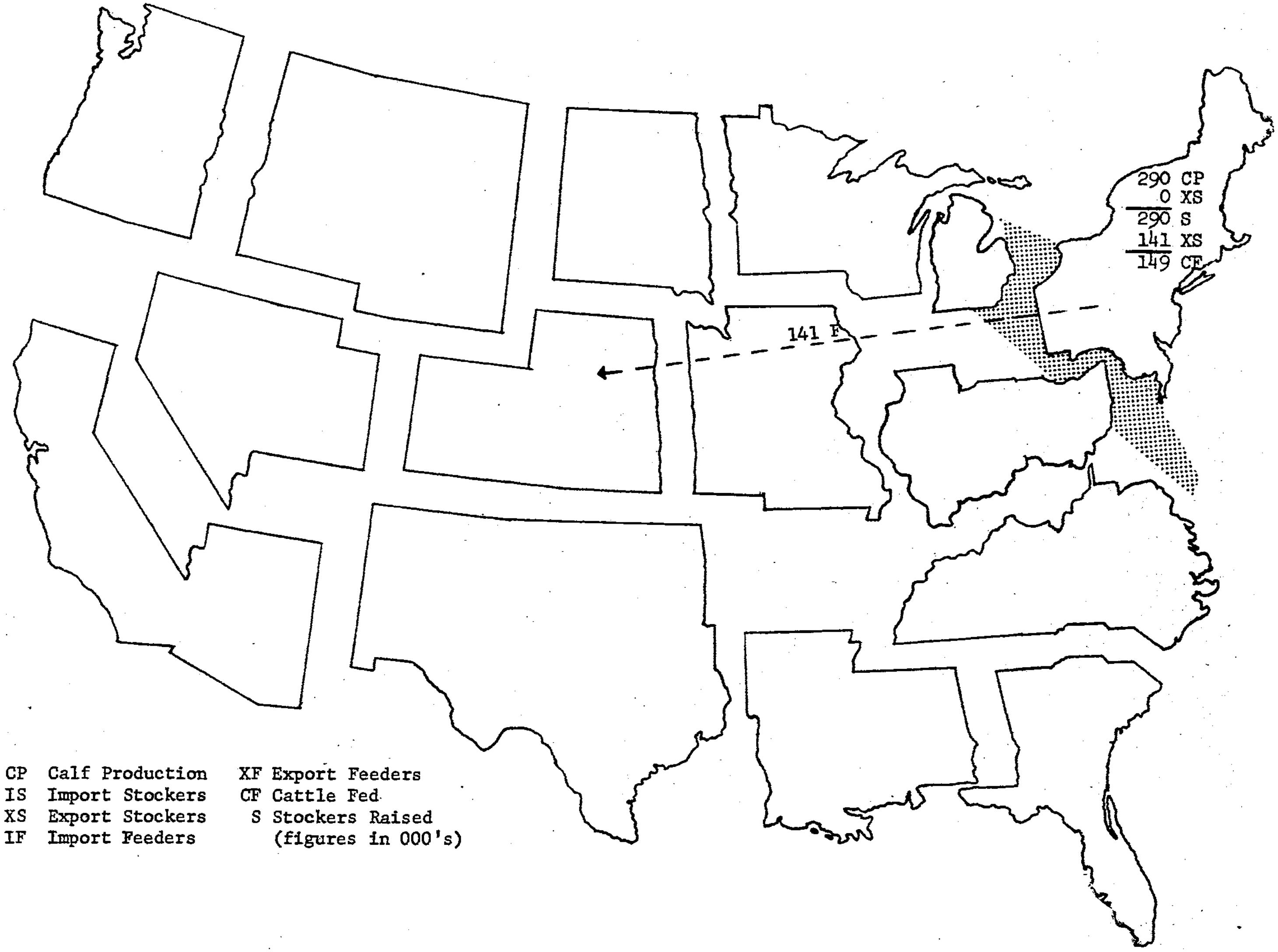

Figure 23. Calf, Stocker and Feeding Operations in the Northeast Regions, Model III

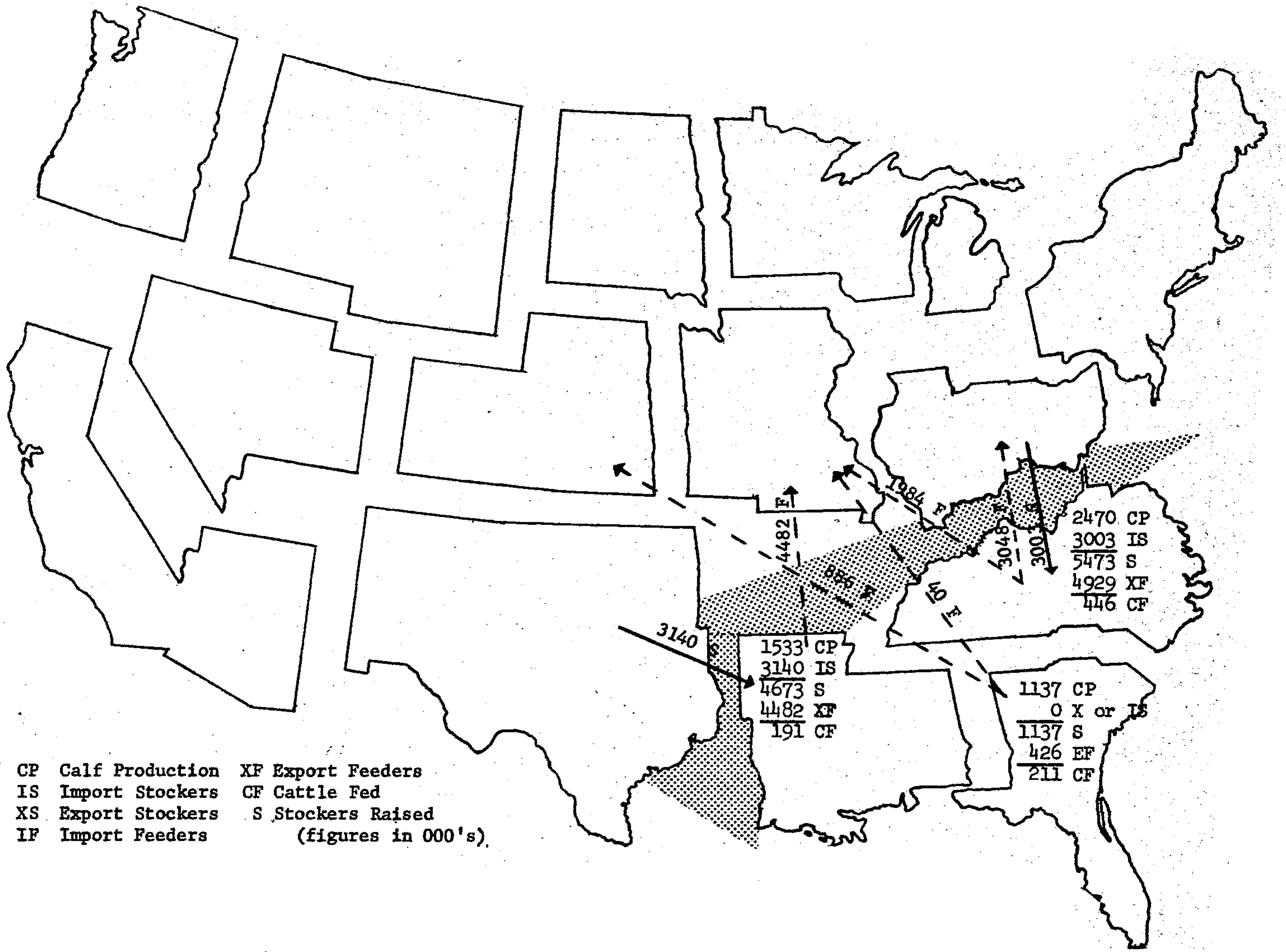

Figure 24. Calf, Stocker and Feeding Operations in the Southern Regions, Model III

the expanded stocker growing enterprise. Feeder cattle grown out in the Upper South were fed in both the Eastern and Western Corn Belts.

Feeding in the Upper South increased to the limit of the available wheat supply. Feed grains were barged into the region from the Corn Belt to blend with the local wheat.

Beef Industry Sectoral Analysis--Model III

Calf Production

Beef production was organized to minimize the movement of heavier cattle. Calves tended to be produced in the peripheral areas, with grass in the feeder areas tending to be used for growing stocker cattle to feeding weights. The Eastern Corn Belt and the Northeast became calf production areas under the demand conditions postulated for 1975. Other regions which had substantially increased calf production included the Lake States, Central and South Plains and the Desert Southwest (Table XXX).

Stocker Operations

Stocker operations became very significant portions of the beef industries in the Upper South, South Plains, and the Desert Southwest (Table XXXI). The Upper South's feeder calves were used for expanded feeding operations in the Eastern Corn Belt. Feeders in the Desert Southwest were used locally as part of a modest beef industry growth which occurred in that region. Stocker operations generally occurred in areas where the calves were eventually fed, or in areas immediately adjacent to their ultimate feeding destination.

TABLE XXX

CALF PRODUCTION IN MODEL III WITH
COMPARISONS FROM MODEL I

Region		Model I 1970	Model III 1975	Change	Percentage Change
		(000 head)			
1	Pacific Northwest	-0-	-0-	-0-	-0-
2	Desert Southwest	862	981	+ 119	+ 14
3	Intermountains	1,958	1,859	- 99	- 5
4	Great Basin	395	405	+ 10	+ 2.5
5	North Plains	1,915	1,620	- 295	- 15
6	Central Plains	1,966	2,173	+ 207	+ 10.5
7	South Plains	7,885	8,312	+ 427	+ 5.4
8	Lake States	2,444	2,731	+ 297	12
9	Western Corn Belt	-0-	-0-	-0-	-0-
10	South Central	1,421	1,533	+ 112	+ 7.9
11	Eastern Corn Belt	-0-	3,138	+3138	+ ∞
12	Northeast	-0-	290	+ 290	+ ∞
13	Upper South	3,142	2,470	- 672	- 21
14	Southeast	1,137	1,137	-0-	-0-
	Total	23,125	26,649		

TABLE XXXI

STOCKER GROWTH IN MODEL III WITH
COMPARISONS FROM MODEL I

Region		Model I 1970	Model III 1975	Change	Percentage Change
		(000 head)			
1	Pacific Northwest	548	548	-0-	-0-
2	Desert Southwest	275	981	+ 706	+ 257
3	Intermountains	-0-	264	+ 264	+ ∞
4	Great Basin	434	405	- 29	- 6.6
5	North Plains	-0-	776	+ 776	+ ∞
6	Central Plains	3,768	3,220	- 548	- 14.5
7	South Plains	4,295	5,171	+ 876	20.4
8	Lake States	2,346	1,540	- 806	- 34
9	Western Corn Belt	2,169	2,169	-0-	-0-
10	South Central	5,011	4,673	- 338	- 6.7
11	Eastern Corn Belt	-0-	-0-	-0-	-0-
12	Northeast	-0-	290	+ 290	+ ∞
13	Upper South	3,142	5,473	+2331	+ 74
14	Southeast	1,137	1,137	-0-	-0-
	Total	23,125	26,647 [a]		

[a]Number may not agree with some previous number because of rounding.

Utilization of Feeding Capacity

Feeding the additional 3.5 million cattle required to meet the demands postulated for 1975 completely utilized all feeding facilities available except for 2.3 million head of capacity in the Western regions. The Desert Southwest and the Intermountain area increased the numbers of cattle fed while the Pacific Northwest and the Great Basin produced the same numbers of fed cattle as in Model I (Table XXXII).

Cattle fed in the three Plains regions increased due to the expansion of facilities in the South Plains. The South Plains purchased capacity for 1,207,000 additional head of cattle. Feed for these cattle was produced locally with a mixture of wheat and feed grains used as the ration base. Other Plains regions retained the same feeding volume as in Model I.

Expansion of facilities in the Eastern Corn Belt by 711,000 head was the major portion of the increased numbers of cattle fed in the Corn Belt. The Western Corn Belt expanded feeding to the limits of the capacity available in the model, but did not purchase additional facilities. Feeding in the Lake States was not affected by the changes in Model III.

One hundred and forty-nine thousand head of cattle were fed in the Northeast. To meet the beef demand in the area, utilization of their facilities became necessary.

Except for expanded feeding in the Upper South, no changes in the levels of cattle feeding occurred in the three Southern regions. The Upper South more than doubled feeding from Model I to Model III, purchasing 252,000 head of additional feeding capacity. The barge

TABLE XXXII

FEEDING ACTIVITY IN MODEL III WITH COMPARISONS FROM MODEL I

Region		Model I 1970	Model III 1975	Change	Percentage Change
		(000 head)			
1	Pacific Northwest	548	548	-0-	-0-
2	Desert Southwest	275	981	706	+ 257
3	Intermountains	277	512	235	+ 85
4	Great Basin	157	157	-0-	-0-
5	North Plains	776	776	-0-	-0-
6	Central Plains	4,247	4,247	-0-	-0-
7	South Plains	3,964	5,171	+1207	+ 30
8	Lake States	1,540	1,540	-0-	-0-
9	Western Corn Belt	8,411	8,675	+ 264	+ 3
10	South Central	191	191	-0-	-0-
11	Eastern Corn Belt	2,332	3,043	+ 711	+ 30
12	Northeast	-0-	149	+ 149	+ ∞
13	Upper South	195	447	+ 252	+ 129
14	Southeast	212	212	-0-	-0-
	Total	23,125	26,649		

transportation system played an extremely important role in this region. Feed grains are transported via barge from St. Paul down the Mississippi and Tennessee River water ways. Enough excess slaughter capacity existed in the Upper South prior to the increased feeding that no new slaughter capacity was necessary. All beef produced in the Upper South was consumed internally.

Cattle Slaughter and the Flow of Beef

Slaughtering of fat cattle occurred at the point of feeding except for the shipment of 227,000 fat animals from the North Plains to the Lake States. Slaughter facilities were built in the Intermountain, Central Plains, South Plains, and Western Corn Belt. Slaughter capacity was completely utilized in those regions that purchased additional capacity, as well as in the North Plains and the Eastern Corn Belt. Excess slaughter capacity was available in all other regions.

Movements of beef under the conditions of Model III were in the same general pattern as observed in Model I. The only changes were that the increased demand in the Lake States was met by beef from the Intermountain and the Western Corn Belt areas. Beef from the Central Plains filled the excess demand in the Pacific Northwest while the Northeast internally provided 149,000 carcasses. The optimal beef flows are shown in Figure 25.

Constraints of the Model

As a result of the increased production necessary for meeting the total demands for beef in Model III, the Desert Southwest and Intermountain areas were the only regions with unused existing feeding

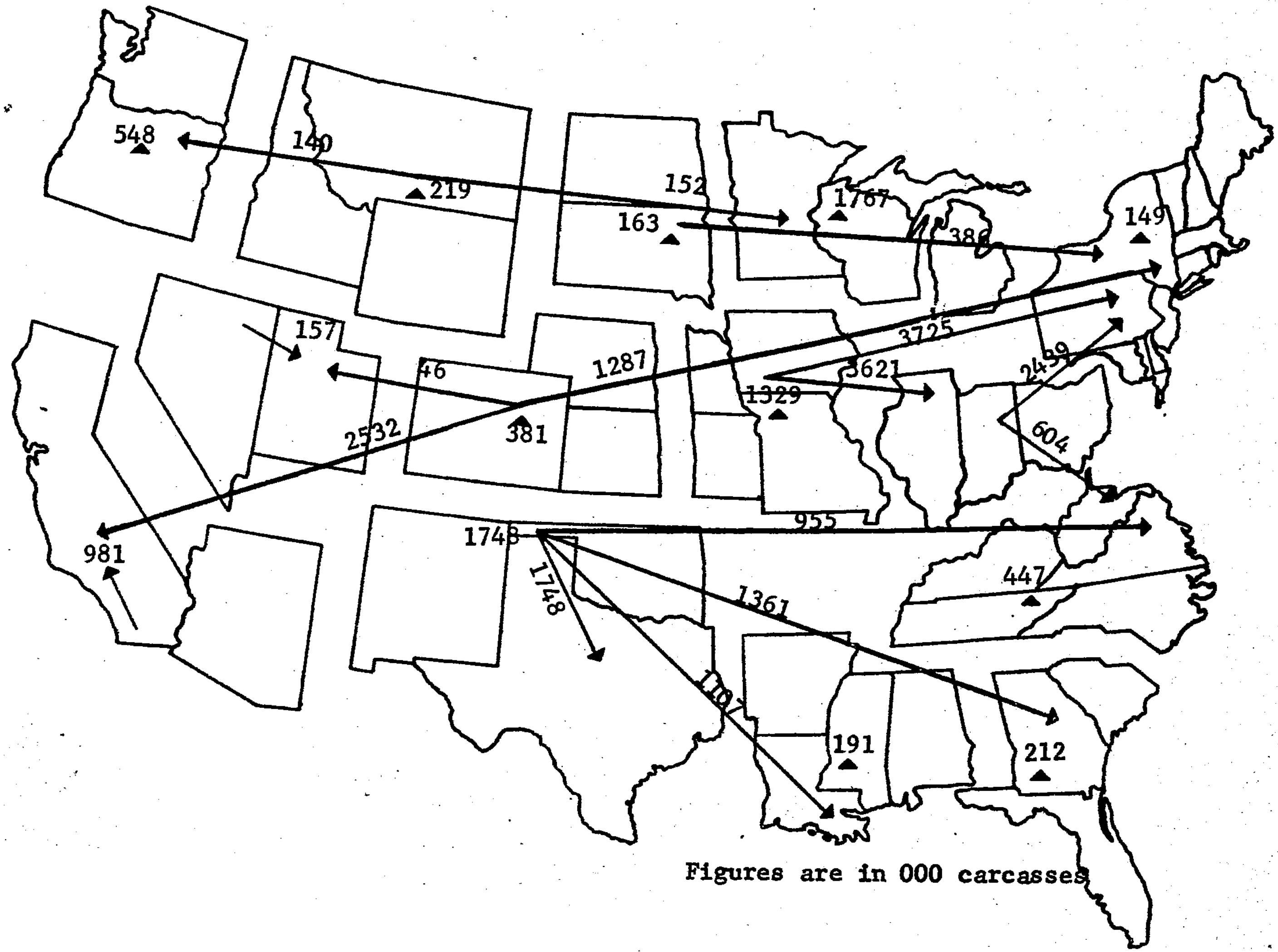

Figure 25. Optimal Meat Flows, Model III

capacity. All other regions were operating at the limits of the constraints in the model with three regions--the South Plains, the Eastern Corn Belt and the Upper South--purchasing new feeding capacity.

The major feeding regions (3, 5, 6, 7, 9, and 11) utilized all existing slaughtering capacity. All other regions had surplus slaughter capacity, even with increased total United States production.

Grassland for producing calves was completely utilized except in the Pacific Northwest and in the Northeast. Only in the South Plains was additional grazing capacity purchased. After the increased feeding requirements had been met, surplus feed grains still existed in the North Plains and the three Corn Belt regions. Surplus wheat was still present in the Pacific Northwest, in all Plains regions, and in the Lake States.

Increased Cost Due to Expansion

The increased demand for beef required that production be expanded to the maximum possible levels of resource utilization in the major regions. Further, production was expanded into the marginal regions such as the Northeast. Assuming that there were no additional per unit cost increases resulting from increased production, the average cost for supplying meat to all regions increased by $9 per animal. This cost increase would be attributed largely to the increased cost of producing calves and feeder cattle in marginal regions. Feeding, for the most part, was accomplished without increasing average costs, and shipment to the markets occurred at the same average costs per animal.

Model IV--1980 Analysis

By 1980, the population of the United States is expected to reach 242,000,000. Per capita income is expected to continue to increase. Beef consumption should continue to grow but probably not at the rate observed during the 1960's. When population increases and moderate increases in per capita income are considered, 8.8 million additional head of fed cattle will be necessary to feed our population by 1980. Model III suggested that 3.5 million additional fed cattle will be needed by 1975. From 1975 to 1980, 5.3 million head in addition to the 1970-75 increase will be required. Resource use was expanded almost to the limit in Model III. Model IV was designed to define the additional adjustments that would be required to move 5.3 million additional fed beef animals through the system between 1975 and 1980.

The West

The Western beef industry would be expected to carry a larger burden in internally supplying the needs of its own region. Prior to 1975, the Pacific Northwest utilized its grazing only for stocker calves. The increased demand for beef forced this region into producing calves which were locally carried to feeding weights. Only those feeders required to fully utilize the locally available feeding capacity were retained in the region with the balance of the feeders being shipped to the Desert Southwest (Figure 26).

The interrelationships between the Intermountain and the Desert Southwest areas are still quite important. Calves produced in the Intermountain area still flow to the Central Plains where they are fed

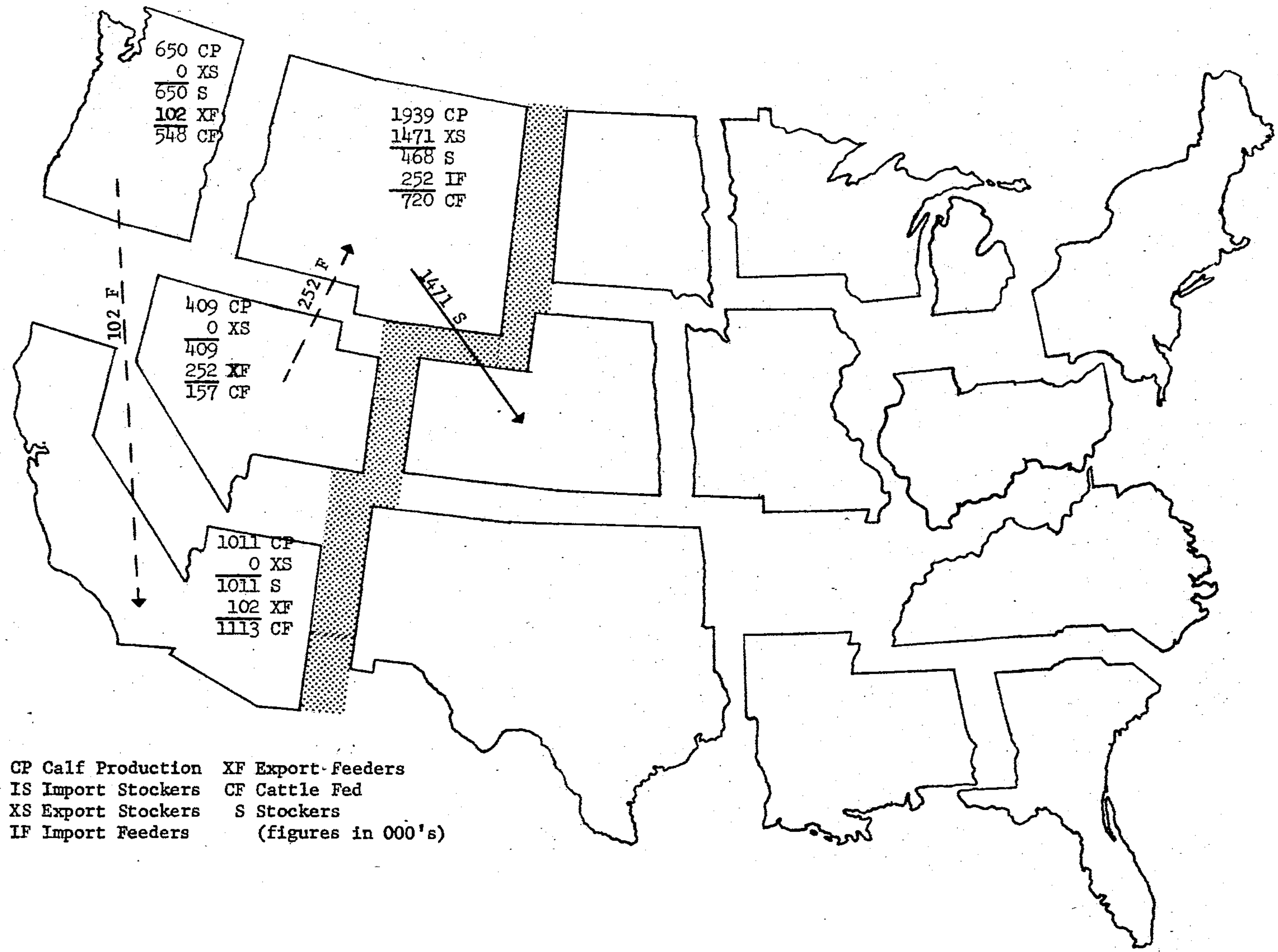

Figure 26. Calf, Stocker and Feeding Operations in the Western Regions, Model IV

and eventually shipped as carcass beef to the Desert Southwest. The Desert Southwest increased all phases of their beef industry by importing feed grain from the Central Plains to carry out the feeding expansion. This movement occurred because feeder cattle were not available at cost levels permitting the Central Plains to further expand feeding operations. Consequently, the Desert Southwest was able to compete to a limited extent for its own beef market.

Overall production in the other two Western regions remained relatively the same over the years. Feeding did increase nominally in the Intermountain area because of its relatively cheap feed grain and low cost feeder cattle.

The Plains

Beef production in the Plains follows the same general patterns as in Model III. Each of the regions utilizes all available grass to produce as many feeders as possible in the purlieu of their feeding industry (Figure 27). The Central Plains is the only Plains region which does not have sufficient grass for growing the necessary numbers of feeder cattle. To balance their feeding program, the Central Plains still imported feeder cattle from the Northeast and Southeast, and shipped excess feed grains to the Desert Southwest.

Within the Plains, the South Plains is the largest single calf producing region. This region produced 8.03 million calves in Model IV, an increase in production of 1.9 percent from Model I. Further, stockers became an increasingly important enterprise. South Plains stocker growing enterprises increased by 87 percent over the ten-year

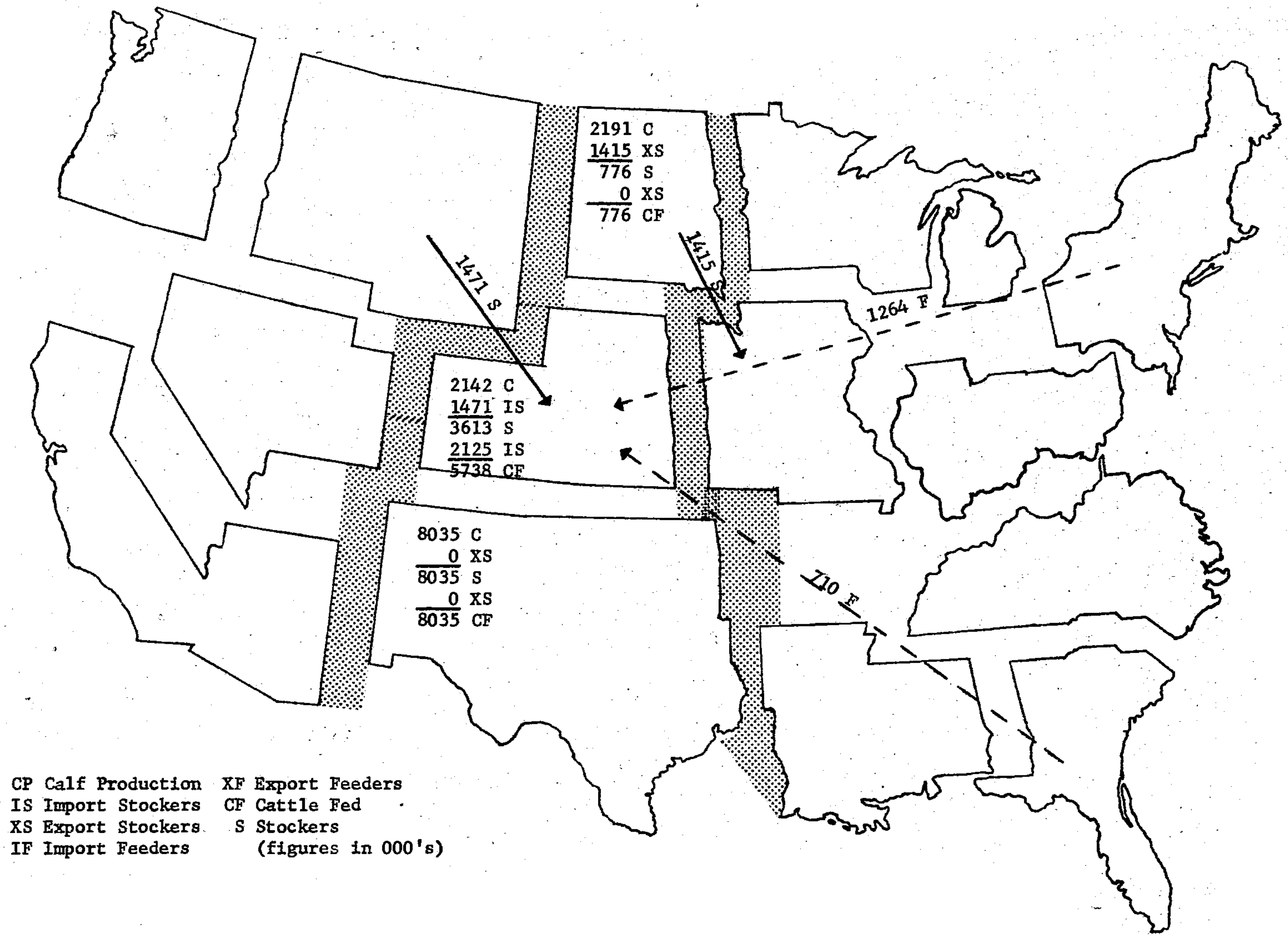

Figure 27. Calf, Stocker and Feeding Operations in the Plains Regions, Model IV

projection period. All stocker calves grown to feeding weights were retained in the region for feeding, utilizing a wheat-feed grain ration.

The Corn Belt

Calf production in the Corn Belt did not change significantly from Model III. Most of the changes in calf production in the Corn Belt regions occurred under conditions expected to prevail by 1975. The Lake States and the Western Corn Belt each expanded their pasture at the projected maximum. The Lake States retained the same numbers of feeders as in previous models, shipping all additional cattle to the Western Corn Belt (Figure 28).

The Western Corn Belt still did not engage in calf production. All of their grazing was utilized for stocker calves which were imported from the North Plains and the other two Corn Belt regions. Again, additional feeders were obtained from the Southern regions to meet Western Corn Belt feeding needs. The Eastern Corn Belt followed the same production patterns as in Model III except they now exported their stocker calves to the South Central region rather than the Upper South. Feeder cattle for Eastern Corn Belt feeding were supplied by the Upper South as in all previous models.

The Northeast

Through 1980, the Northeast expanded their beef operations to help meet the increased total demand for beef. The region held all calves produced to feeding weights (Figure 29). Since the Northeastern region's feeding program remained the same as in Model III, the Northeast now became a substantial supplier of cattle for Central Plains feedlots.

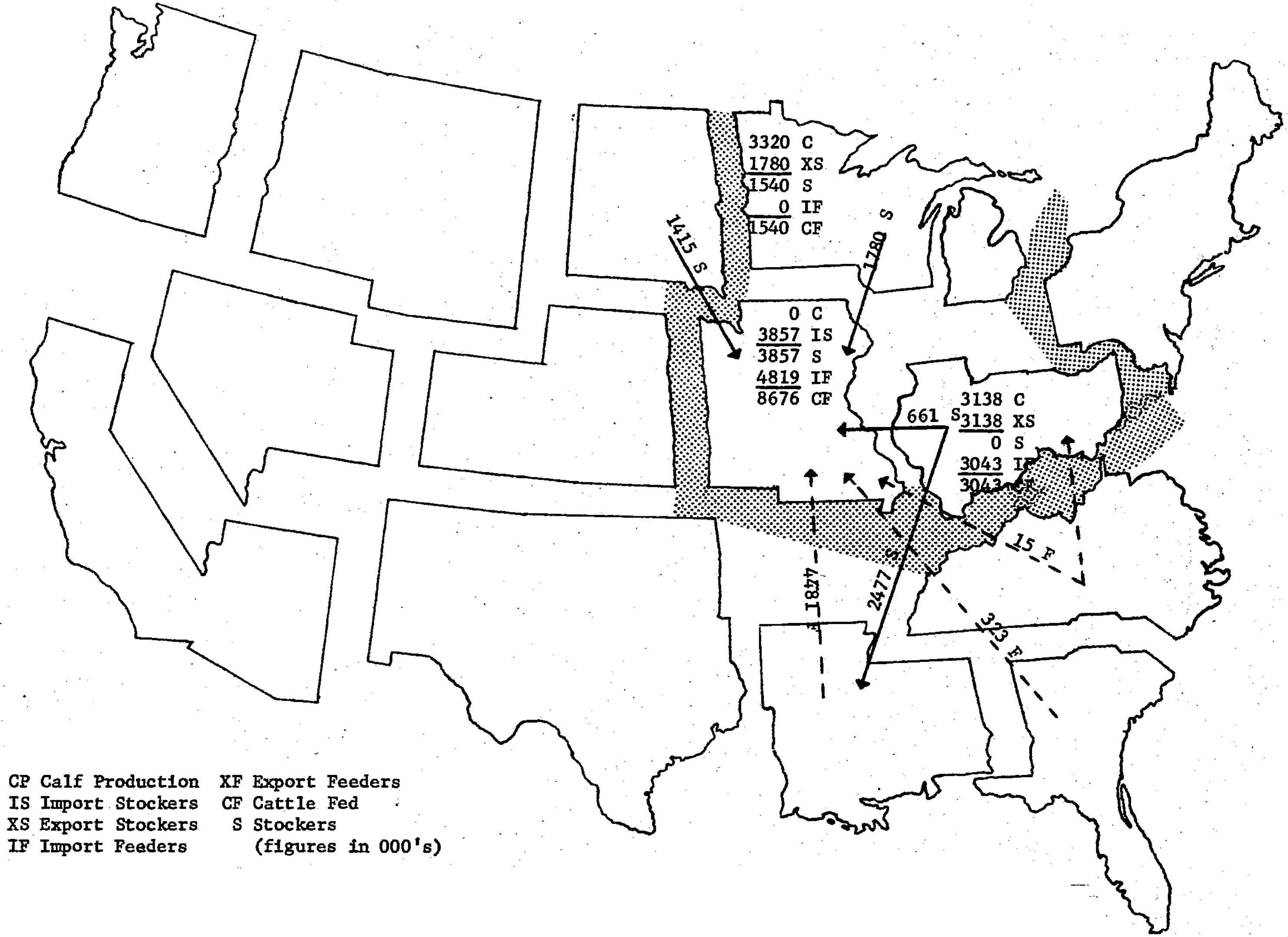

Figure 28. Calf, Stocker and Feeding Operations in the Corn-Belt Regions, Model IV

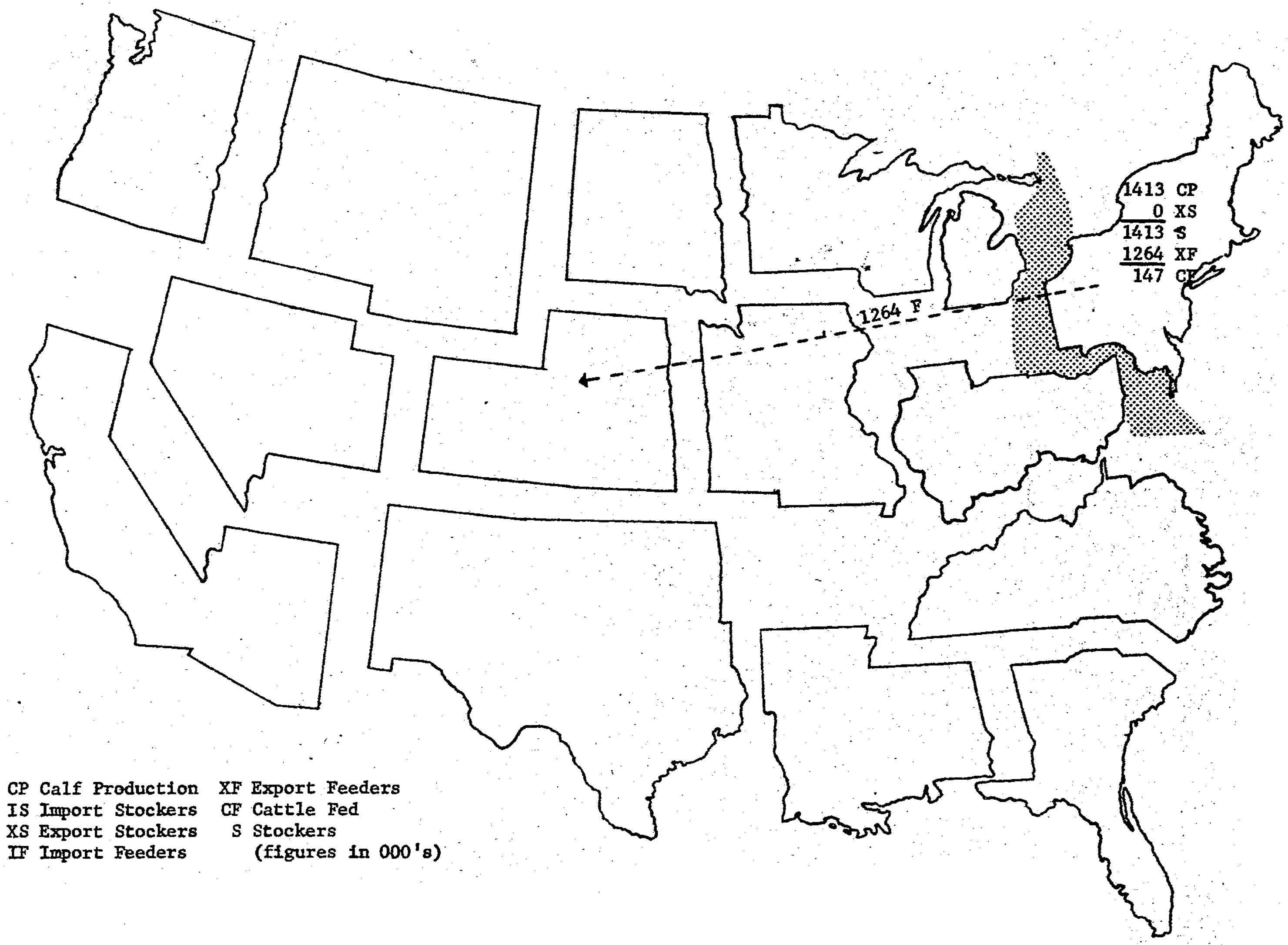

Figure 29. Calf, Stocker and Feeding Operations in the Northeast Regions, Model IV

The South

The South produced 21.8 percent of all calves in Model IV. Production in the Upper South shifted emphasis from calf production to stocker growing. Exports of feeder cattle to the Western and Eastern Corn Belts accounted for the majority of beef production in the Upper South, with the remaining cattle retained for an expanded feeding operation within the region (Figure 30).

The largest percentage increase in production occurred in the South Central area. Calf production increased 54 percent between Models I and IV, with the bulk of the growth coming between 1975 and 1980. Stocker operations remained relatively constant in the South Central area throughout the different models, with inshipments of stockers from the Eastern Corn Belt replacing inshipments from the South Plains between Models I and VI.

The Southeast beef industry was similar to that of the South Central area. The Southeast expanded cow-calf operations by 38 percent, with all of the expansion coming after 1975. All calves produced were held over for the stocker growing activity. Inshipments of stockers did not occur. After the stocker calves reach feeding weights, feeders were shipped to the Central Plains and the Western Corn Belt.

Beef Industry Sectoral Analysis--Model IV

Calf and Stocker Operations

Under the conditions projected for 1980, the optimum calf production would be expected to continue to center in the three Southern regions and the South Plains. Stocker growing was of increasing

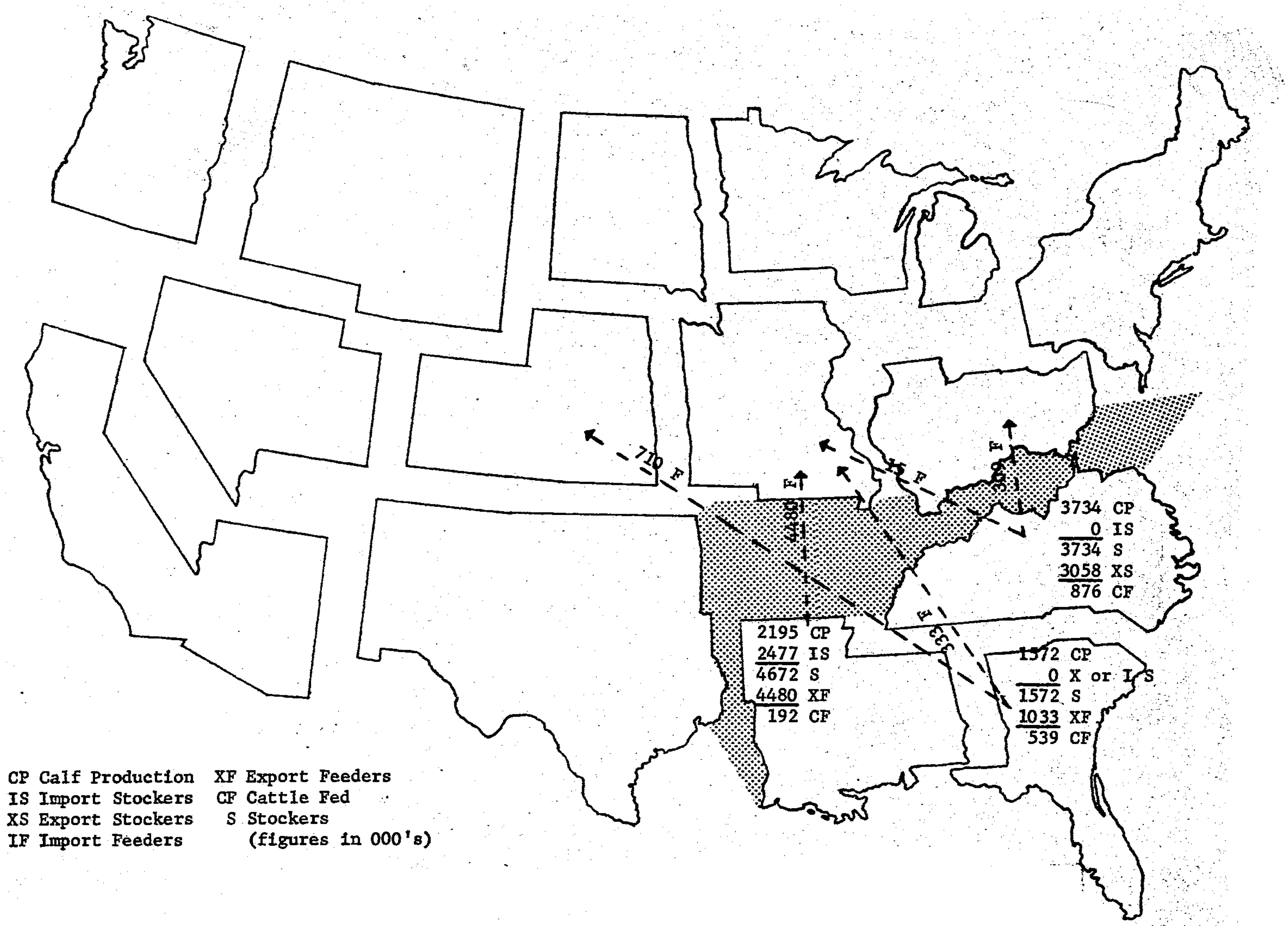

Figure 30. Calf, Stocker and Feeding Operations in the Southern Regions, Model IV

importance in all the Southern regions, but most especially in the Upper South and South Central areas. More calves were produced throughout the South, and fewer inshipments of calves for the intermediate growing period were observed than were observed in Model I.

Calf production was expanded in the Eastern Corn Belt area in the model based on 1975 projections, but the cow-calf enterprise still did not compete favorably in the Western Corn Belt. Western Corn Belt grass was utilized solely for stocker growing operations in all models. Calves utilized grass more efficiently than cows, and the Western Corn Belt's need for feeder cattle coupled with relatively high costs for moving feeder cattle gave the Western Corn Belt a comparative advantage for inshipment of light cattle. The increased needs for calf production forced the Pacific Northwest into calf production. The Desert Southwest was forced to more fully utilize its grass in cow-calf operations, while retaining its calves for growing to feeding weights. The Central and North Plains states increased both calf production and stocker operations. These regions handled cattle which would be fed primarily within the region. The optimal calf and stocker production patterns for the different models are shown in Tables XXXIII and XXXIV.

Feeding Activity Changes

Through 1975, the increased needs for cattle feeding were met primarily by the Plains states and the Corn Belt regions. However, from 1975 to 1980, the Plains emerged as the really significant growth regions (Table XXXV).

Growth in the Western states occurred only in the Desert Southwest and the Intermountain areas. The Desert Southwest expansion was more

TABLE XXXIII

CALF PRODUCTION FROM MODEL IV WITH COMPARISONS

Region		Model I 1970	Model III 1975	Model IV 1980	Change 1970-80	Percentage Change
1	Pacific Northwest	-0-	-0-	650	+ 650	+ ∞
2	Desert Southwest	862	981	1,011	+ 149	+ 17.3
3	Intermountains	1,958	1,859	1,939	- 19	+ 1
4	Great Basin	395	405	409	+ 14	-0-
5	North Plains	1,915	1,620	2,191	+ 276	+ 4
6	Central Plains	1,966	2,173	2,142	+ 176	+ 8.9
7	South Plains	7,885	8,312	8,035	+ 150	+ 1.9
8	Lake States	2,444	2,731	3,321	877	+ 36
9	Western Corn Belt	-0-	-0-	-0-	-0-	-0-
10	South Central	1,421	1,533	2,195	+ 774	+ 54
11	Eastern Corn Belt	-0-	3,138	3,138	+3138	+ ∞
12	Northeast	-0-	290	1,413	+1413	+ ∞
13	Upper South	3,142	2,470	3,934	+ 792	+ 25
14	Southeast	1,137	1,137	1,572	+ 435	+ 38
	Total	23,125	26,649	31,950		

TABLE XXXIV

STOCKER GROWING ACTIVITIES UNDER MODEL IV WITH COMPARISONS

Region		Model I 1970	Model III 1975	Model IV 1980	Change 1970-80	Percentage Change
1	Pacific Northwest	548	548	650	+ 102	+ 18.6
2	Desert Southwest	275	981	1,011	+ 735	+ 267
3	Intermountains	-0-	264	468	468	+ ∞
4	Great Basin	434	405	409	- 25	5.7
5	North Plains	-0-	776	776	+ 776	+ ∞
6	Central Plains	3,768	3,220	3,613	- 155	- 4
7	South Plains	4,295	5,171	8,035	3740	+ 87
8	Lake States	2,346	1,540	1,540	- 806	- 34
9	Western Corn Belt	2,169	2,169	3,857	+1688	+ 77
10	South Central	5,011	4,673	4,672	- 339	- 6.7
11	Eastern Corn Belt	-0-	-0-	-0-	-0-	-0-
12	Northeast	-0-	290	1,413	+1413	+ ∞
13	Upper South	3,142	5,473	3,934	+ 792	+ 25
14	Southeast	1,137	1,137	1,572	+ 435	+ 38
	Total	23,125	26,647[a]	31,950		

[a]Totals may differ from some previous numbers because of rounding.

TABLE XXXV

FEEDING ACTIVITY UNDER MODEL IV WITH COMPARISONS

Region		Model I 1970	Model III 1795	Model IV 1980	Change 1970-80	Percentage Change
			(000 head)			
1	Pacific Northwest	548	548	548	-0-	-0-
2	Desert Southwest	275	981	1,113	+ 838	+ 304
3	Intermountains	277	512	720	+ 443	+ 160
4	Great Basin	157	157	157	-0-	-0-
5	North Plains	776	776	776	-0-	-0-
6	Central Plains	4,247	4,247	5,587	+1491	+ 35
7	South Plains	3,964	5,171	8,035	+4071	+ 102
8	Lake States	1,540	1,540	1,540	-0-	-0-
9	Western Corn Belt	8,411	8,675	8,675	+ 264	+ 3
10	South Central	191	191	191	-0-	-0-
11	Eastern Corn Belt	2,332	3,043	3,043	+ 711	+ 30
12	Northeast	-0-	149	149	-0-	+ ∞
13	Upper South	195	447	877	+ 681	+ 349
14	Southeast	212	212	539	+ 327	+ 154
	Total	23,125	26,649	31,950		

pronounced between Models I and III. However, an additional 132,000 head of cattle were fed in Model IV than were fed in Model III. The other Western region which showed growth was the Intermountain area. This region grew at about the same rate over the ten-year period, an annual increase of 235,000 head during the 1970-75 period and an annual increase of 208,000 head during 1975-1980. The total growth in the Intermountain region amounts to an 84 percent increase over the ten-year period.

The majority of the feeding expansion occurred in the Central and the South Plains regions. The Central Plains expanded by 31 percent, with all growth occurring during the 1975-1980 period (Model IV). Feeding in the South Plains expanded by 4,047,000 animals over the ten-year period with 3,788,000 of these occurring during the 1975-1980 period. Feeding in the North Plains remained constant. Locally available resources for feeding in the three Plains regions gave these areas an advantage for supplying beef to consumer markets. The disadvantages these regions face in distance from the markets for carcass beef were more than made up in lower feeding costs (both feed and non-feed) and in lower costs of acquiring feeders.

Feeding in the Corn Belt leveled off as it became necessary to expand feeding. The Eastern Corn Belt was the only Corn Belt region to expand operations beyond currently available facilities. To feed 3,043,000 cattle under the conditions of Model IV, the Eastern Corn Belt expanded feeding capacity by an additional 711,000 head. The Western Corn Belt remained the largest single region in the feeding of beef cattle. Even though their increase was only three percent, with all of this increase coming during the 1970-75 period, the Western Corn

Belt still fed more than 8.4 million head in Model IV. The region had the feed resources to feed more cattle than were fed in Model IV, but elevated levels of non-feed cost put the region in a position of disadvantage so far as expanded feeding was concerned. Feeding in the Lake States did not change from the previous model, nor did the feeding in the Northeast.

Cattle feeding in the South was small, compared with the other regions of the United States. Only 4.5 percent of the total feeding in the United States occurred in the three Southern regions. Of these regions, the Upper South and the Southeast were the ones to increase their feeding activities. The Upper South increased feeding by 681,000 animals with 252,000 head of the increase occurring between 1970 and 1975, and the remaining 429,000 increase occurring between 1975 and 1980. Cattle feeding expansion in the Southeast occurred during the 1975-1980 period. The number of animals fed in each region for Models I, III and IV are shown in Table XXXV.

Meat Distribution

The patterns in which beef was distributed from the different regions were essentially the same as for all other models except for magnitudes (Figure 31). Three changes did occur in Model IV which were not present in Model I. The Intermountain area shipped excess beef to the Lake States. Beef from the South Plains began to move into the Northeastern market. The Eastern Corn Belt ceased shipping beef to the Upper South as a result of the expansion of feeding in that region.

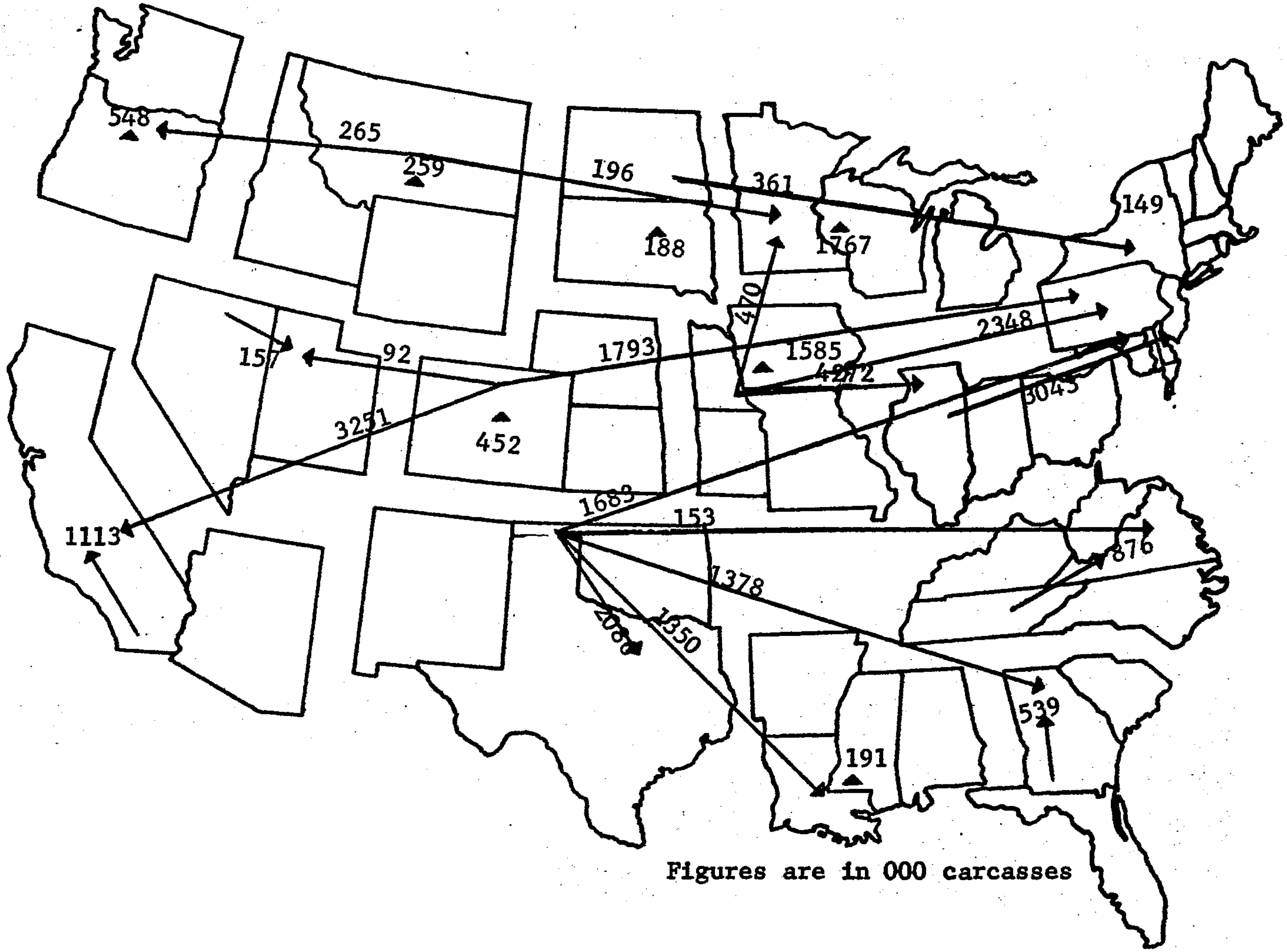

Figure 31. Optimal Flow Pattern of Dressed Beef, Model IV

Feed Grains and Wheat

After the 1980 beef production needs were met, surplus feed grains remained in the North Plains and the Corn Belt while surplus wheat remained in the Pacific Northwest, in the Intermountain area, in all Plains regions, and in the Northern Corn Belt.

For cattle fed under the conditions of Model IV, the Western regions used equal amounts of wheat and feed grains. The Pacific Northwest received feed grain from the Intermountain area while the Desert Southwest purchased feed grain from the Central Plains. The Intermountain area exhausted its supply of feed through local feeding and export. Additional feed grain was imported by rail from the North Plains. Feed grain for Great Basin feeding came from the Central Plains. Without the local supplies of wheat or feed grains, the feeding in the Western regions was of necessity very limited.

Feed grains were the major concentrate used in the Corn Belt. The Lake States utilized only feed grain while the other two regions used limited amounts of wheat.

The Southern regions were deficit regions with regard to both wheat and feed grain. Barge transportation permitted the South Central area and the Upper South to procure grains for feeding at relatively low cost. Each of the Southern regions utilized equal quantities of wheat and feed grain in their rations. Optimal wheat and feed grain movements are shown in Tables XXXVI and XXXVII.

TABLE XXXVI

OPTIMAL SHIPMENT OF WHEAT FROM MODEL IV

Origin		Destination		Quantity Shipped (000,000 therms)
1	Washington, Oregon	1	Washington, Oregon	546
		2	California, Arizona	1,077
2	California, Arizona	2	California, Arizona	35
3	Montana, Wyoming, Idaho	3	Montana, Wyoming, Idaho	711
		4	Nevada, Utah	80
6	Colorado, West Kansas, West Nebraska	6	Colorado, West Kansas, West Nebraska	5,647
7	Oklahoma, Texas, New Mexico	7	Oklahoma, Texas, New Mexico	8,007
9	Iowa, East Kansas, East Nebraska, Missouri	9	Iowa, East Kansas, East Nebraska, Missouri	867
		10	Louisiana, Alabama, Mississippi, Arkansas	143
10	Louisiana, Alabama, Mississippi, Arkansas	10	Louisiana, Alabama, Mississippi, Arkansas	48
11	Ohio, Indiana, Illinois	11	Ohio, Indiana, Illinois	2,748
		12	New England	148
13	Tennessee, Kentucky, West Virginia, Virginia, North Carolina	13	Tennessee, Kentucky, West Virginia, Virginia, North Carolina	445

TABLE XXXVII

OPTIMAL SHIPMENTS OF FEED GRAINS FROM MODEL IV

Origin		Destination		Quantity Shipped (000,000 therms)
3	Montana, Wyoming, Idaho	1	Washington, Oregon	546
		3	Montana, Wyoming, Idaho	687
4	Utah, Nevada	4	Utah, Nevada	12
5	North Dakota, South Dakota	3	Montana, Wyoming, Idaho	24
		5	North Dakota, South Dakota	1,547
6	Colorado, West Nebraska, West Kansas	2	California, Arizona	821
		7	Oklahoma, Texas, New Mexico	1,984
7	Oklahoma, Texas, New Mexico	7	Oklahoma, Texas, New Mexico	6,023
		12	New England	148
8	Wisconsin, Minnesota, Michigan	2	California, Arizona	293
		8	Wisconsin, Minnesota, Michigan	3,069
		13	Kentucky, Tennessee, West Virginia, Virginia, North Carolina	1,301
		14	Florida, Georgia, South Carolina	1,074
9	Iowa, Missouri, East Kansas, East Nebraska	9	Iowa, Missouri, East Kansas, East Nebraska	16,732
		10	Mississippi, Alabama, Louisiana, Arkansas	190
11	Illinois, Indiana, Ohio	11	Illinois, Indiana, Ohio	3,509

FOOTNOTES

[1]U.S. Department of Commerce, Population Estimates, Series P-25, No. 375 (Washington, D.C., October, 1967), p. 34.

[2]National Planning Association, State Economics and Demographic Projections, Regional Projection Series, Report 70-R-1 (Washington, D.C., 1970), p. S-6.

[3]Solomon Bekure, "An Economic Analysis of the Intertemporal Allocation of Ground Water in the Central Ogallala Formation" (Unpub. Ph.D. thesis, Oklahoma State University, 1971), p. 57.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to evaluate the interregional aspects and competitive structure of the beef industry. The specific objectives were:

(1) To specify optimum locations for brood cow herds, stocker operations, feedlots, and slaughter plants subject to existing production constraints of feed grain, wheat, grass capacity, feedlot capacity, and slaughtering capacity.

(2) To examine the effects of removing the constraints of feedlot capacity and slaughtering capacity on the optimum locations of brood cow herds, stocker operations, feedlots, and slaughter plants.

(3) To postulate probable future changes in regional production patterns when the total demand for beef increases.

A transhipment model was used to simulate optimum regional patterns of production and slaughter in the beef industry. Four major models were utilized. Model I showed the optimal locations for the beef industry under conditions approximating the current situation. Model II was designed to define the optimal situation in the beef industry if no feeding or slaughter constraints were in the model. The results of Model II would give indications of which regions could be expected to become commercial producing areas if the "fixed" resources were not fixed. This model suggests the expected directions of change and the magnitudes of the incentive for change in today's beef industry.

Models III and IV analyze the probable adjustments in the beef industry as it strives to serve the demand for beef projected for 1975 and for 1980.

The principal conclusions to be drawn from this analysis relate to the usefulness of the general approach and to the applicability of the findings in indicating probable direction of change in the location of beef production and products flows. Interpretations of the magnitudes of production and geographical flows are conditioned by the characteristics of the data. Since the various areas of published livestock data are frequently inconsistent, the magnitudes of the estimates in this study should be interpreted as relative rather than absolute figures in anticipating the relative changes among the different models and among the different regions of this study.

The Optimum Under Current Conditions

The optimum locations for the different industry segments in the different models are shown in Tables XXXVIII, XXIX, and XXXX. Under current conditions (Model I), the Southern regions (10, 13, 14) and the South Plains (7) predominated in calf production. All of these regions have large acreages of grassland. Further, in recent years vast acreages have been converted to improved pastures. Converting abandoned and low-productivity cropland to high yielding grasses has enabled the South to profitably expand the beef enterprise. Optimally, under present conditions the three Southern regions and the South Plains should carry weaned calves through to feeding weight. There was a transfer of excess stocker cattle from the South Plains to the South Central area. Feeding activities throughout the three Corn Belt

TABLE XXXVIII

OPTIMAL CALF PRODUCTION FOR THE DIFFERENT MODELS

Region		Model I	Model II	Model III	Model IV
		(000 head)			
1	Pacific Northwest	-0-	-0-	-0-	650
2	Desert Southwest	862	1,069	981	1,011
3	Intermountains	1,958	1,958	1,859	1,939
4	Great Basin	395	405	405	409
5	North Plains	1,915	1,387	1,620	2,191
6	Central Plains	1,966	1,923	2,173	2,142
7	South Plains	7,885	6,667	8,312	8,035
8	Lake States	2,444	2,444	2,731	3,321
9	Western Corn Belt	-0-	567	-0-	-0-
10	South Central	1,421	2,313	1,533	2,195
11	Eastern Corn Belt	-0-	-0-	3,138	3,138
12	Northeast	-0-	-0-	290	1,413
13	Upper South	3,142	3,255	2,470	3,934
14	Southeast	1,137	1,137	1,137	1,572
	Total	23,125	23,125	26,649	31,950

TABLE XXXIX

OPTIMAL STOCKER GROWTH ACTIVITIES FOR
THE DIFFERENT MODELS

Region		Model I	Model II	Model III	Model IV
			(000 head)		
1	Pacific Northwest	548	-0-	548	650
2	Desert Southwest	275	-0-	981	1,011
3	Intermountains	-0-	-0-	264	468
4	Great Basin	434	405	405	409
5	North Plains	-0-	1,387	776	776
6	Central Plains	3,768	3,881	3,220	3,613
7	South Plains	4,295	7,735	5,171	8,035
8	Lake States	2,346	2,346	1,540	1,540
9	Western Corn Belt	2,169	666	2,169	3,857
10	South Central	5,011	2,313	4,673	4,672
11	Eastern Corn Belt	-0-	-0-	-0-	-0-
12	Northeast	-0-	-0-	290	1,413
13	Upper South	3,142	3,255	5,475	3,934
14	Southeast	1,137	1,137	1,137	1,572
	Total	23,125	23,125	26,649	31,950

TABLE XXXX

OPTIMAL FEEDING ACTIVITIES FOR THE DIFFERENT MODELS

Region		Model I	Model II	Model III	Model IV
			(000 head)		
1	Pacific Northwest	548	-0-	548	548
2	Desert Southwest	275	-0-	981	1,113
3	Intermountains	277	287	512	720
4	Great Basin	157	81	157	157
5	North Plains	776	2,791	776	776
6	Central Plains	4,247	8,457	4,247	5,587
7	South Plains	3,964	8,253	5,171	8,035
8	Lake States	1,540	-0-	1,540	1,540
9	Western Corn Belt	8,411	-0-	8,675	8,675
10	South Central	191	-0-	191	191
11	Eastern Corn Belt	2,332	2,761	3,043	3,043
12	Northeast	-0-	-0-	149	149
13	Upper South	195	495	447	877
14	Southeast	212	-0-	212	539
	Total	23,125	23,125	26,649	31,950

regions and Northeast relied on feeder cattle supplied from the three Southern regions. The four Western regions, the three Corn Belt regions, the Northeast and the remaining two Plains regions produced 43 percent of all calves in the industry.

The actual locations of cow herds in 1970 (Table XXXXI) suggest there are currently some nonoptimal locations. The most striking differences between the actual and optimal locations are in the Western and Eastern Corn Belts and the South Plains area. The Western and Eastern Corn Belt regions have 17.4 percent of the cows in today's beef industry. The calculated optimum from Model I suggested that grass in the Western Corn Belt should be used in stocker cattle operations and that the Eastern Corn Belt should engage in neither calf nor stocker operations. Also Model I suggested that the South Plains areas should have a larger share of the beef cow herds. These differences may be attributed to several factors. First, within this analysis, stocker operations were considered to be a major enterprise in the beef industry. Historically, the growing of calves to feeding weights has typically been tied either to a cow-calf operation or to a feeding operation. While there are no published data on stocker operations, there is substantial evidence that the growing operation is being separated into a specialized phase of the beef industry. Specialization of this operation for some particular region would be possible within the model, while in actuality the specialization has not yet occurred. Thus, the magnitudes of the stocker operations in the calculated optimum suggest the degree to which the enterprise could be expected to grow. A second reason for the emergence of the specialized stocker growing activity in the optimal solution is that

TABLE XXXXI

COMPARISON OF THE ACTUAL COWS IN THE REGIONS FOR 1970 AND THE OPTIMUM NUMBER OF COWS FROM MODEL I

Region		Actual Percentage of Cows	Percentage of Cows From Model I
1	Pacific Northwest	2.7	0
2	Desert Southwest	3.6	3.6
3	Intermountains	7.4	8.1
4	Great Basin	1.4	1.7
5	North Plains	6.4	7.8
6	Central Plains	8.5	8.0
7	South Plains	20.0	34.0
8	Lake States	6.2	10.5
9	Western Corn Belt	12.7	0
10	South Central	9.9	6.6
11	Eastern Corn Belt	4.7	0
12	Northeast	3.6	0
13	Upper South	8.4	13.7
14	Southeast	4.9	5.3

producers in any region are interested primarily in maximizing returns to the resources utilized in their personal business. The optimal solution utilized the objective of minimizing the cost of all beef production. Thus, the objectives of the model may not be completely compatible with the objectives of the owners or resources, at least in the short run. This possible incompatibility may account for some of the differences between the actual practices and those suggested by the optimal solution.

Feeding activities under the current optimum were centered generally around the South and Central Plains (Oklahoma, Texas, New Mexico, Colorado, Western Kansas, Nebraska) and the Eastern and Western Corn Belts (Iowa, Missouri, East Kansas, East Nebraska, Illinois, Indiana, and Ohio). These regions produced the abundant feed grain supplies. The Central Plains (Colorado, Western Kansas, Western Nebraska) fed only feed grains. Feeding in the South Plains used 52 million bushels of wheat along with 123.9 million bushels of feed grain. Without the abundant supplies of wheat available within the region, feeding in the South Plains under the current optimum would have been reduced by about a third.

Limited numbers of cattle were fed in the South, using cheap barge transportation to move feed grains and wheat into the regions. The cattle feeding done in the four Western regions was based on abundant supplies of feed grains produced in the Intermountain West--primarily in Montana. The Pacific Northwest used equal amounts of locally produced wheat and imported feed grains to meet their feed requirements.

Comparisons between 1970 actual levels of feeding and levels suggested by the optimal solution from Model I are presented in Table XXXXII. Since only 22 states have reported feeding operations, only the discussion of the regions which contain these states is relevant. The largest non-optimal region is the Desert Southwest region of California and Arizona. Through the early 60's, fed cattle production increased sharply in this region, and feeding remains relatively high despite substantial regional deficits of both feed concentrates and feeder cattle. However, the feeding industry has declined during the late 60's as the results of Model I suggest it should. The Central Plains and Western Corn Belt differences may be due to the inability to separate feeding by counties in the states of Kansas and Nebraska--portions of which are included in both regions. Aggregating these two regions suggests that the optimal feeding for these regions are not far from the actual levels observed in 1970.

The results of Model II suggest that as facilities for feeding depreciate to the levels that require replacement, the beef industry will tend to concentrate in the Plains regions. The majority of the calf production would be expected to occur in the Plains with stocker calves being grown either in the Plains or in adjacent regions.

The relative advantage of low costs in both non-feed costs and feed items coupled with relatively low slaughter costs allow the Plains to produce a chilled beef carcass at lower total costs than any alternative region. The only other regions which would be expected to feed to any magnitude were the Eastern Corn Belt and the Intermountain area.

TABLE XXXXII

ACTUAL FEEDING FOR 1970 VERSUS OPTIMAL FEEDING FROM MODEL I

Region		Actual Feeding	Model I Feeding
1	Pacific Northwest	514	548
2	Desert Southwest	2848	275
3	Intermountains	618	277
4	Great Basin	*	157
5	North Plains	640	776
6	Central Plains	5283	4747
7	South Plains	4073	3964
8	Lake States	1339	1540
9	Western Corn Belt	7342	8411
10	South Central	*	191
11	Eastern Corn Belt	2407	2332
12	Northeast	*	-0-
13	Upper South	*	195
14	Southeast	*	212

*Actual feeding is not available for these regions.

Optimum Under Projected Conditions

When the demand for beef was projected for 1980, 8.8 million additional cattle were required to meet the projected needs, 2.4 million of them by 1975. The development of additional grazing was permitted under the conditions of the Model, such development limited to the rates at which the various regions had adopted pasture improving practices during the 1967-70 period. These rates of adaptation were projected to 1980. Irrigated feed grain acreage was allowed to increase in the Plains at the rate estimated by Bekure in research completed at Oklahoma State University.

Under conditions projected for 1980, optimum calf production would be expected to continue to center in the three Southern regions and the South Plains. Stocker growing was of increasing importance in the three Southern regions, but especially so in the Upper South and South Central areas. More calves were produced across the South in order to meet the need for expanded cattle numbers and, consequently, inshipments of calves for the intermediate growing period were reduced.

Calf production was expanded in the Eastern Corn Belt area in the model based on 1975 projections, but the cow-calf enterprise still did not compete favorably in the Western Corn Belt. Western Corn Belt grass was utilized solely for stocker growing operations. Calves utilize grass more efficiently than cows, and the Western Corn Belt's need for feeder cattle coupled with relatively high costs for moving feeder cattle gave the Western Corn Belt a comparative advantage for inshipment of light cattle. Increased needs for total calf numbers forced the Pacific Northwest into calf production, and the Desert Southwest was forced to more fully utilize its grass in cow-calf operations, retaining its calves for stocker growing. The Central and North Plains states increased both calf production and stocker operations. These regions were primarily handling cattle which would be fed internally.

Regions which offered the potential for major feeding growth were the South and Central Plains. These areas have abundant supplies of feed grains and wheat. Large local volumes of feeder cattle are currently available and the indications are that these supplies will be expanded. Further, these regions are centrally located such that they can ship meat competitively in every direction. Any disadvantages the South and Central Plains experience from being located at great distance from the market are more than made up in lower costs--both feed and non-feed.

The Western Corn Belt would be expected to remain the largest single region in the feeding of beef cattle. Ample feed resources are available. Feeder cattle will be produced in close proximity to the region. The major limitation to cattle feeding in the Western Corn Belt appears to be non-feed costs. Slaughter costs also appear to be relatively high in the Corn Belt. The major advantages for the region were abundant feed grains and close proximity to large consuming markets of the Northeast.

Feeding in the Eastern Corn Belt would be expected to increase to its highest level by 1975. No expansion was observed in the Eastern Corn Belt feeding optima between 1975 and 1980. The proximity of the Eastern Corn Belt to Northeastern markets allowed this region with relatively high non-feed costs and moderately high feed costs to take advantage of lower costs of shipping beef.

Cattle feeding in the South was small compared to the other regions of the United States. The Upper South increased feeding from 195,000 head in the current optimum to 876,000 head in the optimum based on 1980 projections. The South Central region fed the same numbers in all four models. The Southeast increased feeding by 377,000 animals (about 160 percent) between the models for current and 1980 conditions.

Implications

The beef industry must produce 8.8 million more fed cattle by 1980 if projected needs are to be met. Of these, 2.5 million will be required by 1975. To meet this 33 percent increase in total demand by 1980, significant adjustments of resources on the part of all producers and processors will be required.

The regions which appear to be most favorably located and regions which profit are the three Plains regions. Within this area, vast acreages of feed grains, wheat, and forage are produced. Also feeder cattle are either available locally or in adjacent regions. Managerial knowledge has proven to be adequate for combining the resources in the production of beef at relatively low costs. Of these three Plains regions, the Central and South Plains appear to have the greatest potential because of their proximity to greater market outlets.

Of the other regions, the Western regions are plagued by the lack of feed grain and feeder cattle. The Intermountains region is the only Western region which has the resources to carry out beef operations of any magnitude. However, market outlets are limited for Intermountain beef, placing the region at a disadvantage.

The Corn Belt will remain the largest producer of fed beef, but the region will not expand as the Plains regions. Grass capacity is limited, forcing the Corn Belt to import the majority of their feeder cattle. Further, non-feed costs and slaughtering costs place the Corn Belt at a disadvantage when compared with the Plains.

Beef production in the South will continue to center around calf production and stocker operations. These Southern states hold the key to meeting future beef needs. Resources are expected to be diverted into developing pasture for the production of calves and stockers.

As the industry grows and new areas develop, processing firms will shift more to the producing areas. Though some old facilities will remain in operation since they are converting variable costs, new facilities will be built where the cattle are produced.

As the feeding moves toward the Plains region, other marketing facilities need to be relocated and made workable.[1] Agricultural programs will have to be broad enough so that grain will be assured not only for human consumption and exports but also to insure ample grain for cattle and other livestock production.

General Limitations and Suggestions for Future Research

The scarcity of uniform and current input data, especially with regard to production costs, is the primary limitation for research investigating the regional competitive strength in any industry, but most especially the beef industry. Data for this study with regard to regional production costs and production capacities were collected from secondary sources, the cost data up-dated by use of the Index of Prices Paid by Farmers. The regional consumption estimates were synthesized from work completed at Oklahoma State University along with secondary information from Household Consumption Reports. Transportation costs for all animals and animal products were furnished by common carriers and by major packers. Grain rail rates were provided by two railway companies and a grain merchandiser. Functional relationships were used for grain transportation costs via truck. The models used in this study show optimal solutions for minimizing the total costs of providing carcass beef in the quantities required within the various regions.

Smaller geographic areas would aid in helping to specify the competitive position of specific regions. However, the more regions that are used the more cumbersome data problems become, and the more expensive the research becomes. Further, some data are simply not available for regions smaller than a single state.

Expansion of the model to include specialized production such as dry lot cow-calf operations, alternative feeding programs for different weights of cattle, and carcass breaking operations would permit a more detailed analysis of the industry. Quantifying quality differences at the stocker calf level is a problem which, if overcome, would allow for a more complete study. A time stage model of livestock feeding and stocker calf operation would allow consideration of differences in seasonality of operations for various regions. Another model of dynamic linear programming could have been used to tie 1980 production to 1975 production instead of using two separate models.

In this study, beef was permitted to use only the grain which remained after all other grain needs had been met. This may or may not reflect the true situation. An integrated study of the complete livestock grain industry which would allow all species to bid for grain would permit a more detailed analysis of the allocation of resources among the different livestock species. A spatial equilibrium analysis designed along these lines could provide valuable information to all levels within the livestock industry as well as to public and private policy making agencies.

Along with the above suggestions for additional research, a simulation model with different decision criteria may be formulated using the basic information of this work. For example, replacement criteria for feedlots might be developed and built into the Model. The alternative of grazing out small grains in the Plains regions could further refine the analysis.

The competitive strength of any region hinges on that region's ability to produce and place beef in the consumer market within that region and other regions at competitive prices. The region must generate returns to the resources engaged in production of beef returns that are high enough to continue to attract resources to the production and processing of beef. Any given region may enjoy advantages in cow-calf operations, in stocker operations, in feeding, or in some combination of these. When a region emerges as being competitive in all segments, it is most likely to be favorably located with respect to both consumer markets and resource supplies.

FOOTNOTES

[1]J. Richard Crow, John B. Riley, and Wayne D. Purcell, "Economic Implications of Geographically Dispersed Delivery Points for the Live Cattle Futures Contract," American Journal of Agricultural Economics, publication forthcoming (1972).

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A P P E N D I X   A

MODEL V

FEED EFFICIENCY IN REGIONS 2, 3, 6, AND 7 IS EQUAL TO 3 POUNDS OF GRAIN PER DAY WHILE EFFICIENCY IS EQUAL TO 2.5 POUNDS OF GRAIN PER DAY IN ALL OTHER REGIONS

TABLE XXXXIII

OPTIMAL CALF PRODUCTION UNDER MODEL V
WITH COMPARISONS FROM MODEL I

Region		Production Model I	Production Model V
		(000 head)	
1	Pacific Northwest	-0-	-0-
2	Desert Southwest	862	882
3	Intermountains	1958	1958
4	Great Basin	395	404
5	North Plains	1915	1915
6	Central Plains	1966	1966
7	South Plains	7885	7885
8	Lake States	2444	2444
9	Western Corn Belt	-0-	-0-
10	South Central	1421	1421
11	Eastern Corn Belt	-0-	-0-
12	Northeast	-0-	-0-
13	Upper South	3142	3112
14	Southeast	1137	1137

TABLE XXXXIV

OPTIMAL STOCKER NUMBERS IN EACH REGION UNDER MODEL V
WITH COMPARISONS FROM MODEL I

Region		Production Model I	Production Model V
		(000 head)	
1	Pacific Northwest	548	-0-
2	Desert Southwest	275	882
3	Intermountains	-0-	-0-
4	Great Basin	434	405
5	North Plains	-0-	-0-
6	Central Plains	3768	3768
7	South Plains	4295	4295
8	Lake States	2346	2346
9	Western Corn Belt	2169	2169
10	South Central	5011	5010
11	Eastern Corn Belt	-0-	-0-
12	Northeast	-0-	-0-
13	Upper South	3142	3112
14	Southeast	1137	1137

TABLE XXXXV

OPTIMAL FEEDING ACTIVITIES FROM MODEL V
WITH COMPARISONS FROM MODEL I

Region	Production Model I	 Model V
	(000 head)	
1 Pacific Northwest	548	548
2 Desert Southwest	275	882
3 Intermountains	277	277
4 Great Basin	157	128
5 North Plains	776	755
6 Central Plains	4247	4247
7 South Plains	3964	3964
8 Lake States	1540	1540
9 Western Corn Belt	8411	8402
10 South Central	191	191
11 Eastern Corn Belt	2332	2332
12 Northeast	-0-	-0-
13 Upper South	195	195
14 Southeast	212	212

TABLE XXXXVI

OPTIMAL FLOW PATTERNS OF STOCKERS
AND FEEDERS UNDER MODEL V

From Region	Stockers To Region	Stockers Quantity (000 head)	Feeders To Region	Feeders Quantity (000 head)
2	2	882	2	882
3	6	1802		
	9	156		
4	4	405	2	277
			4	128
5	9	1915		
6	6	1966	6	3768
7	7	4295	7	3964
	10	3590		
			9	331
8	8	2346	5	755
	9	98		
			6	51
9			9	2170
10	10	1421	9	4820
			10	191
13	13	3112	9	581
			11	2332
			13	195
14	14	1137	6	428
			9	497
			14	212

TABLE XXXXVII

OPTIMAL FLOW PATTERN OF CARCASS BEEF UNDER MODEL V

From Region	To Region	Quantity (000 carcasses)
2	2	882
3	1	26
	3	251
4	4	128
5	5	141
	12	408
6	1	628
	2	1993
	4	35
	6	391
	12	1200
7	9	1487
	10	873
	13	536
	14	1067
8	8	1746
9	8	716
	9	1148
	11	3231
	12	3951
10	10	191
11	12	1301
	13	1031
13	13	195
14	19	212

APPENDIX B

MODEL VI

DECREASED INTEREST RATES TO 2% ON THE CONSTRUCTION OF NEW FACILITIES

TABLE XXXXVIII

OPTIMAL CALF PRODUCTION UNDER MODEL VI
WITH COMPARISONS FROM MODEL I

Region		Production Model I	Production Model VI
		(000 head)	
1	Pacific Northwest	-0-	-0-
2	Desert Southwest	862	862
3	Intermountains	1958	1958
4	Great Basin	395	395
5	North Plains	1915	1915
6	Central Plains	1966	1966
7	South Plains	7885	7885
8	Lake States	2444	2444
9	Western Corn Belt	-0-	-0-
10	South Central	1421	1421
11	Eastern Corn Belt	-0-	-0-
12	Northeast	-0-	-0-
13	Upper South	3142	3142
14	Southeast	1137	1137

TABLE XXXXIX

OPTIMAL FEEDERS PRODUCED IN EACH REGION UNDER MODEL VI
WITH COMPARISONS FROM MODEL I

Region		Production Model I	Production Model VI
		(000 head)	
1	Pacific Northwest	548	548
2	Desert Southwest	275	275
3	Intermountains	-0-	-0-
4	Great Basin	434	434
5	North Plains	-0-	-0-
6	Central Plains	3768	3768
7	South Plains	4295	4295
8	Lake States	2346	2346
9	Western Corn Belt	2170	2170
10	South Central	5011	5011
11	Eastern Corn Belt	-0-	-0-
12	Northeast	-0-	-0-
13	Upper South	3142	3142
14	Southeast	1137	1137

TABLE L

OPTIMAL NUMBER OF CATTLE FED IN EACH REGION UNDER MODEL VI WITH COMPARISONS FROM MODEL I

Region		Production	
		Model I	Model VI
		(000 head)	
1	Pacific Northwest	548	548
2	Desert Southwest	275	275
3	Intermountains	277	277
4	Great Basin	157	157
5	North Plains	776	776
6	Central Plains	4247	4247
7	South Plains	3964	3964
8	Lake States	1540	1540
9	Western Corn Belt	8411	8411
10	South Central	191	191
11	Eastern Corn Belt	2332	2332
12	Northeast	-0-	-0-
13	Upper South	195	195
14	Southeast	212	212

TABLE LI

OPTIMAL TRANSFER OF STOCKERS AND FEEDERS
UNDER MODEL VI

From Region	Stockers: To Region	Stockers: Quantity (000 head)	Feeders: To Region	Feeders: Quantity (000 head)
1			1	548
2	1	548	2	275
	2	275		
	4	39		
3	6	1802		
	8	156		
4	4	395	3	277
			4	157
5	9	1915		
6	6	1966	6	3768
7	7	4295	7	3964
	10	3590	9	331
8	8	2347	5	776
			6	30
			8	1540
9			9	2169
10	10	1421	9	4820
			10	191
13	13	3142	9	615
			11	2332
			13	195
14	14	1137	6	450
			9	476
			14	212

TABLE LII

OPTIMAL TRANSFER OF CARCASS BEEF UNDER MODEL VI

From Region	To Region	Quantity
		(000 carcasses)
1	1	548
2	2	275
3	1	26
	3	251
4	4	157
5	5	141
	12	408
6	1	80
	2	2601
	4	7
	6	391
	12	1169
7	7	1487
	10	873
	13	536
	14	1067
8	8	1767
9	8	50
	9	1149
	11	3231
	12	3981
10	10	191
	12	1301
	13	1031
	13	195
14	14	212

APPENDIX C

MODEL VII

1980 DEMAND FOR MEAT PROJECTED WHILE FEED EFFICIENCY IN REGIONS 2, 6, AND 7 IS EQUAL TO 3 POUNDS OF GRAIN PER DAY

TABLE LIII

OPTIMAL CALF PRODUCTION UNDER MODEL VII
WITH COMPARISONS FROM MODEL IV

		Production	
Region		Model IV	Model VII
		(000 head)	
1	Pacific Northwest	650	650
2	Desert Southwest	1011	1011
3	Intermountains	1939	1844
4	Great Basin	409	115
5	North Plains	2191	2191
6	Central Plains	2142	2545
7	South Plains	8035	8035
8	Lake States	3321	3321
9	Western Corn Belt	-0-	-0-
10	South Central	2195	2195
11	Eastern Corn Belt	3138	3138
12	Northeast	1413	1413
13	Upper South	3934	3919
14	Southeast	1572	1572

TABLE LIV

OPTIMAL FEEDER PRODUCTION UNDER MODEL VII
WITH COMPARISONS FROM MODEL IV

Region		Production	
		Model IV	Model VII
		(000 head)	
1	Pacific Northwest	650	650
2	Desert Southwest	1011	1011
3	Intermountains	468	720
4	Great Basin	409	1240
5	North Plains	776	776
6	Central Plains	3613	2545
7	South Plains	8035	8035
8	Lake States	1540	1540
9	Western Corn Belt	3857	3857
10	South Central	4671	4671
11	Eastern Corn Belt	-0-	-0-
12	Northeast	1413	1413
13	Upper South	3934	2919
14	Southeast	1572	1572

TABLE LV

OPTIMAL FEEDING IN REGIONS UNDER MODEL VII
WITH COMPARISONS FROM MODEL IV

Region		Feeding	
		Model IV	Model VII
		(000 head)	
1	Pacific Northwest	548	548
2	Desert Southwest	1113	2196
3	Intermountains	720	720
4	Great Basin	157	157
5	North Plains	776	776
6	Central Plains	5587	4831
7	South Plains	8035	8035
8	Lake States	1540	1540
9	Western Corn Belt	8675	8675
10	South Central	191	191
11	Eastern Corn Belt	3043	3043
12	Northeast	149	149
13	Upper South	876	876
14	Southeast	539	212

TABLE LVI

OPTIMAL SHIPMENT OF STOCKERS AND FEEDERS UNDER MODEL VII

From Region	Stockers To Region	Stockers Quantity (000 head)	Feeders To Region	Feeders Quantity (000 head)
1	1	650	1	548
			2	102
2	2	1011	2	1011
3	3	720	3	720
	4	1124		
4	4	115	2	1083
			4	157
5	5	776	5	776
	9	1415		
6	6	2545	6	2545
7	7	8035	7	8035
8	8	1540	8	1540
	9	1781		
9			9	3857
10	10	2195	9	4481
			10	191
11	9	661		
	10	2477		
	12	1413	6	1264

TABLE LVI (CONTINUED)

From Region	Stockers		Feeders	
	To Region	Quantity (000 head)	To Region	Quantity (000 head)
13	13	3919	9	95
			11	3043
			13	876
14	14	1572	6	1022
			9	338
			14	212

TABLE LVII

OPTIMAL TRANSFER OF CARCASS BEEF UNDER MODEL VII

From Region	To Region	Quantity (000 carcasses)
1	1	548
2	2	2196
3	1	265
	3	259
	8	1957
4	4	157
5	5	188
	12	361
6	2	2168
	4	92
	6	452
	12	2120
7	7	2086
	10	1350
	12	1356
	13	1539
	14	1705
8	8	1767
9	8	470
	9	1585
	11	4272
	12	2348

TABLE LVII (CONTINUED)

From Region	To Region	Quantity (000 carcasses)
10	10	191
11	12	3043
12	12	149
13	13	876
14	14	212

APPENDIX D

COSTS ASSOCIATED WITH NON-OPTIMAL TRANSFERS

THE FOLLOWING TABLES SHOW THE COST OF USING NON-OPTIMUM TRANSFERS AT THE MARGIN. THE SOLUTION IS FAIRLY STABLE WITH RESPECT TO COST ESTIMATES FOR ACTIVITIES WITH HIGH REDUCED COSTS, BUT IT IS SENSITIVE TO ACTIVITIES WITH LOW REDUCED COSTS.

TABLE LVIII

CHANGES IN THE PER HEAD COST OF MOVING STOCKER CALVES THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL I

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Animal)													
1	•	21.00	15.74	9.83	15.32	13.05	16.11	16.21	13.01	18.00	35.53	21.19	24.28	22.73
2	•	•	9.81	•	6.18	2.15	1.28	7.75	1.59	3.34	24.07	10.05	12.62	9.39
3	1.09	16.16	•	2.21	2.76	•	5.30	3.51	•	1.27	12.44	8.55	•	9.91
4	1.27	12.44	8.55	•	9.91	5.54	8.99	10.85	6.17	13.01				
5	5.00	16.78	8.15	8.96	.59	2.18	7.05	1.32	•		19.21	6.15		
6	9.29	19.40	18.85	10.10	7.00	•	8.05	7.98	2.21	6.11	23.94	9.57		
7	7.66	15.22	11.51	9.38	5.86	2.06	•	5.47	.09	•	19.81	6.95	7.29	6.36
8	7.41	32.90	9.47	10.36	2.22	3.09	5.22	•	•	5.52	17.91	4.84	15.40	9.55
9	11.85	21.43	13.56	13.32	7.54	4.93	7.18	7.61	•	7.54	21.88	9.10	11.86	12.98
10	16.21	34.19	19.06	17.52	12.78	10.15	7.59	11.96	6.01	•	21.85	7.93	8.62	6.20
11	12.96	22.86	15.81	12.70	5.99	5.35	7.67	4.74	1.10	3.19	11.62	•	2.86	4.78
12	23.62	33.48	24.71	24.10	16.86	15.60	19.10	15.92	12.54	14.01	24.25	•	12.34	13.87
13	14.69	21.94	17.02	15.24	9.85	7.65	7.53	6.17	2.99	1.28	14.77	•	•	3.00
14	15.81	23.47	19.07	17.14	12.59	9.95	8.23	10.95	6.69	1.11	18.09	4.24	5.25	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LIX

CHANGES IN THE PER HEAD COST OF MOVING FEEDER CATTLE THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL I

TO REGION / FROM REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Animal)													
1	•	25.34	12.09	13.78	19.76	14.83	26.07	23.33	19.61	37.28	34.65	36.65	41.60	44.89
2	3.85	•	8.48	4.29	13.18	3.73	11.01	15.51	7.73	21.49	22.12	25.19	26.32	30.13
3	12.53	30.40	1.74	14.64	13.82	8.36	20.48	17.61	13.37	31.33	25.60	29.09	35.89	40.50
4	2.81	14.70	∘	∘	12.98	4.88	15.41	16.57	10.63	28.00	24.88	26.68	31.71	36.10
5	10.60	23.51	4.14	14.82	∘	3.47	14.07	5.08	2.63	22.16	14.42	15.49	23.92	29.54
6	16.09	26.48	9.11	17.14	11.46	∘	13.99	15.59	7.84	26.68	21.83	22.52	29.55	34.42
7	9.64	14.17	5.34	11.30	6.95	.20	•	7.45	•	12.28	16.93	17.67	18.41	20.84
8	8.98	23.35	2.77	13.22	∘	∘	10.51	∘	.25	17.15	10.51	11.13	16.39	24.13
9	14.60	24.21	7.88	16.63	6.82	1.59	11.86	9.59	•	20.06	14.98	16.49	22.51	28.16
10	12.47	16.56	5.36	13.95	6.20	.31	5.17	6.44	•	•	6.55	5.54	7.36	9.93
11	13.96	22.73	6.18	16.39	3.62	.59	10.90	4.88	∘	11.63	.12	3.26	7.48	16.09
12	26.46	36.27	20.63	29.20	17.40	14.01	26.20	18.24	14.25	23.65	15.99	.11	20.51	26.50
13	13.97	20.86	7.97	15.45	5.56	.76	7.48	3.27	•	4.95	•	∘	∘	9.26
14	11.92	18.91	6.45	13.82	5.53	•	6.57	5.50	•	1.93	3.04	.59	3.62	∘

[a]The ∘ indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LX

CHANGES IN THE PER CARCASS COST OF MOVING CARCASS BEEF THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL I

TO REGION / FROM REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Carcass)													
1	•	12.62	22.50	14.05	28.70	22.23	24.70	24.07	29.66	21.41	25.91	29.46	28.85	30.14
2	7.90	•	19.25	4.29	23.10	13.76	17.94	18.47	23.04	15.81	18.06	21.06	8.79	11.58
3	•	3.53	•	3.05	8.77	10.27	16.16	2.16	13.07	14.37	5.91	14.37	8.85	10.14
4	8.46	13.99	18.71	•	28.70	18.27	24.16	24.07	24.62	15.07	24.82	21.28	25.92	21.89
5	10.92	9.90	19.19	10.65	•	8.84	8.55	.25	6.96	4.30	1.30	•	.62	1.23
6	•	•	9.23	•	6.29	•	3.56	5.59	3.75	1.77	1.29	•	2.04	1.97
7	2.66	1.37	12.16	1.16	5.93	4.09	•	2.59	4.36	•	3.13	1.09	•	•
8	16.78	18.22	26.28	18.01	9.81	19.43	12.97	•	10.36	9.89	4.84	5.59	4.13	6.07
9	11.19	11.13	20.69	10.92	2.86	7.02	4.93	•	•	3.14	•	•	1.47	.14
10					22.16	22.27	14.44	15.38	19.17	•	7.77	2.32	1.71	3.84
11	10.57	18.01	27.57	17.80	14.86	15.55	14.07	6.42	14.04	4.09	1.29	•	•	1.43
12							34.03	25.63	8.00	14.66	21.06	30.20	32.53	26.20
13					30.20	32.53	26.20	22.95	28.54	14.80	13.84	7.37	•	8.01
14					29.32	29.78	22.87	22.24	26.82	9.07	9.27	5.05	5.12	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXI

CHANGES IN THE PER THERM COST OF MOVING FEED GRAINS THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL I

TO REGION / FROM REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						(Cents/Therm)								
1														
2														
3	•	•	•	•	.01667	.01587	.01677	.01627	.01667					
4	.0069	.0058	.0172	•	.03637	.07857	.02897	.03707	.02807					
5	.05283	.07983	.00123	.01693	•	.006	.0115	.0027	.0038	.0071	.0363	.0261	.0076	.008
6	.00353	.00023	.00213	.00013	.0077	•	.0043	.0083	.0044	.0095	.0323	.0527	.0095	.0093
7	.00503	.00213	.00993	.00693	.0166	.0071	•	.0135	.0072	.0105	.0123	•	.0192	.0107
8	.00413	.00083	.00693	.00623	.0058	.0099	.0128	•	.0054	.0006	.0227	.0079	•	•
9	.00423	.00093	.00713	.00623	.0069	.0058	.0059	.0053	•	•	.014	.0145	.0006	.0012
10														
11					.0415	.0353	.0137	.0247	.0151	.0006	•	.0261	.0002	.0001
12														
13														
14														

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXII

CHANGES IN THE PER THERM COST OF MOVING WHEAT THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL I

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1	•	•	.0085	.0026	.0756	.0266	.0268	.028	.0259					
2	.0968	•	.025	.0116	.1149	.0354	.0356	.0381	.0347					
3	.0042	.0022	•	•	.0092	.0083	.0065	.0077	.0076					
4	.0126	.0041	.0152	•	.0289	.0317	.0319	.0344	.031					
5	.0728	.0033	.0114	.0296	.0054	.0113	.0279	.0305	.0268	.0156	.0435	.0563	.0173	.015
6	.0186	.0098	.0071	.0135	.008	.0004	.0047	.0049	.0048	.0114	.0347	.0779	.0139	.0108
7	.0197	.0109	.0222	.0146	.0208	.0073	•	.0134	.0073	.012	.0143	.0252	.0208	.0095
8	.0207	.0119	.0232	.0156	.0098	.012	.0149	.0022	.0076	.0042	.0268	.0348	.0064	.0022
9	.0189	.0101	.0214	.0138	.007	.006	.0059	.0054	•	.0015	.016	.0392	.0044	.0026
10								.0092	.0094	•	.0107	.0051	.0053	
11					.0394	.0333	.0116	.0226	.0141	•	•	•	.0027	•
12														
13										.0025	.0091	.0037	•	.0023
14														

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXIII

CHANGES IN THE PER HEAD COST OF MOVING FEEDER CATTLE THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL II

TO REGION / FROM REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						(Dollars/Animal)								
1	•	25.77	13.71	15.61	17.21	12.20	18.66	20.58	24.31	34.53	30.44	42.73	37.53	42.27
2	2.04	°	8.99	5.02	9.53	•	2.50	11.63	11.33	17.65	16.81	34.67	21.15	26.40
3	8.08	27.10	°	12.74	7.49	1.95	9.32	11.14	14.34	24.99	17.65	35.93	28.09	34.13
4	°	13.02	°	°	8.18	°	5.75	11.57	13.08	23.00	18.42	35.01	25.39	31.21
5	12.60	26.64	8.53	19.24	•	3.49	9.35	5.09	10.04	22.26	12.91	29.02	22.50	29.61
6	18.22	29.74	13.64	21.69	11.71	°	9.32	15.70	15.37	26.92	20.46	36.17	28.26	34.63
7	16.68	22.35	14.70	20.76	12.15	5.26	°	12.47	12.45	17.49	20.47	36.00	22.04	25.96
8	10.94	26.09	7.14	17.60	°	•	5.69	°	7.62	17.29	8.97	24.63	14.93	24.17
9	15.00	25.74	10.67	19.44	5.32	•	5.47	7.96	5.81	18.62	11.86	28.42	19.49	26.63
10	13.70	18.94	9.29	17.69	5.97	°	°	6.02	7.02	°	4.66	18.78	5.48	9.62
11	16.96	27.25	11.87	21.90	5.12	2.05	7.58	6.22	8.79	13.19	°	18.17	7.44	17.55
12	13.99	24.95	10.65	19.24	3.47	°	7.58	4.11	7.58	9.73	.40	°	4.99	12.49
13	17.09	25.14	13.58	21.08	7.22	2.34	9.28	9.76	8.91	6.79	°	15.13	°	10.84
14	13.46	21.60	10.48	17.87	5.61	°	1.79	5.39	7.33	2.02	1.46	14.04	2.11	°

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXIV

CHANGES IN THE PER HEAD COST OF MOVING STOCKER CALVES THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL II

FROM REGION / TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Animal)													
1	•	22.10	12.74	10.59	12.25	10.05	11.37	13.98	10.78	15.40	31.44	17.18	20.27	19.89
2	3.46	4.56	10.27	4.22	6.57	2.61	•	8.98	2.82	4.20	23.44	9.50	12.07	10.02
3	20.26	•	5.97	2.70	•	3.56	4.28	.77						
4	.51	12.78	4.79	•	6.07	1.78	3.49	7.86	3.18	9.65				
5	7.47	20.36	7.62	12.19	•	1.65	4.78	1.56	.24		17.61	4.61		
6	12.30	23.50	10.85	13.86	6.94	•	6.31	8.75	2.98	6.51	22.85	8.56		
7	12.40	21.06	13.25	14.88	7.53	3.80	•	7.98	2.60	2.14	20.46	7.68	8.02	8.27
8	9.64	36.24	8.70	13.35	1.39	2.32	2.71	•	•	5.16	16.05	3.06	13.62	8.95
9	14.08	24.77	12.79	16.31	6.71	4.16	4.67	7.61	•	7.18	20.02	7.32	10.08	12.38
10	18.81	37.89	18.66	20.87	12.31	9.75	5.45	12.32	6.37	•	20.36	6.51	7.20	5.96
11	25.87	36.87	25.72	26.37	15.83	15.26	15.84	15.42	11.78	13.50	20.44	8.90	11.76	14.86
12	30.51	41.47	28.60	31.75	20.68	19.49	21.25	20.58	17.20	18.30	27.05	2.88	15.22	17.93
13	18.70	27.06	18.03	20.01	10.79	8.66	6.80	7.95	4.77	2.70	14.69	•	•	4.18
14	18.64	27.41	18.90	20.74	12.35	9.78	6.32	11.55	7.29	1.35	16.83	3.06	4.07	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXV

CHANGES IN THE PER CARCASS COST OF MOVING CARCASS MEAT THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL II

TO REGION / FROM REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						(Dollars/Carcass)								
1	•	12.62	22.50	14.05	28.70	22.23	25.79	23.82	26.39	22.50	24.62	29.46	29.94	31.23
2	7.90	•	19.25	4.29	23.10	13.76	19.03	18.22	19.77	16.90	16.77	21.06	9.88	12.67
3	•	3.53	•	3.05	8.77	10.27	17.25	1.91	9.80	15.46	4.62	14.37	9.94	11.23
4	8.46	13.99	18.71	•	28.70	18.27	25.25	23.82	21.35	16.16	23.53	21.28	27.01	22.98
5	10.92	9.90	19.19	10.65	•	8.84	9.64	•	3.69	5.39	.01	•	1.71	2.32
6	•	•	9.23	•	6.29	•	4.65	5.34	.48	2.86	•	•	3.13	3.06
7	1.57	.28	11.07	.07	4.84	3.00	•	1.25	•	•	.75	•	•	•
8	17.03	18.47	26.53	18.26	10.06	19.68	14.31	•	7.34	11.23	3.80	5.84	5.47	7.41
9	14.46	14.40	23.96	14.19	6.13	10.29	9.29	3.02	•	7.50	1.98	3.27	5.83	4.50
10					21.07	21.18	14.44	14.04	14.81	•	5.39	1.23	1.71	3.84
11	10.57	18.01	27.57	17.80	14.86	15.55	15.16	6.17	10.77	5.18	•	•	1.09	2.52
12							27.13		18.72			•	7.75	14.15
13					29.11	31.44	26.20	21.61	24.18	14.80	11.46	6.28	•	8.01
14					28.23	28.69	22.87	20.90	22.46	9.07	6.89	3.96	5.12	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXVI

CHANGES IN THE PER THERM COST OF MOVING FEED GRAINS THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL II

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1														
2														
3	.00777	•	◦	◦	.00662	.00294	.0026	.00888	.0084					
4	.01467	.0058	.0172	◦	.02632	.0707	.0148	.02968	.0198					
5	.07065	.08988	.01128	.02698	•	.00313	.00738	.00536	.00558	.00888	.03808	.03907	.00938	.00978
6	.02422	.01316	.01506	.01306	.01057	•	.00306	.01383	.00906	.01416	.03696	.06855	.01416	.01396
7	.02697	.0163	.0241	.0211	.0207	.00834	•	.02028	.0131	.0164	.0182	.01709	.0251	.0166
8	.02017	.0091	.0152	.0145	.00402	.00524	.0069	.00088	.0054	.0006	.0227	.01909	◦	◦
9	.02027	.0092	.0154	.0145	.00512	.00114	•	.00618	•	•	.014	.02569	.0006	.0012
10														
11					.03972	.03064	.00780	.02558	.0151	.0006	•	.03729	.0002	.0001
12														
13														
14														

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXVII

CHANGES IN THE PER THERM COST OF MOVING WHEAT THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL II

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1	.00137	.00835	.0099	.00768	.07382	.0262	.02449	.02888	.0262					
2	.09057	.00075	.0188	.00908	.10552	.0274	.02569	.03138	.0274					
3	.00557	.01055	.0014	.00508	.00742	.0079	.00419	.00858	.00790					
4	.00889	.00737	.01152	°	.02204	.02622	.02451	.0302	.02622					
5	.07417	.01165	.0128	.03468	.00362	.0109	.02559	.03138	.0271	.02252	.0435	.0563	.01503	.015
6	.01997	.01815	.0085	.01858	.00622	°	.00239	.00578	.0051	.01832	.0347	.0779	.01163	.0108
7	.02338	.02156	.02591	.02199	.02133	.00921	°	.01659	.00991	.02123	.01661	.02751	.02085	.01181
8	.02207	.02025	.0246	.02068	.00802	.0116	.01259	.00308	.0079	.01112	.0268	.0348	.00413	.0022
9	.01997	.01815	.0225	.01858	.00492	.0053	.00329	.00598	°	.00812	.0157	.0389	.0018	.0023
10								.00704	.00667	.00388	.00767	.00207	°	
11					.03762	.0329	.00929	.02348	.0144	.00692	°	°	.00043	°
12														
13										.01168	.01137	.00597	°	.00457
14														

[a]The ° indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXVIII

CHANGES IN THE PER HEAD COSTS OF MOVING STOCKER CALVES THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL III

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Animal)													
1	2.80679	18.80518	19.63679	12.24288	20.17948	16.94679	19.58641	21.66948	18.46948	21.47641	34.87320	34.34000	27.97948	26.20211
2	5.00161	·	15.90161	4.60770	13.23430	8.24161	6.95123	15.40430	9.24430	9.01123	25.60802	25.39482	18.51430	15.05693
3	·	10.06839	·	.72609	3.73269	·	4.87962	5.07269	1.56269					
4	1.66391	7.83230	10.03391	·	12.35660	7.02391	10.05353	13.89660	9.21660	14.07353				
5	2.34731	9.12570	6.58731	5.91340	·	.61731	5.06693	1.32000	·		13.10372	13.84052		
6	8.21000	13.30839	10.85000	8.61609	7.97269	·	7.62962	9.54269	3.77269	5.68962	19.38641	18.82321		
7	6.99038	9.54877	11.93038	8.31647	7.25307	2.48038	·	7.45307	2.07307	·	15.67679	16.62359	7.51307	6.35570
8	4.75731	25.24570	7.90731	7.31340	1.63000	1.52731	3.23693	·	·	3.53693	11.79372	12.53052	13.64000	7.56263
9	9.19731	13.77570	11.99731	10.27340	6.95000	3.36731	5.19693	7.61000	·	5.55693	15.76372	16.79072	10.10000	10.99263
10	15.54038	28.51877	19.48038	16.45647	14.17307	10.57038	7.59000	13.94307	7.99307	·	17.71679	17.60359	8.84307	6.19570
11	9.20731	14.10570	13.14731	8.55340	4.29000	2.68731	4.58693	3.64000	·	.10693	4.40372	6.59052	·	1.69263
12	13.27679	18.13518	15.45679	13.36288	8.56948	6.34679	9.42641	8.22948	4.84948	4.33641	10.44320	·	2.88948	4.19211
13	13.79731	16.04570	17.21731	13.95340	11.01000	7.84731	7.30693	7.93000	4.75000	1.05693	10.41372	9.45052	·	2.77263
14	15.14468	17.80307	19.49468	16.08077	13.97737	10.37468	8.23430	12.93737	8.67737	1.11430	13.96109	13.91789	5.47737	·

[a]The · indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXIX

CHANGES IN THE PER HEAD COSTS OF MOVING FEEDER CATTLE THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL III

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						(Dollars/Animal)								
1	•	13.47155	6.72669	8.38497	17.58120	11.16321	19.55199	19.38395	15.94321	33.70226	31.04312	47.01157	38.18381	41.32159
2	15.76598	•	15.00814	10.78642	22.89265	11.95466	16.38344	23.46157	15.95466	29.81371	30.36458	47.44302	34.79526	38.45304
3	16.20564	22.19766	•	12.90608	15.28991	8.33904	17.61310	17.32273	13.36376	31.37944	25.6424	43.10268	36.13491	40.58269
4	8.23372	8.23426	•	•	16.21135	6.62336	14.30214	18.03410	12.37336	29.83241	26.68327	42.45172	33.70396	37.93174
5	12.81109	13.82811	.94493	11.61801	•	1.97449	9.72855	3.31790	1.14662	20.73489	12.92977	27.99196	22.59981	28.11152
6	19.81404	18.31107	7.43788	15.45096	12.97831	•	11.17213	15.35114	7.86957	26.77784	21.88264	36.53491	29.74276	34.51448
7	16.18600	8.82303	6.49816	12.43292	11.29267	3.04848	•	10.0310	2.85412	15.18412	19.80460	34.55304	21.42472	23.75644
8	12.94560	15.43868	1.33944	11.77252	1.76163	.26900	7.93018	•	.52113	17.47372	10.80420	25.39647	16.79589	24.46604
9	18.29826	16.01529	6.17210	14.90519	8.30885	1.58074	9.00284	9.31221	•	20.11	14.98	30.48	22.68	28.22
10	16.17	8.37	3.66	12.24	7.69	.31	2.32	6.16	•	•	6.55	19.51	7.39	9.98
11	17.66	14.53	4.48	14.68	5.11	.59	8.05	4.60	•	11.68	.05	17.24	7.61	16.13
12	16.15	14.07	4.93	13.48	4.88	•	9.33	3.95	.24	9.69	2.00	•	6.63	12.55
13	17.67	12.67	6.28	13.74	7.05	.76	4.63	3.00	•	4.97	•	13.97	•	9.31
14	15.62	10.72	4.76	12.11	7.02	•	3.72	5.23	•	1.98	3.03	14.57	3.75	•

[a]The · indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXX

CHANGES IN THE PER CARCASS COSTS OF MOVING CARCASS BEEF THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL III

TO REGION → FROM REGION ↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Carcass)													
1	•	9.65	22.50	11.08	25.73	19.26	21.73	21.91	26.69	18.44	22.94	26.49	25.88	27.17
2	10.87	•	22.22	4.29	23.10	13.76	17.94	19.28	23.04	15.81	18.06	21.06	8.79	11.58
3	•	.56	•	.08	5.80	7.30	13.19	•	10.10	11.40	2.94	11.40	5.88	7.17
4	11.43	13.99	21.68	•	28.70	18.27	24.16	24.88	24.62	15.07	24.82	21.28	25.92	21.89
5	13.89	9.90	22.16	10.65	•	8.84	8.55	1.06	6.96	4.30	1.30	•	.62	1.23
6	2.97	•	12.20	•	6.29	•	3.56	6.40	3.75	1.77	1.29	•	2.04	1.97
7	5.63	1.37	15.13	1.16	5.93	4.09	•	3.40	4.36	•	3.13	1.09	•	•
8	18.94	17.41	28.44	17.20	9.00	18.62	12.16	•	9.55	9.08	4.03	4.78	3.32	5.26
9	14.16	11.13	23.66	10.92	2.86	7.02	4.93	.81	•	3.14	•	•	1.47	.14
10					22.16	22.27	14.44	16.19	19.17	•	7.77	2.32	1.71	3.84
11	13.54	18.01	30.54	17.80	14.86	15.55	14.07	7.23	14.04	4.09	1.29	•	•	1.43
12							26.04			17.63		•	6.66	13.06
13					30.20	32.53	26.20	23.76	28.54	14.80	13.84	7.37	•	8.01
14					29.32	29.78	22.87	23.05	26.82	9.07	9.27	5.05	5.12	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXI

CHANGES IN THE PER THERM COST OF MOVING WHEAT THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL III

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1	◦	◦	.00850	.00260	.07560	.02620	.02680	.02800	.02590					
2	.09680	◦	.02500	.01160	.11490	.03500	.03560	.03810	.03470					
3	.00420	.00220	◦	◦	.00920	.00790	.00650	.00770	.00760					
4	.01260	.00410	.01520	◦	.02890	.03130	.03190	.03440	.03100					
5	.07280	.00330	.01140	.02960	.00540	.01090	.02790	.03050	.02680	.01410	.04150	.05430	.01322	.01350
6	.01860	.00980	.00710	.01350	.00800	◦	.00470	.00490	.00480	.00990	.03270	.07590	.00982	.00930
7	.01970	.01090	.0220	.01460	.02080	.00690	◦	.01340	.00730	.01050	.01230	.02320	.01672	.00800
8	.02070	.01190	.02320	.01560	.00980	.01160	.01490	.00220	.00760	.00270	.02480	.03280	.00232	.00070
9	.01890	.01010	.02140	.01380	.00700	.00560	.00590	.00540	◦	◦	.01400	.03720	.00032	.00110
10								.01070	.01090	◦	.01020	.00460	.00272	
11					.04140	.03490	.01360	.02460	.01610	.00050	◦	◦	.00062	.00050
12														
13										.00508	.01118	.00578	◦	.00488
14														

[a]The ◦ indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXII

CHANGES IN THE PER THERM COST OF MOVING FEED GRAIN THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL III

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1														
2														
3	·	·	·	.00010	.01730	.01610	.01740	.01690	.01730					
4	.00680	.00570	.01710	·	.03690	.07950	.02950	.03760	.02860					
5	.05220	.07920	.00060	.01640	·	.00560	.01150	.00270	.00380	.00710	.03630	.02610	.00760	.00800
6	.00330	·	.00190	·	.00810	·	.00470	.00870	.00480	.00990	.03270	.05310	.00990	.00970
7	.00440	.00150	.00930	.00640	.01660	.00670	·	.01350	.00720	.01050	.01230	·	.01920	.01070
8	.00350	.00020	.00630	.00570	.00580	.00950	.01280	·	.00540	.00060	.02270	.00790	·	·
9	.00360	.00030	.0065	.00570	.00690	.00540	.00590	.00530	·	·	.01400	.01450	.00060	.00120
10														
11					.04150	.03490	.01370	.02470	.01510	.00060	·	.02610	.00020	.00010
12														
13														
14														

[a]The · indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXIII

CHANGES IN THE PER HEAD COST OF MOVING STOCKER CALVES THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL IV

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Dollars/Animal)													
1	•	6.58	12.99	4.89	11.99	10.30	11.13	13.48	10.28	13.18	22.28	26.77	20.52	17.90
2	14.42	•	21.47	9.48	17.26	13.81	10.71	19.43	13.27	12.93	25.23	30.05	23.28	18.98
3	3.84	4.50	◦	.026	2.19	•	3.07	3.53	.02					
4	6.21	2.96	10.73	•	11.52	7.72	8.94	13.06	8.38	13.13				
5	7.73	5.10	8.13	6.75	◦	2.16	4.80	1.32	◦		8.70	14.46		
6	12.05	7.74	10.85	7.92	6.43	•	5.82	8.00	2.23	4.04	13.44	17.91		
7	12.64	5.79	13.74	9.43	7.52	4.29	◦	7.72	2.34	.16	11.54	17.52	8.52	6.52
8	10.14	21.22	9.45	8.15	1.63	3.07	2.97	◦	◦	3.43	7.39	13.15	14.37	7.45
9	14.58	9.74	13.54	11.11	6.95	4.91	4.93	7.61	•	5.45	11.36	17.41	10.83	10.89
10	21.03	24.60	21.13	17.40	14.28	12.22	7.43	14.05	8.10	◦	13.42	18.33	9.68	6.20
11	14.59	10.08	14.69	9.39	4.29	4.23	4.32	3.64	◦	◦	◦	7.21	.73	1.59
12	18.04	13.48	16.37	13.58	7.95	7.26	8.53	7.61	4.23	3.61	5.42	•	3.00	3.46
13	18.45	11.28	18.02	14.06	10.28	8.65	6.30	7.20	4.02	.22	5.28	9.34	•	1.93
14	20.64	13.88	21.14	17.03	14.08	12.02	8.07	13.04	8.78	1.11	9.66	14.64	6.32	•

[a] The • indicates that the activity is in the Basis.

[b] Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXIV

CHANGES IN THE PER HEAD COSTS OF MOVING FEEDER CATTLE THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL IV

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						(Dollars/Animal)								
1	◦	◦	.56	2.19	8.93	4.82	12.04	11.89	9.60	27.36	24.70	40.97	31.85	34.98
2	29.27	•	22.32	18.07	27.72	19.09	22.35	29.45	23.09	36.95	37.50	54.88	41.94	45.59
3	22.42	14.91	•	12.90	12.83	8.18	16.29	16.02	13.21	31.22	25.45	43.25	35.99	40.43
4	14.46	.97	◦	◦	13.77	6.48	13.00	16.75	12.23	29.69	26.54	42.61	33.57	37.79
5	21.48	9.01	3.42	14.07	•	4.28	10.87	4.47	3.45	23.04	15.23	30.49	24.91	30.41
6	26.19	11.19	7.62	15.61	10.68	•	9.96	14.21	7.88	26.79	21.89	36.74	29.76	34.52
7	23.92	3.06	8.04	13.94	10.35	4.41	•	10.25	4.21	16.54	21.16	36.22	22.79	25.12
8	20.46	9.46	2.66	13.07	.61	1.41	7.87	◦	1.67	18.62	11.95	26.74	17.95	25.61
9	24.67	8.89	6.35	15.06	6.01	1.58	7.80	8.17	•	20.11	14.98	30.68	22.69	28.22
10	22.56	1.25	3.85	12.40	5.39	.31	1.11	5.01	◦	◦	6.55	19.66	7.39	9.98
11	29.60	12.95	10.22	20.39	8.35	6.14	12.44	9.01	5.50	17.23	5.61	22.99	13.17	21.68
12	22.54	6.95	5.13	-13.64	2.58	◦	8.28	2.80	.24	9.69	2.00	◦	6.64	12.55
13	24.06	5.55	6.48	13.90	4.75	.76	3.47	1.85	•	4.97	◦	14.12	◦	9.31
14	22.01	3.60	4.96	12.27	4.72	◦	2.56	4.08	◦	1.98	3.03	14.77	3.76	◦

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXV

CHANGES IN THE PER CARCASS COST OF MOVING CARCASS BEEF THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL IV

TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FROM REGION	(Dollar/Carcass)													
1	•	10.46	22.50	11.89	26.54	20.07	23.63	21.91	27.50	20.34	23.75	27.30	27.78	29.07
2	10.06	•	21.41	4.29	23.10	13.76	19.03	18.47	23.04	16.90	18.06	21.06	9.88	12.67
3	°	1.37	°	.89	6.61	8.11	15.09	°	10.91	13.30	3.75	12.21	7.78	9.07
4	10.62	13.99	20.87	•	28.70	18.27	25.25	24.07	24.62	16.16	24.82	21.28	27.01	22.98
5	13.08	9.90	21.35	10.65	°	8.84	9.64	.25	6.96	5.39	1.30	•	1.71	2.32
6	2.16	°	11.39	°	6.29	°	4.65	5.59	3.75	2.86	1.29	°	3.13	3.06
7	3.73	.28	13.23	.07	4.84	3.00	•	1.50	3.27	°	2.04	°	°	°
8	18.94	18.22	28.44	18.01	9.81	19.43	14.06	•	10.36	10.98	4.84	5.59	5.22	7.16
9	13.35	11.13	22.85	10.92	2.86	7.02	6.02	•	•	4.23	•	°	2.56	1.23
10					21.07	21.18	14.44	14.29	18.08	•	6.68	1.23	1.71	3.84
11	12.73	18.01	29.73	17.80	14.86	15.55	15.16	6.42	14.04	5.18	1.29	•	1.09	2.52
12							27.13			18.72		•	7.75	14.15
13					29.11	31.44	26.20	21.86	27.45	14.80	12.75	6.28	•	8.01
14					28.23	28.69	22.87	21.15	25.73	9.07	8.18	3.96	5.12	•

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXVI

CHANGES IN THE PER THERM COST OF MOVING FEED GRAIN THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL IV

FROM REGION \ TO REGION (Cents/Therm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1														
2														
3	•	.00040	•	.00050	.01790	.01650	.01310	.01750	.01790					
4	.00640	.00570	.01670	•	.03710	.07970	.02480	.03780	.02880					
5	.05160	.07900	•	.01620	•	.00540	.00660	.00270	.00380	.00710	.03630	.02120	.00760	.00800
6	.00290	•	.00150	•	.00830	•	•	.00890	.00500	.01010	.03290	.04840	.01010	.00990
7	.00870	.00620	.01360	.01110	.02150	.01140	•	.01840	.01210	.01540	.01720	•	.0241	.01560
8	.00290	•	.00570	.00550	.00580	.00930	.00790	•	.00540	.00060	.02270	.00300	•	•
9	.00300	.00010	.00590	.00550	.00690	.00520	.00100	.00530	•	•	.01400	.00960	.00060	.00120
10														
11					.04150	.3470	.00880	.02470	.01510	.00060	•	.02120	.00020	.00010
12														
13														
14														

[a]The • indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

TABLE LXXVII

CHANGES IN THE PER THERM COST OF MOVING WHEAT THAT WOULD GENERATE CHANGES IN THE OPTIMAL SOLUTION OF MODEL IV

FROM REGION \ TO REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(Cents/Therm)													
1	°	°	.00850	.00260	.07560	.02620	.02680	.02800	.02590					
2	.09680	°	.02500	.01160	.11490	.03500	.03560	.03810	.03470					
3	.0042	.00220	°	°	.00920	.00790	.00650	.00770	.00760					
4	.01260	.00410	.01520	°	.02890	.03130	.03190	.03440	.03100					
5	.07280	.00330	.01140	.02960	.00540	.01090	.02790	.03050	.02680	.01410	.04150	.05430	.01300	.01350
6	.01860	.00980	.00710	.01350	.00800	°	.00470	.00490	.00480	.00990	.03270	.07590	.00960	.00930
7	.01970	.01090	.02220	.01460	.02080	.00690	°	.01340	.00730	.01050	.01230	.02320	.01650	.00800
8	.02070	.01190	.02320	.01560	.00980	.01160	.01490	.00220	.00760	.00270	.02480	.03280	.00210	.00070
9	.01890	.01010	.02140	.01380	.00700	.00560	.00590	.00540	°	°	.01400	.03720	.00010	.00110
10								.01070	.01090	°	.01020	.00460	.00250	
11					.04140	.03490	.01360	.02460	.01610	.00050	°	°	.00040	.00050
12														
13										.00530	.01140	.00600	°	.00510
14														

[a]The ° indicates that the activity is in the Basis.

[b]Blanks indicate that the activity was determined not to exist prior to the programming.

APPENDIX E

SHADOW PRICES OF THE GRASS CAPACITY, FEEDLOT CAPACITY, AND SLAUGHTER CAPACITY FOR MODELS I, II, III, AND IV

TABLE LXXVIII

SHADOW PRICES FOR THE OPTIMUM USAGE OF GRASS CAPACITY IN THE FOUR MAJOR MODELS

Region		Model I	Model II	Model III	Model IV
			(Dollars/Animal)		
1	Pacific Northwest	$.	$.	$.	$ 2.54
2	Desert Southwest	.	.	1.15	4.36
3	Intermountains	2.61	2.59	3.41	6.33
4	Great Basin	1.04	.79	1.88	4.69
5	North Plains	2.16	2.10	2.87	5.95
6	Central Plains	1.82	1.80	2.62	5.58
7	South Plains	1.73	2.23	2.92	5.80
8	Lake States	.21	.28	1.31	4.20
9	Western Corn Belt	.43	.24	1.48	4.18
10	South Central	.50	.45	1.22	3.90
11	Eastern Corn Belt	.	.	.03	2.92
12	Northeast	.	.	.	2.80
13	Upper South	.	.03	.76	3.58
14	Southeast	.35	.32	1.08	3.76

TABLE LXXVIX

SHADOW PRICES FOR THE OPTIMUM USAGE OF SLAUGHTER CAPACITY IN THE FOUR MAJOR MODELS

Region		Model I	Model II	Model III	Model IV
			(Dollars/Animal)		
1	Pacific Northwest	$.	$ 12.66	$.	$.
2	Desert Southwest	.	13.43	.	.
3	Intermountains	8.36	11.89	11.89	11.89
4	Great Basin	.	12.99	.	.
5	North Plains	11.53	12.77	12.34	11.53
6	Central Plains	13.21	13.21	13.21	13.21
7	South Plains	11.67	11.67	11.67	11.67
8	Lake States	.	1.49	.	.
9	Western Corn Belt	13.76	13.76	13.76	13.76
10	South Central	.	11.34	.	.
11	Eastern Corn Belt	.	12.77	.76	8.09
12	Northeast	.	.	.	.
13	Upper South	.	10.68	.	6.03
14	Southeast	.	6.63	.	.93

TABLE LXXX

SHADOW PRICES FOR THE OPTIMUM USAGE OF FEEDLOT CAPACITY IN THE FOUR MAJOR MODELS

Region		Model I	Model II	Model III	Model IV
		(Dollars/Animal)			
1	Pacific Northwest	$ 3.43	$ 31.13	$ 12.35	$ 26.24
2	Desert Southwest	.	27.25	.	.
3	Intermountains	.	31.13	.	7.70
4	Great Basin	5.55	31.13	12.13	19.40
5	North Plains	11.76	27.29	21.29	27.13
6	Central Plains	6.25	21.40	14.27	21.40
7	South Plains	15.40	21.40	21.40	21.40
8	Lake States	17.13	37.98	24.89	31.89
9	Western Corn Belt	.	31.30	8.35	16.19
10	South Central	21.22	36.38	28.58	34.82
11	Eastern Corn Belt	25.52	31.57	31.57	31.57
12	Northeast	.	37.45	12.77	15.22
13	Upper South	31.60	36.38	36.38	36.38
14	Southeast	23.71	36.38	31.07	36.38

VITA

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