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The future for beef

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THE FUTURE FOR BEEF

The Center for Agricultural and Economic Adjustment

College of Agriculture

Iowa State University
of Science and Technology

Ames, Iowa

1963

Work of the Center supported in part by a grant from the W. K. Kellogg Foundation
FOREWORD

Beef is a fast-growing, multi-billion dollar industry today in the United States. And the outlook for tomorrow is most favorable. Beef consumption has increased by 26 pounds per capita during the past 15 years, hitting an all-time high of 90 pounds per capita in 1962. During the same period quality has improved, and now beef commands even wider consumer acceptance than in the mid-1940's. New technology has lowered production and marketing costs.

But even a strong, healthy industry must be sensitive to change--and take advantage of new opportunities for growth and improvement. The beef industry is no exception.

Thus the planning committee was aware of many changes taking place in all segments of the beef industry as it began shaping the program for the National Beef Cattle Conference. Committee members recognized that there is a close interrelationship between the production, processing and retailing sections of the industry--further that new developments in any one segment may alter relationships between segments of the industry.

Some obvious changes and developments considered in planning the conference were:

Increase in beef cow numbers in the Midwest, South and Southeast.

Growth of cattle feeding in the West and Southwest.

Development of large commercial feedlots.

Performance-testing to improve production performance and beef quality.

Development of new feed additives, feed forms and feeding procedures.

Influence of dual grading, federal grazing policies and the feed-grain program.

Change in freight differentials between beef carcasses and live cattle.

Decentralization of the processing industry and relocation near areas of production.

Improvement of beef processing techniques.

Influence of the shifting U. S. population, rise in consumer income and formation of the European Common Market upon the demand for beef.
Demand by chain stores for beef of a specified weight and quality.

Demand for the meat-type steer.

The National Beef Cattle Conference was staged Nov. 12, 13 and 14, 1962, in Ames, Iowa, to study such developments and aspects of the beef industry. It was sponsored by the Center for Agricultural and Economic Adjustment, Iowa State University.

Papers read at the conference comprise this report. They provide a wealth of background information useful to anyone concerned with the beef industry--farmer, rancher, equipment manufacturer, feedman, breed organization representative, processor, market manager, educator or agricultural journalist.

This report attempts to focus attention on and enlarge understanding of the beef industry's problems and opportunities of the present and the future, to the extent that this goal has been achieved, the Planning Committee can thank the many qualified individuals who participated as resource people in the conference.

W. G. Zmolek
Lee R. Kolmer

Co-Chairmen, Planning Committee
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GENERAL SUMMARY

Magnitude of Our Beef Market

As a nation, the United States, prefers beef to any other meat. In 1955, we used 13.7 billion pounds of beef (carcass weight); the estimated consumption for 1962 is 16.6 billion pounds. This long-time trend of higher total and per capita beef consumption is expected to continue. By 1967 we expect a population of 202,000,000 persons and a total beef consumption of 18.4 billion pounds. This represents both a total and a per capita increase in consumption.

The present. The North Central region has the biggest share of the national beef market - 30.3% of the population and 36.6% of the beef consumption. The North East follows with 26.7% of the population and 27.4% of the beef consumption. The South has 32.1% of the population and 21.6% of the consumption. While the West has only 10.9% of the total population it has a higher per capita consumption level and thus accounts for 14.4% of the national beef consumption.

The future. In the future, the most important changes in the total and regional consumption pattern for beef will result from population. The 202,000,000 people projected for 1967 constitutes a 22% increase in population. This should result in a proportionate increase in total beef consumption. This is especially true if incomes continue to increase during the next five years. And incomes are expected to increase - from 22% to 30% in the various regions. The largest increases in income should occur in the South. Thus the largest increases in consumption per capita of beef should also occur in the southern regions.

Fat question. While future consumption levels are expected to be higher than present levels there is some concern about the effect of fat in the diet. This has become a major consideration for many U. S. consumers. This is an area that vitally affects the welfare of the beef industry. The current emphasis on polyunsaturated fats in the diet has caused much discussion and much controversy. However, present research does not indicate the optimum combination of monosaturated and polyunsaturated fat for American diets. More research is needed in this area in determining the relationship between heart disease, levels of cholesterol and the intake of animal fats.

Export market. While the domestic market represents the bulk of the total market for U. S. beef, the export market is also important to the U. S. beef business. The United States is the world's largest beef exporter, and in 1961-62 we were the world's largest agricultural products exporter. We exported 5.13 billion dollars worth of agricultural commodities in 1961-62. Approximately 70% of these sales were for dollars and 30% were made under trade agreements, Public Law 480 and other arrangements. Cattle and cattle products constituted approximately 5% or $266,000,000 of our total exports in 1961. These exports consisted mostly of tallow, hides and variety
meats. Beef and veal export sales amounted to $12,200,000 of this total and live cattle sales amounted to approximately $9,000,000. Our cattle product exports have been increasing. Among the better customers for tallow and hides are Japan, the Netherlands, West Germany, Italy and Canada. While the total dollar volume of cattle product exports is not large as compared to the total dollar volume of the national beef business, exports do constitute an important outlet for commodities which have a much lower value in domestic uses than they have in overseas markets.

**Beef imports.** The United States is also the largest importer. Imports of cattle products in 1961 included 665 billion pounds of beef and veal valued at $228,000,000. Live cattle imports amounted to $101,000,000, and hide imports amounted to $13,000,000. The total of all cattle and cattle product imports was $350,000,000. The meat imports were composed mainly of live cattle, mostly from Canada and Mexico, and of lower grades of boned beef for use in processing. Many live cattle were imported as feeder cattle for fattening and processing in the United States.

While the export demand does not represent a major outlet for United States cattle products, there is opportunity for market expansion. However, the cattle industry must be realistic. As the European Economic Community moves toward self-sufficiency there will be need for aggressive selling and negotiating in order to protect our interests in the European market. However, there are also opportunities in other parts of the world as income levels increase, standards of living rise, and there is increased demand for animal products in diets. This represents opportunities for additional export sales of U. S. cattle and cattle products.

**Changes in market institutions.** While we have had major changes in the make-up of the U. S. beef market, the market institutions serving the American public have also made major changes to accommodate and to adapt their operations to meet consumer needs. Today more beef is being purchased by voluntary or co-operative groups as compared to several years ago. This means that buying decisions have been consolidated and that fewer meat buyers, representing larger retail groups, are each buying larger quantities of beef. There also has been much discussion in the retail trade of moving the processing operation out of retail stores to central warehouses and/or the packer. Several systems are being used at present including central warehousing, store processing and a combination of both. The users claim satisfaction and success. The eventual nature of the beef fabricating operation will, in large part, be determined by the changes that retailers make as they try to supply consumers with the goods and services they demand but yet remain competitive with other retailers in their area.

Part of the problem of remaining competitive with other meats and
with other retailers in the area is the need for a carcass that will provide the yield of cuts and the size of cut that appeals to the American housewife. Retailers need carcasses that yield approximately 78% saleable cuts from animals that weigh from 800 to 900 pounds for heifers and from 900 to 1100 pounds for steers.

The changes that have occurred in the retailing sector have been accompanied by changes in the processing sector of the beef business. There have been major shifts in the technology of beef processing in packing plants. Development and use of new equipment has increased capital requirements, labor productivity and capital use and output per plant. The major objective of these changes has been to provide a more acceptable product to the retailer and at the same time reduce the costs of processing and thereby maintain a competitive position within the industry.

Product development. While these changes have been taking place in the technology of processing, extensive research has been pursued in product development for beef. Research has been done on cutting and breaking carcasses. Also on cutting methods needed to realize the greatest value from a carcass. This probably will be accomplished not by measuring each carcass but by significantly different methods of grading than we are using at present.

The expansion of buying beef on a specification basis will continue. These buying programs will help stimulate the development of cutting methods that permit the realization of greater returns from different types and qualities of carcass.

Pre-packaged frozen meat has had many failures in the past. But processors feel that a demand can be created for it if some of the pre-conceived judgments and aversions of consumers can be overcome.

Tenderization is becoming increasingly important. There has been some success in this area. However, a major expansion in the use of tenderizers in the beef business could perhaps mean a shifting of our quality standards toward beef with less finish.

Dual grading. The search for more precise methods of differentiating beef quality and value has resulted in a revised grading method being proposed by the USDA. Since last July 1, the method of dual grading beef has been made available to the industry on a voluntary basis. At present approximately 3% of the beef is being graded using the dual grading method. The issue in dual grading is the question of who will do the grading. While dual grading has been made available on a trial basis by the government, the industry claims that it can provide the same service at lower cost. On the other hand, the federal government claims that there is a need for governmental participation in this area in order to insure a lack of bias in the grading...
process. At the present stage of development, no one can make definite statements as to the future of this method of grading. If the industry becomes convinced of the value of the method, it will adopt it; if the industry is not convinced of the economic value involved or develops satisfactory alternative methods, it very likely will not adopt dual grading on a mass basis.

Marketing Patterns

Cyclical shifts. Changes in the consuming sector, in the retailing sector and in processing have brought about changes in the marketing patterns for cattle and cattle products. The traditional cyclical supply and price shifts in the beef industry have been costly to the industry. In recent years, month-to-month and year-to-year variations in supplies and prices have been reduced. However, there is still much room for further reduction. Accurate forecasting of supplies and output would benefit everyone - the producer of feeder calves, the feedlot operator, the processor, the retailer and the consumer. This fluctuation is a unique problem: its solution results in significant gains to each sector of the industry. At present the analytical methods, computational machines and professional competence are such that accurate forecasts of supplies and prices can be made for both the long and short run. However, resources to make such forecasts on a continuing basis must be made available if the industry wishes to move further toward stabilizing output and increasing total returns.

Shifts in other areas of the beef business have also resulted in changes in marketing patterns for beef. Plant location has changed significantly in the last 10 years. There are more plants in the North Central, Southeastern and Mountain states today than 10 years ago. This trend will continue. There is more competition among marketing agencies for producer accounts. Competition between terminals, auctions and direct marketers will continue to grow as the number of cattle feeders declines and the size of individual feeding operations increases. The increase in the size of the feeding operation will open more opportunities for contract selling between feeders and processors. While this trend is not likely to become as prevalent as it is in the Southwestern and Pacific Coast states, there is still likely to be significant increase in contractual selling of livestock.

The changes on the selling side of marketing have also resulted in changes in sources of supply and methods of procuring feeder cattle.

Substantial feeder cattle supplies are available from areas that 10 years ago were not considered significant feeder cattle producing areas. The prejudices of the past in terms of origin of feeder cattle and their desirability have been dying out as quality has been improved and competition for feeder calf supplies increases with the growth of
feeding in the Southwestern and Pacific Coast areas. We can expect signifi­cant increases in feeder calf production in the South Central states, the Lake states and the Corn Belt. These increases will tend to displace some of the feeder cattle from Mountain and Plain states that traditionally have been fed in the Corn Belt. At the same time, the increased feeding in the Plains, the Southwest and the Pacific Coast will provide added market outlets and com­petition for feeder cattle from the western range areas.

Promotion. The increased demand for beef and the added competition for the consumers meat dollar caused by expanded poultry consumption has re­sulted in much interest in producer-sponsored promotional efforts. There is much controversy as to the value of producer-sponsored commodity pro­motions. However, there are some possibilities for beef promotion. Con­sumers prefer beef. Thus promotion would perhaps assist the industry in exploiting this basic preference. Also, beef enjoys a near unitary elasticity of demand. This means that increases in supply will be accompanied by proportional declines in price. This situation is significantly different from that facing many other agricultural commodities. In the latter case increases in supply are accompanied by more than proportional declines in prices.

In planning promotional efforts, one of the major problems is to identify goals that are common to the producer and market institutions. This is vital if the various sectors of the industry are to avoid conflicts in their promotional objectives. There is also a big problem of assessing the value of promotion as a tool to expand consumption and thus farm income. Pro­motion is only one tool among many for achieving this goal. There is no magic in the promotional process. A producer group must study many economic and social factors involved before committing large sums of money for promotional activities.

Changes in Production Technology

Many changes have occurred in production technology during the past decade. (The art of feeding cattle is being rapidly replaced by the science of cattle feeding.) Some of the scientific areas of research include new methods of storing and preserving feeds, automation, frequency of feeding, the ratio of concentrates to roughage, pelleting feeds and the use of feed additives.

Possibilities for future. Harvesting equipment is needed that will harvest and shell ear corn, separate and process the cobs and stalks in one operation. Cobs and stalks comprise 39% of the nutritional value of the corn plant. Thus the cobs and stalks from 1.5 acres of corn provide enough nutritional value to feed a cow and a calf.

Corn stalk-cob silage offers possibilities to expand feeder calf production in the Corn Belt.

Use of automatic feeding systems will further speed the adoption of more
mechanized harvesting and preserving operations. Hand feeding has been declining in importance, and push button systems and self feeding are becoming more common. More frequent or self feeding of beef cattle has demonstrated significant advantages in terms of the rate of gain obtained.

While automation and mechanical harvesting methods are important, they must be adopted to a ration that will permit optimum gains and optimum efficiency. This means that feeding systems must be so constructed that a ration containing approximately 20% roughage can be utilized. Experimental results have shown that the physical form of feed can have a significant influence upon the gains, and that a 20% roughage ration is required for best results.

Pelleting of feed. One means of achieving proper roughage-grain proportions in the ration and still utilizing automatic feeding methods is through pelleting of feed. Pelleting feeds encourages greater animal consumption, especially of the lower grade roughages, and consequently results in superior performance. Pelleting will become more important in the future as harvesting and processing machinery and feeding systems become more sophisticated and refined.

Management. To achieve gains from advances in livestock nutrition it is necessary to combine nutrition and common sense management in profitable cow-calf operations. Four major factors involved in profitable feeder calf production are: (1) the percentage of calf crop, (2) the weaning weight of calves, (3) the cost of production per calf, and (4) the price per hundred weight of the calf crop. These four factors are crucial for the cow-calf producer irrespective of location. Nutritional advances, breeding advances and other technology will only be valuable if they are expressed as improvements in the above factors.

Selection and breeding. The profitability and competitiveness of the beef cattle industry in relation to other meats will be greatly affected by the type of selection and breeding programs used by producers in future years. The direct selection of beef cattle for traits of economic value could improve several of the major characteristics by 5 to 10 percent over the next 10 years. Trends in the industry at present seem to be in the direction of intensive selection for characters important in efficient production. To develop cattle with maximum production potential we likely will do four things:

1. Have our breeding seed stock herds raised and evaluated under conditions that are close to the commercial conditions that will be experienced by their progeny.
2. Maintain larger seed stock herds than at present.
3. Employ more technical people for the evaluation of seed stock.
4. Use more technical evaluation methods than at present.
Carcass quality and cutability. There are several factors that can influence the quality and yield of the carcass such as feeding procedure, age, weight and sex of animal. It appears that young animals should be fed liberal rations to attain maximum muscular development. Tenderness decreases as age increases. External or waste fat increases with advancing age of cattle. Thus, young beef animals destined for ultimate slaughter should be grown and finished at as young an age as possible. Steers, heifers, and bulls, will all produce highly desirable beef. Steers are the most versatile feed animal. Bulls should be finished for market shortly after weaning.

Herd health. So far as the individual producer is concerned, many of the gains made by the adoption of new technology in feeding, breeding and management can be lost through inadequate herd health programs. Maintaining animal health is a large and continuing problem to the United States. Last year the costs to the U.S. producers from health losses were estimated to be more than $2,000,000,000 (billion). In recent years, the situation has improved some. For example, brucellosis losses have dropped from approximately $100,000,000 per year to $20,000,000 per year in the last 10 years.

This reduction in brucellosis losses was the result of concentrated campaigns for brucellosis eradication. Similar programs could be carried out to reduce losses from anaplasmosis, leptospirosis, vibrosis and, to a lesser degree, cattle grubs.

The industry needs more research on infectious bovine rhinotracheitis, virus diarrhea and mucosal diseases.

Herd health programs can only reach the optimum in success if they are part of an integrated program of applied techniques in feeding, breeding, management and disease control. This means a preventive program in disease control rather than a "rescue-the-sick" program.

The well-being of the beef industry is also partly dependent upon the transportation rate-making, grazing, and feed grain policies of the United States. While individual producers, processors and distributors can not materially affect the total policy framework of the United States, the policies promulgated do have a very significant and direct effect upon the well-being of individuals within the industry.

Transportation. Transportation policies that will permit more economical movement of meat and meat products from production areas to consumption areas would contribute substantially to the well-being of the beef industry. Structural changes in the beef industry that have taken place in the last 20 years indicate a need for objective study of our transportation policies in relation to the requirements that face the beef industry today.

Grazing policies. The cost and availability of feeder calves from the western range areas will be partially determined by the degree of certainty or uncertainty facing ranchers in their use of public grazing lands. Here
again, the changes in the beef industry, coupled with the shifts in demand for public lands for recreational and other uses, have resulted in some conflict in objectives and much confusion as to the role and use of public grazing lands by stockmen.

**Feed-grain policies.** Feed-grain policies that will be pursued by the United States in future years will have significant effect on the number and location of cattle being fed. Our agricultural policy during the past years has been a middle ground policy, away from both extremes of no control and complete control. Recent experience with the voluntary feed-grain programs indicates that voluntary programs will work. During the past several years, the carryover supplies of feed grains have been reduced substantially. While there is more flexibility in a voluntary program, the cost of a voluntary program is about the same as that of a mandatory program. In one instance a greater proportion of the costs come from the treasury, while in another instance the greater proportion of the costs may come through the market place. However, the total cost is not substantially different.

Livestock producers, by and large, have been convinced that a program which controls feed-grain output has proven to be a reliable method of controlling meat animal output. This is substantially what we have attempted to do in agricultural policy in the United States.

So far as future policy is concerned, any program that reduces feed-grain output is favorable to the beef industry. The relatively higher price for concentrate grains increases the value of roughage and forage in the beef feeding ration. Concentrate-using livestock that do not have the alternative of obtaining a substantial proportion of their gains through the use of forage and hay will not have this advantage in production. L.R.K.
STRUCTURE OF THE DOMESTIC MARKET FOR BEEF

by Robert J. Lavell

To fully develop a market one can't know too much about the people who compose it. I would like to tell you all about the market for beef in the United States; who eats beef, what cuts, what grades, how much and at what price, where the purchaser lives and where he shops. I would like to tell you all of this about today's market and about tomorrow's market as one guide to develop fully the potential that exists.

Of course, you realize I won't. Time would not allow it even if I were able. But I shall discuss the size of the market in the various regions of the country in the not too distant past, and the consumption of certain groups within each region. I shall also discuss why beef consumption has varied from one group to another. And, based on this discussion, I will speculate with you on the potential market for beef in the United States five years from now.

As a starting point, let's look at the domestic disappearance of beef in the United States during recent years. (Table 1.) In 1955, we ate, or used, 13.7 billion pounds of beef in this country, measured by carcass weight. Five years later we used an eighth more -- 15.5 billion pounds. It is estimated that we will use over 16.6 billion pounds this year. During this period the population also increased, true, but not as fast as consumption. We have been eating more beef per person, continuing a long time trend.

The most recent projection indicates that five years from now, when the population will be about 202 million, 18.4 billion pounds of beef will be eaten in the United States. This, too, implies an increase in per capita consumption.

Factors Affecting Consumption of Beef

Who has been eating beef and why has the per capita consumption changed? The average consumption of beef, as of any food, involves a wide variation in consumption rates among individuals and among different groups in the population. Physiologists, nutritionists, psychologists, economists and others have identified many factors that directly influence an individual's food consumption. We assume that some physical factors such as size and health of individuals are randomly distributed throughout the United States and that therefore they have the same effect on average food consumption in all groups.

In general socio-economic and other physical factors vary, sometimes systematically, from group to group, and affect average food consumption rates of each

1/ Dr. Lavell is economist, Economic & Statistical Analysis Division, Economic Research Service, USDA.
group. By socio-economic factors we mean such things as money available for food, type of community in which one lives, occupation, education, sex, age, tastes and food habits.

For economic analysis of beef consumption it is necessary not only to identify factors but also to be able to measure them and their effect on consumption. Not all the factors mentioned are susceptible of direct measurement, and matched consumption data are available for none. However, we can use several indirect influences as key factors because they summarize the effect of other influences on food consumption and matched consumption data are available for these key factors. They include income, degree of urbanization and region.

Why region affects beef consumption. The region itself influences food consumption. This is partly because of the history of local food supply, but mostly because of the distinctive overall culture and economy that has developed in the region. Each region in the United States has different natural resources: climate, soil, topography, navigable rivers and coast lines. To each region the settlers brought different ethnic and cultural backgrounds, occupations, food habits and standards of living. Working with the natural resources available, the first comers developed a local economy and society, and food habits, adapted to local conditions. Food habits changed slowly as industry and commerce developed and people with other backgrounds arrived. Those in industrial areas were able to buy more products (including food) from outside their region than could people without as much opportunity for exchange. Concurrently, improved techniques of agriculture led to greater food output in some regions, while development of transportation and other marketing facilities expedited the distribution of this food to other regions. These advances were made at different rates in the several regions. This situation contributed to the differences in regional economies and cultures we find today.

Many forces work to break down regional differences in food consumption -- more adequate incomes, mobility of the population, spreading nutritional knowledge and nationwide advertising campaigns through mass media, and modern transportation and marketing facilities. Yet food habits developed in the local environment have proved to be highly persistent. Data from the 1955 Food Consumption Survey illustrate the extent of regional differences in beef consumption at that time, and we can expect to find significant differences for many years to come.

Degree of urbanization. The degree of urbanization -- whether a person lives in urban, rural nonfarm or farm surroundings -- reflects the influence of factors having to do with population density, occupation and food supply institutions. Beef consumption in each urbanization category is influenced to a different degree by (a) the amount of home-produced beef available; (b) accessibility of different types of food stores; (c) economic factors related to occupation, nonmoney income, prices of beef and of other foods and nonfood goods and services; and (d) social and cultural factors such as schools, newspapers, clubs,
and other institutions that help form the folk ways and related food ways of sub-groups.

By the very nature of the factors that the degree of urbanization summarizes, their influence varies by region. The degree of urbanization influences the consumption of beef within each region. But the influence of any one urbanization category varies from region to region.

**Effect of income.** Income is a good indication of money available for food, though by no means a direct measure. Nonmoney income such as home-produced food and rent-free dwellings directly affects food and nonfood needs. However, measures of it are not available for all groups. Variations in family size, age and sex composition of different groups as well as the stage of the family cycle also blur the relationship of income to consumption of beef. (For instance variations in family size influence food and nonfood competition for money within each family.) But income is still the best measure available to reflect the economic considerations involved in the purchase or consumption of beef, or any food. In this analysis I used measures of money income after income taxes in certain cases because they were available. In other cases, I had to use measures of total personal income because that was the only kind available for the data breaks I needed.

Regional and urbanization differences enter into the income picture, too. There is a full range of incomes within all urbanization categories in the several regions. However, the proportion of families at each level differs by urbanization and region. More highly industrialized regions generally have a greater proportion of families in the upper income groups.

Not only does distribution of income vary by region and urbanization category, but the influence of the same size income on consumption of beef varies from region to region in each urbanization category because of different combinations of other factors found in each such group. For example, contrast a West Coast steak cook-out with a New England clam bake. The same kind of people are involved in both, but only one group uses beef.

**Structure of the Household Market for Beef in 1955**

To what extent, then, do these factors influence beef consumption? The 1955 survey is the only source of consistent estimates of beef consumption of groups of people cross-classified in these categories. Table 2 presents some information on the structure of the household market for beef developed from that survey. The rest of this discussion springs from this table, and will be limited to consumption of all beef combined, measured at retail weight. No distinction will be made for different cuts, different grades or different prices. I have not yet integrated into the 1967 projections information on grades and cuts, such as the Cooperative Extension Service here at Ames has done in its series of consumer marketing bulletins and handbooks. Thus I am leaving them out of the 1955 frame-
work. Prices are for the most part left out to limit the problem to manageable proportions. Veal is excluded for the same reason, and veal consumption is becoming less important.

Table 2 indicates a number of general tendencies in the ways these key factors influence the consumption of beef.

**Income effect measured.** In all urbanization categories in each region beef consumption per person generally increases as incomes rise. However the successive increases in consumption are smaller at each step upward on the income scale. This may seem to be reading an awful lot into the erratic consumption rates presented. But then, the rates include a lot of variation due to sampling and to other differences in each group such as average age and stage of life cycle of the family. The general tendency is still there.

One way to measure the effect of income on consumption is by the income elasticity with respect to quantity. When all families are grouped into low, medium, and high income groups, the income elasticity of beef for the low income group was .27, for the medium income group .24, and for the high group .13.

Income elasticity with respect to value of consumption is another story. Data for this are not included in the table. For the low income group it was .39, for the medium group .32, and for the high .24. Though the high income group would not buy many more pounds of beef in response to an increase in income, they probably would spend quite a bit more for better grades and more costly cuts.

**Urbanization effect measured.** At first glance at Table 2, it would seem that only one fact stands out concerning the effect of the degree of urbanization on beef consumption. This fact is that in any one region in the same income group consumption varied by urbanization category, usually quite a bit. There have been vagueness and frequent changes in definition of what each urbanization category consists and consequently difficulty in achieving a good measurement of its effect. Thus we have no urbanization elasticity to indicate what variation in consumption is related to differences in degree of urbanization. However, some consistent relationships can be observed that are useful for market analysis. Except in the South, farm consumption of beef per person in the same income groups was generally greater than the urban rate. This is explained by the fact that from 60 to 70 percent of beef consumed by the farm population was from home-produced beef. In the South only half of the beef consumed on farms was home-produced. Home production of beef got a special lift when satisfactory home storage that new freezing facilities brought became generally available.

The main fact to note about the influence of degree of urbanization on beef consumption rates is that in each region there is generally a sizable difference in rates at the same money income level in the several urbanization categories. The category with the highest consumption rate varies from region to region.
Because of its effect on income degree of urbanization has a more consistent indirect effect on consumption. For example, there are relatively more urban families in the upper income groups, which are usually the ones with the larger beef consumption rates. So we find, as in the North Central region on Table 2, that average consumption of beef of all urban households in close to average farm consumption though at each income level farm consumption rates are generally much higher.

Region effect measured. I have already mentioned many aspects of the effect of region on consumption rates of beef. In Table 2 you can see how consistent the effects of region is. Taking comparable groups -- that is, the same urbanization category and the same income size -- the South's consumption rate of beef is almost always the lowest. The Northeast is next up the scale, followed by the North Central. Consumption rates are highest in the West. Regional food habits at work!

Since region is the only one of the key factors that has geographical unity (can be identified as a contiguous area) it is the one by which it makes most sense to divide the national market. To do this, not only consumption rates in each cell of the cross classification are needed, but also the size of the population that falls into each cell. From these two sets of information the size of the regional market can be calculated. Though distribution of the population among the subgroups is not included in Table 2, its effect can be seen in the last column on the right. In this column the weighted average consumption rate for each urbanization category in each region is recorded, along with the weighted average for the entire region.

With population in the Northeast in 1955 estimated at 44.1 million, in the North Central at 50.1 million, in the South at 53.1, and in the West at 18.0, the regional breakdown of the domestic market for beef in that year is:

<table>
<thead>
<tr>
<th>Region</th>
<th>Mil. lbs.</th>
<th>Percent of U. S. beef market</th>
<th>Percent of U. S. population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>3,758</td>
<td>27.4</td>
<td>26.7</td>
</tr>
<tr>
<td>North Central</td>
<td>5,012</td>
<td>36.6</td>
<td>30.3</td>
</tr>
<tr>
<td>South</td>
<td>2,968</td>
<td>21.6</td>
<td>32.1</td>
</tr>
<tr>
<td>West</td>
<td>1,978</td>
<td>14.4</td>
<td>10.9</td>
</tr>
<tr>
<td>U. S.</td>
<td>13,716</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

(In this table weekly retail quantities have been converted to annual carcass weight equivalents to match the U. S. disappearance figures.)
Comparison of the regional percentage of the beef market to the regional percentage of population is a measure of the overall effect of the region on beef consumption.

**Percentage of households using beef.** There is another element shaping the structure of the market for beef that I think should be mentioned -- the percentage of households using beef in each of the cross-classified cells. These survey data refer to one week's consumption. Obviously they contain some sampling error, but I'm sure the general tendencies are sound.

Almost everyone likes beef. Beef is good for one nutritionally. Though generally higher than pork and poultry, it is not expensive. Thus it is not surprising to find that for the U. S. as a whole almost 90 percent of the households reported using some beef during the week about which they were questioned. In the Northeast, 93.3 percent of all households ate some beef, in the North Central 94.0 percent, in the West 93.5 percent, but in the South only 77.3 percent. This is part of the explanation why consumption rates in the South were so much lower than in the rest of the country, since the rate for each sub group was calculated by dividing the total amount of beef consumed by the total number of people in the group. Naturally, if many households did not eat beef, it would lower the group average.

A higher proportion of urban households, on the whole, ate beef than in the other two urbanization categories. The fact that the average consumption in most subgroups of farm households was high and the proportion of households eating beef low indicates that those who did eat beef -- usually home-produced -- ate very much.

Another tendency was for the proportion of families eating beef to be larger in successively higher income size groups. Income, then, probably was an absolute limiting factor for some. This tendency partially accounts for the pattern of beef consumption with respect to income observed earlier. (By consumption pattern, I mean the relationship of the various consumption rates found in any cross-section consumption data. An example is the relationship of the consumption rates of beef in successively higher income groups.)

This aspect of the market structure can be a guide for directing promotional efforts. Would a given expenditure get more results by trying to win new beef-eaters or by trying to persuade those who do eat beef to eat more? Since income seems to be a limiting factor for some, are lower prices the only way to win these holdouts?

This income-urbanization-region framework indicates what the United States household market for beef looked like in 1955. It's interesting; it gives some insights; but it's history. If I may bruise Kipling to make a point,
That's all gone beyond us
Long ago and far away
And you may not sell beef tomorrow
As you sold beef yesterday.

Structure of the Beef Market in 1967

We have been examining the results of some of the decisions that people made several years ago concerning their consumption of beef. Also the part that the three key factors played in influencing these results. Any speculation in this framework on how big and where the future market will be must be based on how much the population changes in each of these subgroups. And on the influence which the key factors will have at that time on beef consumption decisions.

Population size. The most important change in the 1967 population relative to today, or 1955, is how much it increases. Population growth alone will account for more of the increase in the domestic beef market than almost any change that you could imagine in the factors we have been examining. Population in 1967 is projected to be about 202 million, more than a 22 percent increase over the population in 1955, the year of our base structure. There's a 22 percent increase we should be able to count on right off.

Age distribution. I only mentioned age distribution of the population as a factor influencing beef consumption because I have not been able to find any matching consumption data. However, as a general principle, it is safe to consider that children under 15 and senior citizens (in this case those over 65) as a group do not eat as much beef per person as those from 15 to 65. Table 3 summarizes census data on age groups in our population for several years. The proportion of big beefeaters is dropping, for we are getting proportionately more children and at the same time more elders in our society. Although this would tend to lower consumption rates, it is not considered an important factor influencing beef consumption, at least in those groups with many young children or many elders.

Shifts in urbanization. Because of the great differences in consumption rates that were found associated with it in earlier studies, degree of urbanization was used as a key factor in the 1955 structure in spite of difficulties in measuring it. Projecting urbanization shifts is another matter. The Bureau of the Census changed its farm definition in 1950 to add to the confusion. But even with the same definitions, the causal factors that shaped the characteristic consumption patterns in each urbanization category are vastly different today than they were just a few years ago. There have been tremendous changes in food merchandising. We have more convenient travel and shopping, more universal advertising, more prosperity. All of these things tend to break down many of the distinctive consumption habits we associated with each urbanization category. Consider how many of the rural nonfarm households in 1967 will really be exurban households with much the same consumption habits of urban households with comparable incomes.
Because I was unable to work out a satisfactory projection of shifts in degree of urbanization and because in 1967 there may be only around 12 million people living on farms, not quite 6 percent of the population, I used no urbanization categories in the 1967 structure. However, in adjusting the consumption pattern for each region I did take cognizance of the smaller proportion of people that will be living on farms. This tends to lower consumption rates because as a rule farm households ate more beef per person than nonfarm households.

**Regional distribution.** In Table 4 I have also summarized census data, including projections, on population growth in the several regions. You can see the West is growing, proportionally, at the expense of the Northeast and the South. Considering the relatively higher consumption rates in the West, the U. S. market would tend to increase more than proportionally to population growth as a result of these regional shifts.

**Income distribution.** I mentioned that one of the assumptions on which the 1967 domestic disappearance of beef was based was an economic growth rate of about 3 percent. Within the rest of the economic framework of the projection this implies a disposable personal income per capita almost 11 percent above 1961, and about 25 percent above 1955. To translate the U. S. overall rate of increase in real income into regional rates, I used trends calculated from the Survey of Current Business estimates of personal income by states. In terms of U. S. per capita personal income, the per capita income varies like this:

<table>
<thead>
<tr>
<th>Region</th>
<th>1950</th>
<th>1955</th>
<th>1960</th>
<th>1967</th>
<th>Percentage increase from 1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>116</td>
<td>116</td>
<td>116</td>
<td>116</td>
<td>25</td>
</tr>
<tr>
<td>North Central</td>
<td>106</td>
<td>105</td>
<td>104</td>
<td>103</td>
<td>23</td>
</tr>
<tr>
<td>South</td>
<td>76</td>
<td>77</td>
<td>79</td>
<td>81</td>
<td>30</td>
</tr>
<tr>
<td>West</td>
<td>113</td>
<td>111</td>
<td>109</td>
<td>108</td>
<td>22</td>
</tr>
<tr>
<td>U. S.</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

These, in turn, I converted to income distributions within each region. These changes were accomplished by shifting the cumulative frequency curve of the 1955 distributions by the percentage changes just calculated.

Table 5 gives the 1955 distributions and the calculated 1967 ones. You will note the shift to higher income groups, particularly in the South. This is another factor tending to increase the domestic market for beef more than the increase in population.
Supply shifts. To get away from people for a moment, look at the regional changes in beef supply portrayed in Table 4. Unfortunately, these measures of regional shifts in production and slaughter can not be used as a basis for shifting consumption rates because they don’t tell the most important part of the story, the amount of beef shipped from the region where it was slaughtered to the region where it was consumed. This table gives us the seeming anomaly of slaughter in the South going down while elsewhere we have consumption going up. I merely mention this as one of many types of inconclusive data that seem to relate to regional analysis, but are of little or no help.

Changes in consumption patterns. No satisfactory comparable sets of cross-section consumption data for different years, particularly by region, exist on which to base changes in consumption patterns of beef. Though two other national food consumption surveys were made in the last 20 years, one in 1942 and one in 1948, many problems confuse comparisons. One can adjust for general price level changes for the different years, but the other differences, probably more important, still remain. For instance, 1942 was a war year. In 1948 meat prices were relatively high and meat supplies, particularly of beef, were low. In 1955 there were plentiful beef supplies of beef and meat prices were lower than in 1948.

Nonetheless, comparisons can be made and some useful knowledge gained from them. The most striking fact that comes out of such an exercise is that the whole consumption pattern tends to move up under favorable circumstances, not just one part of it. The change from 1948 to 1955 is particularly clear on this point. Though this evidence could not be used to judge how much the consumption patterns might change sometime in the future, it can be used to indicate how the patterns change. The whole level changes, with perhaps a bit more of a raise at the lower end of the income distribution.

After taking into consideration all factors that I have mentioned, I adjusted the patterns graphically and settled on the regional consumption patterns for 1967 you see in Table 5. In the table they are compared to the respective 1955 smoothed-out consumption rates for all urbanizations combined in each region.

Evaluating the structure. Where will the market for beef be in 1967? As you have seen in 1955, the three elements necessary to measure the segments of the domestic market for beef are (1) the consumption rate for each cell of the cross-classification, (2) the distribution of population among these groups, and (3) the total number of people involved. A regional market will change if any one of these elements changes. For instance, an increase in income, which means a greater proportion of people in the higher income groups, would increase the market for beef even though the total number of people remained the same and the consumption pattern was unchanged. In the 1967 predictions all three elements have been changed. According to Tables 4 and 5, the regional distribution of the 18.4 billion pounds of beef projected as the domestic disappearance in 1967 will be:
Million pounds  Percent of U. S. beef market  Percent of U. S. population

Northeast  4,190  23  24.5
North Central  6,100  33  29.6
South  4,450  24  29.2
West  3,670  20  16.2
U. S.  18,400  100  100.0

How can these data be used? Even if one thought they were correct does it mean that he should accept this future as inevitable? Or are there aggressive counter measures he could take to improve his future opportunities and possibilities? I certainly expect no one to take this as the final answer, much less feel that these trends are immutable. This structure was based on relationships bought by all the production science, nutritional knowledge, promotional effort and natural vagaries of human nature in the past. Perhaps all the directed efforts were optimum and would continue to be so through the next five years. Even under such unlikely conditions, unforseen changes undoubtedly would occur. These data, at best, can serve as a guide to areas where aggressive action could or should be taken. And what are the chances of success?

Wetmore, Able, Learn and Cochrane, in their excellent two-part study, *Expanding the Demand for Farm Food Products*, examine the problem noted by Adam Smith that, after all, there is a limit to the capacity of the human stomach. Their conclusion is that total food consumption is highly responsive to changes in price and income. Large variations are needed to achieve a small change in total food consumption.

The current Food Stamp Plan is directed toward raising the nutritional level of the recipients, who can not afford the proper food. Follow-up study has shown, in many cases, that the total intake of recipients has been increased, measured by almost any standard. But, for the country as a whole, these programs are so small that large gains would make imperceptible changes in total meat consumption.

Though total food consumption may not be very susceptible to change, one food can be substituted for another. Apparently that is what happened between beef and pork. Though I know of no study showing the degree to which chicken has been substituted for potential beef consumption, I am sure such substitution has taken place since the production revolution so drastically lowered chicken prices.
One final observation in this area. Last year we ate about 94 pounds of beef and veal combined per person in the U. S. In Uruguay the per capita consumption rate was 161 pounds and in Argentina 168 pounds. I don't think we could aspire to such heights here. We would have much to overcome, for in those countries they don't have the food alternatives we do, nor the nonfood competition for the consumer's dollar. And I can't visualize the time when we would be able to say here, as is said about the pampas, that a steak and a bottle of wine is a poor man's lunch. But their consumption rates show that we have plenty of room for expansion.

What can be done about raising the consumption rate of beef in the U. S.? I don't know. That is the puzzlement. A study of the structure of the market may give some useful insights.
Table 1. -- Total and Per Capita Consumption of Beef in the U. S. for Selected Years \(^1\) (Carcass weight)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total domestic disappearance</th>
<th>Population</th>
<th>Per capita consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mil. lb.</td>
<td>Mil.</td>
<td>Lb.</td>
</tr>
<tr>
<td>Projected</td>
<td>18,409</td>
<td>202.2</td>
<td>91.0</td>
</tr>
<tr>
<td>1967</td>
<td>18,409</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>16,694</td>
<td>185.8</td>
<td>89.5</td>
</tr>
<tr>
<td>1960</td>
<td>15,464</td>
<td>179.3</td>
<td>86.0</td>
</tr>
<tr>
<td>1955</td>
<td>13,716</td>
<td>165.3</td>
<td>83.0</td>
</tr>
</tbody>
</table>


Table 2. -- Beef Consumption Per Person in Households of 2 or More by Region, Urbanization and Family Income Size in a Week, Spring 1955 \(^2\)

<table>
<thead>
<tr>
<th>Region and urbanization</th>
<th>Family income after taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>: Under $1,000</td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
</tr>
<tr>
<td>All urbanizations</td>
<td>.86</td>
</tr>
<tr>
<td>Urban</td>
<td>.71</td>
</tr>
<tr>
<td>Rural nonfarm</td>
<td>.97</td>
</tr>
<tr>
<td>Farm</td>
<td>1.74</td>
</tr>
<tr>
<td>North Central</td>
<td></td>
</tr>
<tr>
<td>All urbanizations</td>
<td>1.20</td>
</tr>
<tr>
<td>Urban</td>
<td>1.30</td>
</tr>
<tr>
<td>Rural nonfarm</td>
<td>.91</td>
</tr>
<tr>
<td>Farm</td>
<td>1.29</td>
</tr>
<tr>
<td>South</td>
<td></td>
</tr>
<tr>
<td>All urbanizations</td>
<td>.46</td>
</tr>
<tr>
<td>Urban</td>
<td>.80</td>
</tr>
<tr>
<td>Rural nonfarm</td>
<td>.32</td>
</tr>
<tr>
<td>Farm</td>
<td>.44</td>
</tr>
<tr>
<td>West</td>
<td></td>
</tr>
<tr>
<td>All urbanizations</td>
<td>1.63</td>
</tr>
<tr>
<td>Urban</td>
<td>1.37</td>
</tr>
<tr>
<td>Rural nonfarm</td>
<td>.98</td>
</tr>
<tr>
<td>Farm</td>
<td>1.82</td>
</tr>
</tbody>
</table>

\(^2\) 1955 Household Food Consumption Survey Reports No. 1-5 Food Consumption of Households in the United States and in the Northeast, North Central Region, South, and West.

\(^b\) Retail weight.
### Table 3. Population by Region and Age Group for 1955, 1960, and Projections for 1967

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>165.3</td>
<td>61.8</td>
<td>179.8</td>
<td>59.7</td>
<td>202.2</td>
<td>59.3</td>
</tr>
<tr>
<td>Northeast</td>
<td>44.1</td>
<td>64.3</td>
<td>44.8</td>
<td>62.1</td>
<td>49.5</td>
<td>60.9</td>
</tr>
<tr>
<td>North Central</td>
<td>50.1</td>
<td>61.5</td>
<td>51.7</td>
<td>59.0</td>
<td>59.9</td>
<td>57.9</td>
</tr>
<tr>
<td>South</td>
<td>53.1</td>
<td>61.6</td>
<td>55.1</td>
<td>61.2</td>
<td>60.0</td>
<td>60.7</td>
</tr>
<tr>
<td>West</td>
<td>18.0</td>
<td>60.6</td>
<td>28.2</td>
<td>60.0</td>
<td>32.8</td>
<td>59.3</td>
</tr>
<tr>
<td>United States</td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>26.7</td>
<td></td>
<td>24.9</td>
<td></td>
<td>24.5</td>
<td></td>
</tr>
<tr>
<td>North Central</td>
<td>30.3</td>
<td></td>
<td>29.7</td>
<td></td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>32.1</td>
<td></td>
<td>30.7</td>
<td></td>
<td>29.7</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>10.9</td>
<td></td>
<td>15.7</td>
<td></td>
<td>16.2</td>
<td></td>
</tr>
</tbody>
</table>


### Table 4. Production on Farms and Ranches, and Slaughter of Cattle and Calves, by Region, 1947, 1954 and 1959

<table>
<thead>
<tr>
<th>Region</th>
<th>Production (live weight) Quantity (Mil. lb.): Quantity (Mil. lb.)</th>
<th>Proportion of U. S. total (Mil. lb.): Proportion of U. S. total (Mil. lb.)</th>
<th>Slaughter (carcass weight) Quantity (Mil. lb.): Quantity (Mil. lb.)</th>
<th>Proportion of U. S. total (Mil. lb.): Proportion of U. S. total (Mil. lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>878 1,183 1,010 4.6 4.3 3.6</td>
<td>1,321 1,483 1,397 11.0 10.1 9.6</td>
<td>6,720 7,928 8,109 55.8 53.4 55.6</td>
<td>2,137 2,763 2,298 17.8 18.9 15.7</td>
</tr>
<tr>
<td>North Central</td>
<td>9,737 13,770 14,011 51.0 49.9 49.5</td>
<td>13,189 14,083 14,511 102.0 101.0 100.5</td>
<td>6,720 7,928 8,109 55.8 53.4 55.6</td>
<td>2,137 2,763 2,298 17.8 18.9 15.7</td>
</tr>
<tr>
<td>South</td>
<td>5,018 7,643 7,860 26.3 27.7 27.8</td>
<td>7,478 8,312 8,512 55.8 53.4 55.6</td>
<td>2,137 2,763 2,298 17.8 18.9 15.7</td>
<td>2,137 2,763 2,298 17.8 18.9 15.7</td>
</tr>
<tr>
<td>West</td>
<td>3,456 4,984 5,399 18.1 18.1 19.1</td>
<td>4,920 5,812 6,012 55.8 53.4 55.6</td>
<td>1,859 2,573 2,783 15.4 17.6 19.1</td>
<td>1,859 2,573 2,783 15.4 17.6 19.1</td>
</tr>
<tr>
<td>United States</td>
<td>19,087 27,580 28,280 100.0 100.0 100.0</td>
<td>26,420 29,840 30,280 100.0 100.0 100.0</td>
<td>12,037 14,647 14,587 100.0 100.0 100.0</td>
<td>12,037 14,647 14,587 100.0 100.0 100.0</td>
</tr>
</tbody>
</table>

Table 5. -- Weekly Beef Consumption Per Person and Distribution of Population, by Family Income Size, and by Region, 1955 and 1967a

<table>
<thead>
<tr>
<th>Region, item, and year</th>
<th>Family income after taxes</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under $1,000</td>
<td>$2,000</td>
<td>$3,000</td>
<td>$4,000</td>
<td>$5,000</td>
<td>$6,000</td>
<td>$8,000</td>
<td>$10,000</td>
<td>$12,000</td>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (percent)</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>21</td>
<td>23</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>4</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>19</td>
<td>19</td>
<td>21</td>
<td>11</td>
<td>4</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Consumption (pounds)</td>
<td></td>
<td></td>
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a/ Estimates based on 1955 Household Food Consumption Survey data.
FOREIGN MARKETS FOR BEEF

by Max Myers

The United States produces more beef than any other nation. It has some influence over almost every aspect of the commercial cattle business in the world.

It is appropriate to consider the beef cattle situation at this time and in this place. Remarkable changes are taking place in the industry, particularly in the Midwest and the Plains areas. Much of the technical information for these changes comes from Iowa State University and land-grant institutions in other states.

It is appropriate also to consider the international trade aspects of the beef cattle business. Exports and imports are important to the industry to an extent and in ways we sometimes fail to understand.

My purpose is to picture with broad strokes but in some perspective the foreign trade side of our beef market--first to discuss our exports of beef products and cattle, then our imports, and finally certain major areas of opportunity or difficulty in our world trade.

I attempt to do this in ordinary language with limited use of statistics. Those interested in more detailed information are advised to consult the selected data and references listed at the end of this chapter.

Our Beef Exports

We are the world's largest exporter of all goods and services and are setting new records as the world's largest agricultural exporter. During the 1961–62 fiscal year our agricultural exports, at world prices, totalled $5,130,000,000. Slightly less than 70 percent of those sales were for dollars, with the balance under various special programs.

Against this background our export trade in cattle and products from cattle appears to be important but not spectacular. In 1961, we exported about $266,000,000 worth, or about 5 percent of the agricultural total. However, these exports of cattle and beef were almost all commercial sales for dollars and without subsidies. They consisted principally of by-products such as tallow, hides and variety meats. The beef and veal portion of the 266 million dollars was only twelve million and represented only about 28 million pounds of our annual production of more than 16 billion pounds. Live cattle accounted for 9 million dollars of the total.

These exports have been increasing in quantity and value in recent years. For example, the 1961 export values for tallow, variety meats, and cattle hides were, respectively, 135 million, 27 million and 77 million dollars. The corresponding

1/ Dr. Myers is professor of economics, South Dakota State College.
annual average totals for the 1951-55 period were 84 million, 6.4 million and 33 million dollars. There have been increases also in exports of beef and veal and live cattle.

The increases have not come about by accident. Some credit must be given to deliberate promotion and sales efforts by U. S. business groups, farm groups and the Foreign Agricultural Service of the U. S. Department of Agriculture. These efforts have emphasized "surplus" products and have been aimed primarily at Western Europe and Japan, areas where consumer purchasing power has been increasing.

Our better customers for tallow and hides include Japan, Netherlands, West Germany, Italy and Canada. U. S. variety meats go principally to West Germany, Netherlands, the United Kingdom and France. Our major beef and veal exports are to Canada and other nearby areas. Our live cattle exports consist of breeding stock, most of which go to nearby Latin America. (A somewhat similar situation exists for exports of swine and sheep.)

Our exports of cattle are more important than the dollars or pounds would indicate. These are mostly dollar exports and consist of by-products which our consumers do not need or do not buy in the quantities produced. Finally, these shipments point up opportunities for building larger markets for our products as economic development occurs in other parts of the world.

Our Beef Imports

The U. S. is the world's largest importer of all goods and services and the second largest importer of agricultural products. In fiscal year 1961-62 these were valued at $3,767,000,000. Of this total about 46 percent consisted of complementary items (non-competitive with our production) and 54 percent of supplementary items (partly competitive).

Our imports of cattle and beef products in 1961 included 665 million pounds of beef and veal valued at $228,000,000, live cattle worth about $101,000,000 and hides at $13,100,000. In addition, some portion of $19,000,000 worth of other meat products was beef. So total beef imports were somewhere near $350,000,000 or slightly less than 10 percent of total agricultural imports.

Live cattle and beef and other meat imports have increased somewhat in recent years. The greater part of this increase has come in feeder cattle, and in lower grades of meat for manufacturing purposes. We have had some shortages in domestic production in these categories.

Most of the live cattle come from Mexico and Canada. The beef and veal originates principally in Australia, New Zealand, Argentina, Uruguay, Brazil, Ireland and Mexico. The fresh meat portion of this comes only from countries free of foot and mouth disease.
These imports have more importance and deserve more study than would seem to be justified by their quantities or values. It is not sufficient to say "Oh, that's a small part of our consumption, so don't pay any attention to it." Neither is it sufficient to claim "They are competitive so we should cut off all imports of cattle or beef." Neither view is completely accurate or practical.

Opportunities and Problems

In view of the foregoing information I feel that I can describe our foreign trade in cattle and products from cattle as important but not as the most important subject of this conference. Nevertheless, the continuation or improvement of the present export situation seems to be in the best interests of the industry. Careful scrutiny of the import situation with regard to specific competitive imports would seem to be called for.

Opportunities do exist to build new and larger overseas markets for some of our products. At the same time several current factors in the international realm threaten our economic situation in the cattle business. These include trends and policies toward self sufficiency in Western European countries, trade and aid policies of our own government, and certain domestic policies of our government. I wish to discuss several items in turn although these are inter-related, and to look at each with the question "What can we do about it?"

Building larger export markets. There exist an increasing need and demand for high quality breeding stock in many countries. There are increasing demands for meat products in countries which have growing economies.

We have a productive and efficient industry. We can build markets overseas. If we wish to do so we businessmen (including cattle producers) by ourselves and in cooperation with the U. S. government must continue and expand market development and sales activities in selected locations.

This effort can include use of special P. L. 480 programs for such items as tallow in countries which cannot presently pay in foreign exchange. If such countries learn to use and value the product and if economic development continues, they can become a dollar market for the product.

Competing against self sufficiency moves. The European Economic Community, through its Executive Commission, has announced its common agricultural policy for cattle and beef. This provides for common internal support prices intended to increase local production, for removal of tariffs between the six countries and for common external restrictions including tariff, variable import levies, import certificates and deposits. Although the effects of EEC restrictions would be spread over several years, they threaten our major overseas markets for beef tallow, and variety meats, as well as other livestock products. Our total beef product exports
to the EEC countries in 1961 were valued at $78,200,000 plus $11,400,000 to the United Kingdom, which is seeking membership in the EEC.

It is important to note that the proposed restrictions which threaten our trade with these countries arise from efforts at self-sufficiency and from farm price support programs, not from antagonism toward us. The same threat of losing markets faces countries like Australia, New Zealand, Canada and Argentina. If these countries lose trade in Europe, they will try to increase exports of farm products to the USA, because they live by export trade.

If we wish to hold our trade with Western Europe and help these other producing countries to do the same, we shall need to work more aggressively than we have yet done to cause the EEC to modify its proposed restrictions, both privately and through our government.

In addition, we may need to reconsider U.S. farm policies and programs which are protectionist and price support oriented, and hence inconsistent with our stated international trade policies.

Protecting ourselves in the clinches. In the political and economic world in which we operate, each individual, firm and industry must be alert to changes and policies which will work against one's own interests.

If we U.S. cattle industry people wish to maintain a favorable position in foreign trade, we must watch several developments during the coming months and years.

We must be even more efficient and competitive to meet the challenge of increased beef production and export by other countries.

We must watch and influence the trade policy of the U.S. government. We, as a nation, state that we are in favor of increased multilateral free trade. We have taken steps in this direction, and I happen, personally, to favor this direction. However, at the same time, we have given increased protection to some industries. What can be more dangerous, and less visible, is the tendency to negotiate concessions for U.S. exports of one sort by opening our market to competitive imports of another sort.

We must influence our government foreign aid agencies to utilize surplus U.S. commodities such as tallow where feasible in aid programs, particularly where the commodity or the currency earned can be used for market development without impairing other objectives.

Keeping our perspective. I have presented my material from the viewpoint of beef cattle industry. However, I'm sure that you realize that we are citizens as well as cattlemen. We have concern for the general welfare and the long view in
addition to our legitimate, short run, selfish interests.

We must necessarily operate in an environment of competition within our own group of competition, with other products, and of competition with other nations. We must realize that we constitute only one pressure group of many which are trying to influence national or international policies. We must not automatically assume that other interests are evil or vindictive. (However, we shouldn't sit back in the saddle on the opposite and equally unwarranted premise that others are benevolent and will protect our interests.).

Summary

Foreign trade in cattle and beef products has become important to us in various ways. For good or ill, it will become increasingly important to us in the near future.

This beef cattle industry, which has shown real determination and success in solving its own problems, today is challenged, but not overmatched, as it faces the opportunities and problems of foreign trade of the coming years.

References of particular timeliness:

U.S.D.A. -- Foreign Agricultural Service

Leaflet "The European Common Market In Brief" (Feb. 1962)

Circular "U. S. Trade In Livestock, Meat and Meat Products in 1961" (L & M FLM 15-62 September 1962)

Circular "European Common Market Proposals for Cattle, Beef & Veal and By Products" (L & M FLM 13-62 September 1962)
# FOREIGN MARKETS FOR BEEF

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ANIMAL FAT IN THE DIET

by A. J. Siedler

One of the problems confronting the meat industry is the implication that saturated fats in the human diet may cause hardening of the arteries or arteriosclerosis.

The symptoms characteristic of arteriosclerosis are described in ancient Egyptian writings. This fact indicates that people have known of this disease for thousands of years. However, Lobstein first used the term "arteriosclerosis" around 1820. In the middle of the 19th century, Rokitansky concluded that arteriosclerosis was a disease of blood clotting. As early as 1856 Virchow thought that the disease was an inflammation followed by deposits of cholesterol in the arteries. Atherosclerosis, which is arteriosclerosis localized in the heart and aorta, is probably the most familiar form.

A number of general factors have been associated with atherosclerosis in man. These include genetic factors, physical activity, hypertension or high blood-pressure, age, mental and physical stresses and diet, including obesity. Recently heavy cigarette smoking also has been associated with the disease.

There are many statistical associations between the incidence of heart disease and certain biochemical changes, primarily in the blood lipids. Scientists have related at least four blood lipid changes to atherosclerosis.

1. A high level of serum cholesterol is associated with a high incidence of atherosclerosis.

2. A high blood triglyceride concentration (hyperlipemia) is associated with a high incidence of atherosclerosis.

3. Differences in the beta-lipoprotein fractions are related to a high incidence of atherosclerosis. The ratio of beta to alpha lipoprotein ("Beta ratio") is often used as a more critical measure.

4. A low level of polyunsaturated fatty acid in the serum is often associated with atherosclerosis.

The blood lipid which has received the most attention in recent years has been serum cholesterol. However, a number of investigators do not believe that the correlation between high-serum cholesterol and the incidence of atherosclerosis indicates that a high serum cholesterol causes atherosclerosis. Nevertheless, there

Dr. Siedler is chief, Division of Biochemistry and Nutrition, American Meat Institute Foundation, Chicago.
has been major interest in serum cholesterol as a possible causative agent or indicator of the presence of atherosclerosis. This interest has been based on a number of statistical studies. (i.e., studies of various population groups in certain countries). However, caution is in order. One of our leading biostatisticians has indicated that statistics can be misused. He warns:

"Perhaps the most serious pitfall in biostatistics is that of leaning on them as a drunkard does on a lamp post: using them for support rather than illumination."

Properly used, statistics is of great value in determining the possible relationship between cause and effect, and other factors.

Diets containing large amounts of saturated fats are associated with high serum cholesterol levels in human beings as well as in experimental animals. Increased serum cholesterol levels have also been associated with physiological stresses, including tuberculosis, syphilis and starvation. It is not known whether there is a true causal relationship between atherosclerosis and increased serum cholesterol. However, high serum cholesterol levels often indicate stresses and are therefore not a good sign.

A number of dietary and chemotherapeutic agents decrease serum cholesterol levels in man and experimental animals. Polyunsaturated fatty acids usually lower serum cholesterol when substituted for saturated fats in experimental diets. Several theories have been advanced as to why they have this effect. Certain polyunsaturated fatty acids have a vitamin-like function. Moreover cholesterol accentuates the need for these polyunsaturated fatty acids or essential fatty acids. Therefore, some scientists postulate that atherosclerosis is a symptom of a deficiency in essential fatty acids. Others postulate that polyunsaturated fatty acids are chemically added to cholesterol and that this form of cholesterol is used by the body at a faster rate than other cholesterol compounds. Research indicates that the degree of solubility of cholesterol in the fat may be related to the serum cholesterol lowering or raising effects. The serum cholesterol raising effects of saturated fatty acids may be due to their ability to dissolve more cholesterol than the polyunsaturated fatty acids. Therefore, cholesterol compounds present in the intestinal tract would be absorbed at a high rate with a saturated fat diet. This high absorption increases serum cholesterol values.

Under certain conditions, exercise decreases serum cholesterol levels in experimental animals. Certain anti-metabolites such as aminopterin (an antifolic acid compound) and MER-29 (an inhibitor of the biosynthesis of cholesterol) decrease serum cholesterol values; however, these compounds may be toxic. The vitamin niacin, in high concentrations, decreases serum cholesterol, whereas nicotinamide does not lower serum cholesterol under the same conditions. Resins which absorb bile salts and prevent reabsorption also lower serum cholesterol levels. Cases are reported of certain metal ions, such as vanadium and magnesium, lowering serum cholesterol. A number of natural hormones have both plus and minus
effects on serum cholesterol levels. Thyroid active compounds markedly lower serum cholesterol, but anti-thyroid compounds such as thiouracil have the opposite effect. Antibiotics have also been shown to have some cholesterol-lowering effects.

The response of animals to differences in protein quality or protein levels in the diet markedly influences serum cholesterol. We recently published a study showing that very high levels of protein do appreciably increase the serum cholesterol in the adult male rat. It has also been shown that diets very low in protein have a cholesterol-raising effect in the rat and chick. Thus, adding more protein or amino acids to these poor diets decreases the serum cholesterol. High-protein diets produced very pronounced effects on the blood lipid picture in mature rats during very short term isocaloric feeding tests conducted recently in our laboratories.

Diets in which bile salts plus thiouracil cause fantastic effects; causing increases up to 10 times the normal serum cholesterol levels. These tremendous increases in serum cholesterol are accompanied by a heavy incidence of infarcts (tissues which are dying because their blood supply has been cut off, for instance by a blood clot). There is, however, no basis for predicting which animal will have an infarct. Those animals which appear to be resistant to infarcts remain immune no matter where the serum cholesterol level is maintained. Therefore, even in highly inbred populations, there appears to be strong individual tendencies designating whether the animal will be responsive to the dietary stress, or not. Whether this carries through to human populations remains to be seen. However, I think there are fairly strong indications that certain individuals do have this type of "metabolic defect" which may show up under certain conditions of stress.

Another experimental index of atherosclerosis in the living animal, is the relative amounts of lipoproteins in the blood. These are proteinacious components found in the human blood, which carry lipids including cholesterol. Some research has indicated that the amounts of the various lipoproteins in serum is an index of atherosclerosis. Many investigators believe this is a much more critical technique for detecting atherosclerosis than other indices.

The study of blood coagulation is a biochemical technique which has been used in attempting to determine the causal agent of atherosclerosis. It has been known for some time that lipemia, or a high incidence of fat in the blood, will lower blood clotting times. Whether this is actually an occurrence that may take place within the animal is not known. There are differences between the clots formed in the test tube and those found in the live animal. At any rate, there appears to be a relationship between blood-clotting time and the amount of fat in the serum, as well as the type of fat. In laboratory studies, the presence of saturated free fatty acids shortens the clotting times, whereas, polyunsaturated free fatty acids generally have little or no effect on clotting time. Triglycerides, lecithin and cholesterol also do not appear to be factors in shortening the clotting time.
Correlations between heart disease and patterns of human behavior have been observed. A very competitive drive, a feeling of time urgency, rapid conversation, and muscle tension are associated with higher serum cholesterol levels and lower clotting times. This type of behavior is further associated with the overproduction or oversecretion of adrenalin. These associations are related to the so-called tension or stress syndrome which has been statistically linked with a higher incidence of heart disease.

Obesity (being overweight) has been closely correlated with the incidence of heart disease, and many investigators believe this to be one of the prime causes of heart disease. English workers have published some rather interesting results indicating that high-fat, high-protein diets are good reducing diets because they tend to decrease caloric intake. These diets have an apparent high satiety value, and the individual does not eat as much as he would with larger amounts of carbohydrate in the diet. Thus the English workers say that these diets should not be called high-fat, high-protein diets, but instead, low carbohydrate diets.

Recently, workers have shown that diets very high in polyunsaturated fats may not be the answer to our ills. A research group in Australia has shown that in the rat, lowering of serum cholesterol by including large amounts of polyunsaturated fatty acids in the diet is followed by increased deposits of cholesterol in the liver, heart, and aorta. Diets high in polyunsaturated fatty acid also will increase the vitamin E requirement in man and experimental animals.

Preliminary data from a study of Irish brothers—one living in Boston, and the other living in Ireland—indicate that the incidence of heart disease is not associated with a high animal fat intake or caloric intake. Rather the difference probably is in the manual labor routinely done by the Irish subjects.

It has been postulated that we are in the state of changeover from active people to sedentary people and our metabolism has not caught up with us yet. Be that as it may, life expectancy statistics show that the meat-eating populations enjoy relatively high longevity.

What does all this mean as far as the human diet and the production of beef is concerned? What fatty acids are contained in a lean piece of beef?

A large percentage of the intracellular fatty acids (primarily the phospholipid fraction) of beef is polyunsaturated—linoleic and arachidonic acid. Therefore, lean beef does not have as high a percentage of saturated fat and, of course, has less total fat. Our problem may lie in consumer and producer education. Good tenderizing procedures may be a solution to the problem of marketing very lean beef.

Another potential method of improving the product would be to increase the polyunsaturated fatty acid content of beef products. This is quite difficult, since the rumen (first stomach) is notorious for producing the same amount of metabolite, regardless of feed input. The beef animal takes in a considerable amount of
polyunsaturated fatty acids in its range diet. For example, by eating 100 pounds of grass in a day it will ingest about 450 grams or 1 pound of lipid. The principal portion of this will be polyunsaturated fatty acids, which are rapidly converted in the rumen to saturated fatty acids. How the cow manages to salvage enough of the polyunsaturated fatty acids to satisfy its essential fatty acid requirements is not known, but apparently the cow is able to do this. Future studies on the series of reactions which go on in the rumen as well as the types of microorganisms which carry out these reactions should be extremely valuable. From them researchers may be able to cause the bacteria to form metabolites in the rumen which would lend themselves more to unsaturated fatty acid biosynthesis than saturated fatty acid biosynthesis.

We do have a potential problem in the meat industry because of the fact that saturated and monounsaturated fatty acids are major components of the fat in meat products. However, meat has a host of positive nutritional values which should not be overlooked. These more than off-set the possibility that saturated fats in meat products may impair the nutritional qualities. We should, however, constantly be aware of developments in this area and, at the same time, strive to improve the product by every feasible means.
PRODUCTION AND NUTRITIONAL DEVELOPMENTS

by W. M. Beeson

Scientific knowledge and new techniques rapidly are replacing the "art" of feeding and producing beef cattle. No longer is it true that "the eye of the master fattens the cattle." The human eye is being augmented by the "electronic eye" to formulate rations and "automate" livestock feeding operations. Back of these developments is basic and applied research in nutrition, physiology, genetics, medicine, mathematics and engineering.

To date scientists have only scratched the surface in determining the factors which influence growth, fattening and reproductive processes in beef cattle. Nutrients, physical form of the feed, frequency of feeding, environment, disease, genetics and many other factors directly bear on beef cattle production from the day of conception to the final market product--beef on the table. Today beef is the preferred meat. But beef cannot retain this position without constant attention to unsolved problems. The tempo of beef cattle research must be increased in all areas--breeding, nutrition, rumen physiology, meats, automation, diseases, management and marketing.

This chapter briefly summarizes the present and future possibilities in the following areas as applied to beef cattle: (1) harvesting and preserving feeds, (2) automation and frequency of feeding, (3) roughness factor, (4) the ratio of concentrate to roughage, (5) pelleting, (6) vitamin A, (7) zinc, and (8) certain feed additives and nutrients such as antibiotics, choline, enzymes, dehydrated alfalfa meal, tranquilizers and vitamin E.

Harvesting and Preserving Feeds

Eventually we will harvest and immediately store feeds in the form that they are to be fed to livestock. We will eliminate many of the in-between processes and chores involved in handling the feed several times before it is fed to animals. The best example is the picking of high-moisture ear corn and directly ensiling it or grinding it into a silo (air-tight structure). This process will preserve feed in a form that is high in nutritive value. Research at Purdue and Iowa has shown that the ensiling of high-moisture ground ear corn (30-32%) for cattle improves its feed value 10 to 12 percent on a dry matter equivalent basis as compared to low-moisture ground ear corn. In fattening cattle high-moisture shelled corn has a slightly higher feed value per unit of dry matter than low-moisture shelled corn.

Harvesting equipment is needed that will simultaneously field-shell high-moisture corn into one bin and chop the cobs and stalks into a wagon to make cornstalk and cob silage. Corn yielding 120 bushels or 15 tons of whole corn plant per acre produces the following total digestible nutrients:

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According to these figures, 61% of the nutritional value of a corn crop is in the corn kernel and the remaining 39% in the cobs and the stalks. Enough energy is produced from the stalks and cobs from each 1.5 acre to maintain a beef cow for a year and raise a calf. Cornstalk-cob silage offers a real potential for increasing the beef cow herds in the Corn Belt region.

In the next decade machinery will be developed to harvest the entire corn plant, separate it into its component parts as needed and store it in silos for automatic feeding. No longer will it be necessary to go through the laborious task of picking, cribbing, shelling and grinding corn fed to livestock.

Hay making by the baling process will gradually pass out of the picture, and machinery will be developed to pellet hay in the field ready for feeding. Research at several experiment stations has shown that coarsely grinding and pelleting hay doubles its feed value per ton for beef cattle. Two hundred and twenty pounds of beef were produced from a ton of pelleted hay and only 115 pounds of beef from a ton of the same hay baled. Haylage (ensiling 45% moisture hay in an air-tight silo) is being tested in many feed lots and offers a new way of preserving hay in a palatable and nutritious form.

Methods for preserving and storing all types of feed will be improved so that the original feed value can be retained without deterioration. We are just on the brink of discovering anti-mold and anti-fungal compounds to preserve high-moisture grains and silage. Also, antibiotics and other substances are being developed to control bacterial fermentation so that only the most favorable acids are produced in silage.

Automation and Frequency of Feeding

Hand-feeding of livestock is rapidly becoming a thing of the past, and in the future all types of meat animals will be fed by "push button" methods. The shovel and pitchfork will be replaced by power equipment, automatic feeders and unloaders, and other mechanical devices, which will reduce the work involved in feeding. Self-feeding will become a common practice. Energy intake will be controlled by compounding complete rations with various proportions of roughages. Instead of gradually being fed more grain cattle and sheep will be started on full feed the first day. In fact, this has already been done for several years in research with cattle and sheep at Purdue University. Digestive disorders and "going off feed" result from a lack of a balanced diet rather than from too much food.
Twice daily feeding of cattle will be replaced by self-feeding or more frequent automatic feeding--maybe six times daily at 4-hour intervals around the clock.

Tests at the University of Illinois (Mohrman et al., 1959) showed that cattle fed six times a day gained 11 to 21% faster, consumed 5 to 17% more feed daily and required from 3 to 5% less feed per unit of gain than those fed twice a day. Cattle self-fed gained 7% faster than those fed twice daily but required 5% more feed per pound of gain.

Research at Iowa (Woods et al., 1961) indicated that feeding six times a day as compared to twice a day will increase daily gain 0.83 pound (3.60 vs. 2.70) and improve feed efficiency about 25% (558 vs. 740 lb. feed/100 lb. gain). Apparently feeding of fattening cattle several times a day keeps the rumen microorganisms in a high state of activity and thus improves microbial synthesis.

**Roughness Factor**

Roughage is still an important ingredient in the ration of ruminants. Even though roughage possesses a low energy value, it has other nutritional properties which cannot be replaced by concentrates. Most data show clearly that for best feedlot results, a complete ration should contain not less than 20% roughage or fiber equivalent. Strangely, as good a growth rate and carcass quality can be produced on a ration containing 40% roughage as one containing 20% roughage. Some roughage in the diet keeps the rumen functioning properly. Roughness stimulates the growth of beneficial microorganisms. It has a scouring effect on the rumen, thus improving microbial activity. Even though cattle can be experimentally fattened on no-roughage diets, it may not be wise to make a one-stomach animal out of a ruminant.

The "Roughness Factor" is clearly illustrated by the improved performance of beef cattle obtained by adding 1% or 2% blasting sand to a high concentrate ration (Woods et al., 1961). Adding 1.0% sand to a high concentrate ration improved the average gain by 7.6% and feed efficiency by 4.0%. Adding 2.0% sand gave a 15.2% increase in gain and 9.4% better feed conversion. No benefit was obtained from adding sand to rations which contained adequate and proper amounts of roughage. The authors (Woods et al., 1961) explain that possibly one of the functions of coarse roughages is to keep the rumen lining scrubbed and active.

How ruminants use energy in feedstuffs is closely related to the amount and ratios of acetic, propionic and butyric acids produced in the rumen. When the animals consume starchy rations lactic acid is often found in the rumen. Normally, organic acids such as n-valeric, isobutyric, 2-methyl butyric and iso-valeric occur in small amounts. Large amounts of volatile fatty acids (VFA) are produced within the rumen through microbial action, and these account for about 50 percent of the energy derived from feed by ruminants. Recent research indicates that the key to improving efficiency of feed conversion in cattle and sheep is to control the end products of microbial metabolism in the rumen.
Shaw et al. (1960) showed that the physical form of the feed has a significant effect on gain and feed conversion. Pelleting alfalfa hay and steam flaking corn increased the daily gain of steers 22% and improved feed efficiency 18 percent. Changing the physical form of the ration increased the propionic acid in the rumen from 16.3% to 41.1% and the total volatile fatty acids from 580 to 1357 milligrams per 100 milliliters of rumen fluid.

This classical discovery has shown that the physical form of a feed for ruminants has a decided effect on its feed value. This phenomena I have named the "Roughness Factor." The physical form of the feed is almost as important as the nutritional form. Physical stimulation or scouring of the rumen lining has a beneficial effect on the performance of ruminants. Finely ground feeds depress grain, feed conversion, milk production and butterfat percentage.

**Ratio of Concentrates to Roughage**

Research data has shown that growing and fattening cattle don't need as much roughage if their rations contain the nutritional and other factors ordinarily supplied by roughages. Specific nutrients are partially replacing the factors formerly supplied by high-quality roughages. Geurin et al. (1960) demonstrated that steers or heifers can be fattened on a ration of 90% rolled barley and 10% well-balanced supplement without any roughage except the fiber furnished by the barley. California feed trials (Henly, 1961) indicated that the primary advantage of high-energy rations (90% barley) was improvement in feed conversion and dressing percentage. Other types of high-energy rations commonly used in the United States are (1) 89% ground ear corn and 11% supplement, (2) 70% rolled shelled corn, 20% sun-cured alfalfa pellets and 10% pelleted supplement, and (3) 60% rolled shelled corn, 30% rolled oats and 10% pelleted supplement. An example of a 32% supplement which will balance grains with no roughage is as follows: 65% soybean oil meal, 14% dehydrated alfalfa meal, 14% cane molasses, 5.2% dicalcium phosphate, 1.8% salt with trace minerals and 10,000 to 20,000 international units (I.U.) of vitamin A per pound.

Seven trials at Kansas and Nebraska, using chiefly milo or corn and alfalfa hay, showed no advantage in extremely high concentrate rations with a concentrate to roughage ratio of 5:1 (Table 1).
Table 1. Effect of Varying the Concentrate-to-Roughage Ratio for Fattening Yearling Steers and Heifers.

<table>
<thead>
<tr>
<th>C:R ratio</th>
<th>1:1</th>
<th>3:1</th>
<th>5:1</th>
<th>Moving Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain, lb.</td>
<td>1.99</td>
<td>2.16</td>
<td>2.22</td>
<td>2.12</td>
</tr>
<tr>
<td>Average daily feed intake, lb.</td>
<td>25.6</td>
<td>21.8</td>
<td>21.5</td>
<td>22.8</td>
</tr>
<tr>
<td>Feed per cwt. gain, lb.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>642</td>
<td>743</td>
<td>769</td>
<td>710</td>
</tr>
<tr>
<td>Roughage</td>
<td>650</td>
<td>290</td>
<td>198</td>
<td>330</td>
</tr>
<tr>
<td>Yield, %</td>
<td>59.3</td>
<td>60.6</td>
<td>60.5</td>
<td>60.0</td>
</tr>
<tr>
<td>Carcass grade</td>
<td>Gd+ to Ch-</td>
<td>Ch-</td>
<td>Ch-</td>
<td></td>
</tr>
</tbody>
</table>

Research at Illinois (Webb et. al., 1959) indicated that cattle grow satisfactorily (1.71 to 1.81 lb. daily) on a pelleted ration of 100% hay, or 15% concentrate and 85% hay. But the carcasses are inferior, grading standard. There was no significant difference in the performance of steers, fed on concentrate to roughage ratios of 60-40 and 80-20 from the standpoint of daily gain or carcass grade. In fact, less total digestible nutrients were required to produce a pound of gain with the 60:40 ratio than with the 80:20 ratio.

The trend toward high energy and low roughage diets for cattle will continue as long as the price of grain is much cheaper per unit of TDN than roughage. However, ruminants need some roughage in the diet to stimulate bacterial synthesis of nutrients and to prevent digestive disturbances. For best results a steer or heifer requires a minimum of 2 to 3 pounds of roughage per head daily. Many times on high concentrate rations steers will do well for a short period of time. But then their rate of gain and feed efficiency drop. This is because the body has been depleted of certain essential nutrients. These nutrients are provided by bacterial synthesis, which is stimulated by roughage.

**Pelleting**

Research reports from several experiment stations have shown that the pelleting of hay and other roughages increases the consumption by ruminants, and improves daily gains and feed efficiency. Tests at Illinois (Webb et. al., 1957) showed that beef calves gain 1.73 lb. daily on a pelleted hay and only 0.63 lb. on the same hay baled or chopped. Two hundred twenty pounds of beef were made from a ton of pelleted hay and 115 pounds of beef from a ton of the same hay baled.
Research by Wallace et al. (1961) revealed that beef calves wintered on chopped, wafered and pelleted meadow hay gained, respectively, 0.37, 0.30 and 0.71 pounds a day and required 32.8, 39.5 and 17.8 pounds of hay per pound of gain. Pelleting hay into a 3/8-inch pellet improved the daily gain 136% and feed efficiency 85%. Wafering did not significantly change the feeding value of the hay.

Pelleting high energy diets has not improved the daily gain of cattle but, in some instances, has increased the feed efficiency. A test at Purdue (Perry et al., 1958) showed that the pelleting of a diet containing 70% corn cobs and 30% concentrate improved the daily gain from 1.57 to 1.98 pounds. Steers on the pelleted rations required 14% less feed per unit of gain. Similar diets containing 20-45% corn cobs showed no improvement in daily gain or feed efficiency.

An average of 21 experiments comparing meal and pelleted fattening rations for cattle showed that pelleting a complete ration decreases daily gain 6% and improves feed efficiency 2.8 percent.

There is a great interest in the pelleting of all types of roughage such as sorghum silage and corn silage, and many large feed lots will use this method in their cattle feeding operations in the future. Pelleting has gained in popularity in the formation of supplements for beef cattle. Cattle usually eat pelleted feed much quicker than meal. Pelleting also permits the simultaneous feeding of several nutrients in a condensed form.

Although the fundamental reason is not known, it appears that diets high in fiber are more adapted to pelleting than those high in energy. Condensing a bulky feed like hay allows the animal to consume more, permitting a larger intake of nutrients above maintenance requirements.

**Vitamin A**

Research and feedlot reports show evidence of vitamin A deficiency in beef cattle on rations that were formerly considered adequate in carotene (pro-vitamin A). Evidence suggests that nitrates and/or some unidentified substance inhibits the conversion of carotene to vitamin A in the ruminant animal. Heavy use of nitrogen on crops in recent years has increased the nitrate content of feedstuffs, especially silages and pasture grasses. However, vitamin A deficiency occurs in rations low in free nitrates. Thus nitrogen in feedstuffs is not the sole cause of the problem. Apparently there are other factors which are reducing the efficiency of conversion of carotene to vitamin A. In view of these facts, a majority of beef cattle rations and supplements are fortified with preformed vitamin A.

**Conversion of Carotene to Vitamin A.** The natural plant source of vitamin A for cattle is carotene present in an unstable form in yellow corn, green-colored dry roughages and green pasture. Carotene is readily destroyed by oxidation and high temperatures. After carotene is taken into the body, it must be converted into
vitamin A in the intestinal wall before it can be used. Any naturally occurring substance or condition of the animal which alters the conversion of carotene to vitamin A reduces or stops carotene's activity. In the absence of interfering agents, 100,000 I. U. of vitamin A from carotene has a biological activity equal to 25,000 I. U. of vitamin A from a preformed source for beef cattle. In other terms, one milligram of beta-carotene (1666 I.U.) is equivalent to 400 I. U. of vitamin A for beef cattle. Due to the present uncertainty and variability of the biological activity of carotene in natural feedstuffs, research needs to be conducted to re-evaluate the conversion ratio of carotene to vitamin A in all species of animals.

Symptoms of Vitamin A Deficiency. Vitamin A deficiency in cattle is characterized by swelling of the brisket and hind legs, dull watery eyes, stiffness in the hindquarters and night blindness. Simultaneously, feed intake is reduced; gain and feed efficiency are depressed. Cattle on low vitamin A rations suffer more from heat and are usually dull appearing. The hair coat, eyes and muscle tone do not exhibit the bloom and vigor of steers receiving vitamin A.

Vitamin A Requirements. Early studies on the carotene and vitamin A requirements of cattle were based on the minimum amount necessary to prevent night blindness and not on the need for maximum performance. Also, in the past 25 years many changes have been made in cattle production which have a definite influence on the vitamin A requirement; namely, (1) increased growth rate, (2) genetic composition, (3) feed composition, (4) environment, (5) thyroid activity, (6) stress, (7) disease, and many other factors. Neither animal nor man lives in a stable state of nutritional needs.

Several experiments in different sections of the United States have shown that vitamin A supplementation is needed in feedlot rations. For example, two experiments at Purdue University (Beeson et al., 1961) have revealed that steers require a supplemental source of vitamin A if fed on a ration containing either 1.0 or 2.26 milligrams of carotene per pound or a daily intake of 18 to 46 milligrams of carotene. This is equivalent to 7,200 and 18,400 I. U. of vitamin A activity using present conversion standards. The ration furnishing the higher level of carotene contained 10% of sun-cured alfalfa pellets. Fortification of either ration with 20,000 I. U. of preformed vitamin A per head daily increased daily gain 15% to 30% and improved feed efficiency 6% to 10 percent. High levels--30,000, 40,000 and 50,000 I.U.--of vitamin A fed during the cool months of the year did not improve performance of the steers over the 20,000 I. U. level. On the basis of these studies and feedlot observations, Purdue workers recommend that a minimum of 20,000 I.U. of biologically active vitamin A be given per steer daily in cool weather and 30,000 I. U. or more during hot weather.

In brief, the vitamin A requirements can be summarized as follows:

1. Growing or fattening steers or heifers - 20,000 I.U. of vitamin A daily in the cool months and 30,000 to 50,000 I.U. daily during the hot months.
2. Breeding cows during the winter months or dry pasture conditions - 30,000 I. U. of vitamin A daily.

3. For cattle shipped to the feedlot from dry ranges in the fall - 50,000 I. U. of vitamin A daily as indicated for the first 14 to 28 days.

4. At present there is no evidence that supplementary vitamin A is needed for cattle being grazed or fed on green pasture.

**Zinc**

With the shift to high concentrate diets for cattle and the loss of certain trace elements by soils and plants there has been a revival of research on the mineral needs of ruminants.

Zinc has been recognized as a required element for ruminants for many years, but only recently has research revealed its essential nature. Miller and Miller (1960) reported a zinc deficiency in young Holstein calves fed a semi-purified diet containing 2.7 p. p. m. (parts per million) of zinc. With the low zinc diet the following early symptoms were observed: red and inflamed nose and mouth, loss of hair from the rear legs, breaks in the skin around the hoofs, rough scaly skin on the rear legs, and retarded growth. After 11 weeks the calves exhibited such symptoms as swelling of the hocks and knees, loss of hair and wrinkled appearance on the legs. Calves on the same basal diet fortified with 46.0 p. p. m. of zinc did not exhibit any symptoms of zinc deficiency.

Haaranen and Hyppola (1961) observed that itch and hair slicking of dairy cattle in Finland could be cured by feeding affected cows 300 to 500 milligrams of zinc per day per 1000 pounds of bodyweight. Milk production of the itching cows (zinc deficient) was 11.4% smaller than that of the non-itching cows. The authors concluded that it has been statistically demonstrated that the itch and hair slicking adversely affect milk production, fertility and tranquility in dairy cattle. Also, this condition can be cured or prevented with zinc chloride, sulphate or oxide.

Recently Beeson et al. (1962) reported that preliminary data indicate a favorable effect from fortifying a fattening ration for beef cattle with zinc. Supplementing a high energy ration of corn, corn cob and soybean meal with 100 p. p. m. of zinc (0.25 lb. zinc oxide per ton) resulted in a 17% increase in daily gain, a 5% increase in feed consumption and an 11% improvement in feed efficiency. Although a good response was obtained in this experiment by adding zinc, additional research is needed to determine beef cattle's need for zinc under a variety of feeding conditions. During 1962, feeding zinc (100 p. p. m.) in a ration to cattle self-fed on pasture caused no significant change in daily gain or feed conversion. The only observable difference was that the cattle fed zinc had more attractive hair coat and bloom. However, this was only an aesthetic value and was not reflected in the selling price or carcass grade.
Certain Feed Additives and Nutrients

**Antibiotics.** Antibiotics will be more universally used in cattle feeding to improve gain, feed efficiency and carcass quality and to reduce the occurrence of condemned livers. Numerous studies have shown that antibiotics and stilbestrol are complimentary and additive in their effect from the standpoint of gain, feed efficiency and carcass quality. Low level feeding of antibiotics (75 to 80 mg. daily) tends to increase fat deposition in the presence of stilbestrol. Cattle feeders who desire maximum performance and are feeding to grade and specifications are using antibiotics. This trend will increase.

**Choline** is a member of the vitamin B-complex and technically should not be classified as a feed additive unless it acts as a drug instead of a nutrient. It is well-known that choline may be combined with homocystine in the formation of methionine, an essential amino acid.

Interest in choline chloride for ruminants was stimulated by the research of Dyer (1961) of Washington State University. In two out of four trials increases in daily gain were obtained by the feeding of 126 mg. of choline chloride per pound of feed. In this first series of four tests, choline stimulated gains an average of 0.1 pound daily. In the fifth experiment, feeding 3.25 grams of choline chloride per steer daily gave a 7.2% increase in gain and a 2.7% improvement in feed efficiency. There was no change in the digestibility of the dry matter in the rations from feeding choline.

At Purdue (Perry et al., 1962) feeding 3.25 grams of choline chloride per steer daily showed no significant effect on gain or feed efficiency.

More research needs to be conducted with choline to study its mode of action in the ruminant and whether it will promote growth on different types of rations.

In view of new techniques in feeding ruminants, other B-vitamins need critical investigation—especially in the young calf and lamb prior to rumen development.

**Enzymes** are essential for the digestion and utilization of all nutrients in the animal body. In general, the results reported to date on the effect of the amylolytic-proteolytic type of enzymes have been negative and inconsistent. Enzymes are needed that will improve the digestion of roughages. Bacteria in the rumen break down roughages to some degree but not completely. Eventually enzymes will be isolated which can enhance the digestion of cattle feeds. At present the cellulase and fungal type enzyme preparations look the most promising.

**Alfalfa,** especially dehydrated alfalfa meal, and other high quality legumes and young grasses contain unidentified factors which stimulate maximum performance of cattle. Feedlot rations that are properly balanced daily supply 0.5 to 2.0 lbs. of dehydrated alfalfa meal or its equivalent per steer. In the absence of
interfering agents, 100,000 I. U. of vitamin A from carotene (DeHy alfalfa) have a biological activity of 25,000 I. U. of vitamin A for beef cattle. The feedlot of tomorrow will use more alfalfa and grass pellets in the daily ration.

Mineral supplementation shall be tailored according to the character and mineral content of the natural feeds. More attention will be paid to (1) mineral element interrelationships, (2) the effect of chelating agents in making minerals more available for use, and (3) minerals supplied in the drinking water. Urinary calculi and several other feedlot diseases are basically a mineral–vitamin balance problem.

Tranquilizers have helped man respond to his environment. But none of them has achieved any consistent beneficial effects in beef cattle except for medical purposes. Cattle feeders know that calm, quiet cattle are more desirable feeders. Tranquilizers likely will be discovered eventually which improve the performance of beef cattle under specific feedlot conditions.

Vitamin E is essential for reproduction and to protect young lambs and calves against white muscle disease or muscular dystrophy. However, the feeding of 40 I. U. of vitamin E per head daily to steers either singly or with vitamin A (12,500 I. U.) had no beneficial effect on gain or feed conversion (Beeson et al., 1962).
Literature Cited


NUTRITION AND THE COW-CALF OPERATION

by Bruce Taylor

The western and southwestern ranges were formerly considered the only fit breeding grounds for cow outfits. But this just isn't true any more. Now, profitable cow and calf operations can be large or small and located just about any place. Nevertheless, four facts determine returns:

- The percentage of calf crop.
- The weaning weight per calf.
- The cost of production per calf.
- The price per cwt. of the calf crop.

If you stop to think it over a minute, nutrition and some common sense management are involved in each of these four points. Nutrition -- too many nutrients or too few -- is important in the performance and longevity of the cow and the success of the operation. The annual cost of keeping a cow, pregnant or open, is 70% feed, and the winter feed bill runs half the total in some areas.

Our nutritional knowledge advances as each well planned and conducted experiment ends and the results are published. But the essential requirements have been and remain:

1. T. D. N. (total digestible nutrients) to produce gain or control weight loss in the dry cow and for milk production and conception after the calf is on the ground.

2. Abundant vitamin A or its equivalent in carotene.

3. A minimum of 7.5% crude protein.

4. Phosphorus and calcium.

5. Water and salt.

Considering the world and the nation, T. D. N. (or just the plain energy part of T. D. N.) is the most limiting factor in cow-calf production. Let us consider this factor of gain, which is the end result of energy consumed.

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1Dr. Taylor is professor and head of the animal science department at the University of Arizona.
How Much Gain Is Enough?

The effect of different winter feeding levels and subsequent summer gains can be determined best by such items as calving regularity, percent calf crop, longevity, calving date and the adjusted weaning weights of the calves. Thus, long term or lifetime studies of cows are needed. Oklahoma State University has done just that. OSU started with heifers, fed them at three levels of winter supplementation, grazed them alike on bluestem grass and continued the study until the cows were worn out.

Their three levels of supplementation were designated as low, medium and high -- good man-on-the street terms for how much was fed per day on an every-other-day basis. The low level won the race and hence would best be termed "optimum." The levels were: 1 pound of cottonseed pellets per head daily, 2.5 pounds of the same, and 2.5 pounds of cottonseed meal pellets plus 3 pounds of oats per head daily.

Now these levels may not fit your area, so let us put them in terms of mature cow weights and changes in weight around the calendar. A rather poor year selected in the Oklahoma work provides these data for cows which calved in March and grazed yearlong, receiving 1 pound of cottonseed meal, the lowest level of supplementation of the study. Cows weighing 1193 pounds on November 1, 1957, gained 31 pounds per head to calving. They then lost 230 pounds per head by April 11, 1958 -- this from calving and the first month of suckling the calf. The summer grazing gain, while suckling a 95% calf crop, averaged 220 pounds per cow. The cows finished the year at an average weight of 1209 pounds or 16 pounds more than on the same data the previous year. Over the 14-year experiment the cows had lost an average of about 10% of their fall weight by the time of the next grazing season.

Surprising or not, this is very near the National Research Council's recommended level for 1200 pound cows. For example:

<table>
<thead>
<tr>
<th>T. D. N. Requirement And Gain (N. R. C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cow weight (pounds)</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>800</td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>1200</td>
</tr>
</tbody>
</table>

At this point we are most concerned with the recovery gain figures in the table (gain before calving) and mature weights of cows.

With mature cows of the beef breeds, a weight of not less than 900 pounds
to 1000 pounds before calving is usually necessary to support regular rebreeding and sufficient milk production to produce heavy calves. Thus, as shown in the accompanying table, the thin "sucked down" 800 pound cow increases to 1050 pounds just before calving; the medium-fleshed 1000 pound cow to 1072 pounds at calving. The 1200 pound cow, assumed to be fleshy, remains "status quo" on the same feed that produces .4 pound per day gain on a cow of medium flesh weighing 1000 pounds.

Stated differently, a thin cow needs to gain as much as she will lose in calving and the first drain of nursing the calf until grass reverses the decline in weight.

A cow in medium flesh needs to gain one-half as much as she will lose in calving or about 75 pounds. A fleshy cow need not gain at all and may even lose weight without reproductive failure or permanent harm.

In handling cows there is still a place for the "eye of the master" in this more scientific age. A thin cow to Tom, Dick and Harry may be three different things, but a cow that is strong, alert and thrifty -- but thin -- is a good working cow to a cowman. Even though he has no scales to weigh her he senses when she is losing or gaining in weight and knows why. He knows also that cows licking themselves are thrifty and OK; if not, it is due to lice or lack of feed, salt, mineral or water and the matter demands his immediate attention.

**Over Feeding Can Be Costly**

Getting back to the Oklahoma trials, let us consider:

<table>
<thead>
<tr>
<th>Two Levels -- Two Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Calf crop</td>
</tr>
<tr>
<td>Cost/year/cow</td>
</tr>
<tr>
<td>Cost/cwt. of calf</td>
</tr>
<tr>
<td>Net return/cow</td>
</tr>
</tbody>
</table>

In the above example, the optimum level was the so-called "low level" in the Oklahoma studies. Being good to the cows by providing more supplement than was necessary even shortened the average life of the cow. Note also that in the above table the "optimum +" level cost $19.00 more per cow per year. It also reduced returns by $27.00 per cow per year. The cows fed at the higher level produced fewer but only slightly heavier calves.
Workers at Nebraska's Fort Robinson Station did some excellent work on determining when the cow herd demands nutrients in abundance. It shows that even less energy than the N. R. C. lists as required will suffice for the dry period. But there is just no way to keep a cow doing a good job of suckling a calf and simultaneously rebreeding so she can do it again without a top ration abundant in total digestible nutrients including protein, minerals, vitamin A and energy. Perhaps the key to the situation is what the cow produces, and when.

It is lactation not pregnancy that is rough on the cow.

<table>
<thead>
<tr>
<th>Nutrients Represented in Products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Minerals</td>
</tr>
<tr>
<td>Carbohydrate</td>
</tr>
</tbody>
</table>

Thus, it is apparent that producing the fetus is no great nutrient expense to either cow or owner. But suckling the calf well is quite another matter. Although a lot of cows do the best they can on less, the N. R. C. requirement of 28 pounds of something that is 60 per cent T. D. N., 8 per cent protein, .24 per cent calcium, and .20 per cent phosphorus and no less than 40,000 I. U. of vitamin A is not an exaggeration of what is needed for top performance.

Nature, it seems, must have planned for the bovine young to be born in periods of lush grass; unless we change the calving season, grass becomes the answer. Even alfalfa hay comes up long on protein, but short on T. D. N. in meeting the requirement of the first few months of lactation. Remarkably, we expect the cow to rebreed with dispatch and become pregnant in the same period of high nutrient demand. The cow is really an extraordinary animal!

Another word on reasonable winter weight loss. Even though the demands of the fetus are small, cows losing 35 per cent of their fall weight during the winter produced calves that year which were individually inferior to calves from cows which lost only 15 per cent of their fall weight. Science is wonderful and can show when nutrients need be increased for maximum results. But science has come up with no substitutes
for nutrients in the daily life and occupation of the mother cow.

Heifers Are a Special Consideration

A medium level of nutrition has been shown in several studies to be desirable and economically sound. In this, the weanling heifer should be fed to gain approximately .5 pounds daily throughout the first winter and fed each succeeding winter to maturity so that winter losses including calving are no more than 10% of fall weights.

Let us re-emphasize the point that consistent production must be the goal, and this year's decision must always be made in the light of any effect on next year's calf crop. Percentage of calf crop is a first consideration and average weight of calves is a companion criteria. The two are very much involved in the returns per cow or per herd. For example:

| Necessary Selling Price of Calves to Break Even With a $50 Per Cow Annual Cost | Average weight of calves |
|---|---|---|---|
| Calf crop | 400 pounds | 450 pounds | 500 pounds |
| 95% | 13¢ | 12¢ | 11¢ |
| 85% | 15¢ | 13¢ | 12¢ |
| 75% | 17¢ | 15¢ | 13¢ |

A 10% increase in calf crop is equivalent to a 50 pound increase in average calf weight as a determiner of necessary selling price. You may construct your own table using a different annual cow cost, but the relationship of 10% increase being as good as 50 pounds gain holds. Thus:

| Necessary Selling Price of Calves to Break Even with a $35 Per Cow Annual Cost | Average weight of calves |
|---|---|---|---|
| Calf crop | 400 pounds | 450 pounds | 500 pounds |
| 95% | 9.2¢ |
| 85% | 9.2¢ |
| 75% | 9.3¢ |

There are areas and outfits in this vast country of ours that are economically ahead to arrive at an optimum rather than a maximum percentage calf crop. There are also areas that can produce a high percentage calf crop of late calves without supplemental feeding, whereas it would be costly to produce early calves. In some of these cases the late calves need be carried
over and sold as yearlings. Even though this requires a different country for grazing yearlings, it is good business to so proceed.

There are other farm type herds that are ideal for the production of fall calves which can be finished as mixed steers and heifers with only 30 to 60 days in dry lot after creep feeding. The Kansas beef production contests show top producers selling fat calves at 11 months of age with an expenditure of 15 to 25 bushels of corn or equivalent grain. Naturally, annual cow costs are high ($50 or more per cow) in such a system. But returns have justified the program, which fits a number of farms, the feeds produced thereon and the availability of labor in the winter months. After all, each producer must think, plan and proceed on what is best for his operation based on the climate, the home-produced feeds that need a market and the potential market for his product. There is still room for originality in the cow business.

Methods of Feeding

This country is so varied that only general statements can be made in this regard. It is quite well established that cows being supplemented on dry grass do equally well when fed only every other day if the amount is double that needed for daily feeding. Preliminary work at Oklahoma shows every fourth day feeding to be promising. Fundamentally, there is no storage of protein as such in the animal body. This fact eliminates feeding intervals of great length.

It would be easy to obtain testimonials of producers who prefer "protein blocks," "More liquid supplement" and others; but no one system seems universally best for every area. There is still nothing wrong with supplementing every day.

Since World War II labor has been a major consideration in supplementing range cattle. In some areas of the west the topography of the country limits travel by wheeled vehicles to the fewest trips possible. Thus, the salt:meal mixes to be fed free choice evolved as a practice of necessity from university and ranch research. Today, salt:meal mixes are commonly used in our state. The mixes used for cows include a 2:1 meal:salt in which the cows on dry range will consume approximately 1 pound of meal per day; or the 3:1 meal:salt mix in which the daily meal consumption is approximately 2 pounds per head. Thus, vitamin A is added at 10,000 to 20,000 I. U. per pound of mix.

Another way to approach the meal:salt mix idea is to assume that a dry range cow will eat a pound of salt a day plus whatever you put with the salt. This will work in some parts of Arizona, but not in all areas. A wet cow will eat more salt per day to obtain supplement, for example 1.87 pounds per head daily in an Oklahoma experiment.
Low Quality Roughages

Generally speaking, steer finishing rations have moved toward more grain and less roughage. More definitely, we are finishing our fed cattle at lighter weights and we are finishing younger cattle than a few years ago. Thus, more roughage -- high quality and low quality -- is available for cow herds. We need to use these roughages in beef production and the cow herds seem to be automatically elected for the job. Certainly we have the requirements pinned down accurately enough to build a ration around anything a cow will consume without harm to her physical well being. Fortifying low quality roughages to be fed in feed bunks (hence subject to analysis) is easier than supplementing a browse-type range where the analysis of that which cows actually select is quite difficult. The principle and methods are well known by many in the various areas and I will spend no more time on this now. Rather I would caution on the need to watch vitamin A in cow wintering rations involving long use of low quality roughages.

It is pretty hard to ignore a blinking red light in our scheme of traffic control. But no such attention getting device flashes any signals that a percentage of our cows has expended their vitamin A reserves. I have seen cows so deficient in vitamin A that their newborn calves were too weak to have any interest in America, yet the cows showed no symptoms of vitamin A deficiency. Whereas an average cow coming from several months' grazing on growing grass has a six-month storage of vitamin A of carotene origin, the individual variation is great -- perhaps three to nine months. Young heifers and immature cows store much less.

This suggests a most important management procedure, that of classifying cows by ages or by condition and supplementing accordingly. Assume any group of several hundred cows has a percentage of first calf heifers and a percentage of very thin cows, whereas 70% are normally strong but thin working cows. Perhaps 1 pound of supplement would suffice for the 70%, whereas the other 30% need 2 or even 3 pounds per head daily. It is obvious, I hope, that 350 cows adequately supplemented at a rate of 1 pound per day plus 150 cows receiving 2 pounds per day involves a total supplement of only 650 pounds per day, whereas 500 head at 2 pounds per day take 1,000 pounds of supplement per day. The classified procedure will also do the best job.

Now a few thoughts on vitamin A. A lot of midwest recommendations assume the book values of mixed carotene in various hays to be a fact. We cannot do this in our country as the loss in carotene from June to October in baled or wafered alfalfa hay is as much as 75%. Our irrigated alfalfa hay is outstanding in protein, leafiness, color and is quite low in fiber. The color remains when stored in the bale pile, but the carotene disappears.

We have just completed a growing trial in which 1/2 ton of the alfalfa produced 100 pounds of growing gain on 450 pound calves -- and that takes good alfalfa hay! My point is, we cannot depend on the carotene content; hence, we fortify with preformed and stabilized vitamin A palmitate.
Fortification is cheap and good insurance. We feel the N. R. C. requirement for cows is none too high, but we have not determined this point accurately. Remember that a milligram of mixed carotene as found in plants is not worth 1667 international units to a ruminant and never was. It is worth no more than 400 international units (the N. R. C. value) in the cow business; and if you are depending on it in hay, be sure it is still there. We have areas, and I live in one, in which the heaviest season of supplementation comes simultaneously with the breeding season as grass becomes green again only after the July rains. This emphasizes again that recommendations for vitamin A fortification will be on less than a national or world wide basis. Our minimum recommendation is 20,000 I. U. of preformed A per day for dry cows and 40,000 I. U. per day for cows nursing calves.
SUMMARY

1. The National Research Council recommendations for both wintering dry cows and for cows nursing calves are excellent and safe guides which have not been proved incorrect.

2. Do not select your commercial cows too small. Nine hundred pounds is a minimum mature cow weight before calving if regular rebreeding and sufficient milk flow to produce heavy calves are expected.

3. A thin cow needs to gain as much as she will lose in calving and the first drain of nursing the calf (150 to 200 pounds) before the recovery period on lush grass reverses the decline in weight.

4. A cow in medium flesh needs to gain one-half as much as she will lose in calving, or about 75 pounds.

5. A fleshy cow in the 1,150- to 1,200-pound range need not gain before calving and may even lose weight without reproduction failure or permanent harm.

6. Replacement heifers should be fed to gain 0.5 pound per head daily the first winter and thereafter lose no more than 10 per cent of fall weight from calving and the first month of nursing the calf.

7. Calves from poorly wintered cows are lighter at both birth and weaning. They will show retarded skeletal and muscle development for a period of six to ten months following weaning.

8. Fall calving should not be attempted without an abundance of feed. The cow nursing a fall calf will require a minimum of 35 per cent more feed and perhaps as much as 75 per cent more than a dry cow.

9. Improving the calf crop by 10 per cent is equivalent to adding 50 pounds to the average weight of the calf crop. If you can improve both without a prohibitive increase in cost, progress is certain.

10. Never take carotene for granted. Know or learn about your area; be alert to winters and breeding periods following dry grazing seasons. Fortification with preformed vitamin A is inexpensive and is excellent insurance.
BEEF CARCASS QUALITY

...As Influenced by Feeding Regime, Age, Weight and Sex

by Earle W. Klosterman

Factors indicating quality in beef have been reviewed by Pearson (36) and hence will not be discussed in detail here. He has listed color of fat and lean, firmness, tenderness, juiciness, texture, aroma and flavor as factors of importance and has discussed these in relation to such traits as finish, marbling and maturity. Doty (9) reviewed relationships between beef quality and grade and concluded that they were related but emphasized that the relationship was not close, particularly in the lower grades. Although marbling has been reported (36) to be only slightly correlated with juiciness and even less with tenderness, Wheat and Holland (49) found a very high correlation between marbling and carcass grade after ribbing. Carcass grade, whether it be a specified USDA grade or its equivalent, is of great importance to the beef cattle industry since grade and dressing percentage determine the market value of slaughter cattle. Thus, even though its importance may be debatable, marbling currently has a very definite practical value.

The proportion of the beef carcass which is edible is not generally considered as a quality factor. The American consumer demands lean, tender, flavorful beef with a minimum of fat. At present, these desires are difficult to satisfy without trimming and discarding variable amounts of fat. The importance of this excess waste fat to the beef industry was emphasized throughout a beef improvement conference (41) held at Colorado State University in 1961. This desire for high quality, lean beef with a minimum of fat is presently one of the major objectives of many feeding, breeding, management and meat investigations. For these reasons, in this discussion the term quality will be broadened to include cutability or yield of edible beef. Thus, the effects of methods of feeding, age, weight and sex upon quantitative as well as qualitative traits will be considered.

Feeding Regime

Levels of feeding. The classical growth studies of McMeekan with swine and of Palsson and Verges with lambs have been reviewed by Palsson (35). These studies

1/ Dr. Klosterman is professor of animal science, Ohio Agricultural Experiment Station, Wooster, Ohio.
2/ Numbers in parentheses refer to citations listed at end of this chapter.
show that carcass composition varies markedly with different levels of nutrition during growth and fattening. Larger differences were found in swine than in lambs. But in both of these species maximum amounts of lean and minimum amounts of fat were realized when these animals were fed liberal rations during early growth and somewhat restricted rations when growth rate normally declines and fattening occurs. In this country beef are frequently produced under the opposite procedure. Many cattle are grown primarily on roughage and fattened on high energy rations just prior to slaughter.

Several experiments have been conducted in recent years to compare various levels of feeding in relation to carcass quality in beef. The most extensive of these have been conducted at Oklahoma State University. Researchers at this station (40, 17, 18) conducted a series of three experiments in which rapid and moderate rates of gain were investigated. Feeding was managed to secure four different patterns of gain: (1) rapid gain throughout, (2) rapid gain first half and then moderate, (3) moderate gain first half and then rapid, and (4) moderate rate of gain throughout feeding period. In all three experiments, steers fed to gain rapidly for the entire feeding period produced carcasses which graded highest, had the most fat and the smallest amount of lean. There was, however, no advantage in tenderness; this finding indicated no large differences in quality.

In the first two experiments it was concluded that the moderately fed steers produced the most desirable carcasses. Both of the two mixed patterns of gain3 gave better results than did rapid gain throughout but not as good as did moderate gain throughout. In the third experiment the moderate-high treatment was the most efficient, and the high-moderate produced more desirable results than it did in the first two experiments. It is of interest that, in all three experiments, the two groups of steers fed at the high level during the first half had higher marbling scores than the two groups fed at the moderate rate during the same period of gain. These scores were verified by higher percentages of fat in the eye muscle as determined by chemical analyses. In this series of experiments the steers on rates of gain were fed for the same total gain.

In a fourth experiment reported by the Oklahoma Experiment Station (19), steer calves were fed for rapid gains or moderate gains for the same length of time or moderate gains for the same total gain. Steers fed for rapid gains were the most efficient and produced the highest grading carcasses. It was concluded that there were only small differences, other than fatness, in carcass composition of calves making different rates of gain when slaughtered at the same time or at equal weights. In their most recent publication (16) the Oklahoma investigators reported results of feeding steer calves high or moderate levels of nutrition for either 200 or 400 pounds of post-weaning gain. They concluded that the first 200-250 pounds of gain were highly important since it is during this period that

3 The two mixed growth patterns or treatments were, as described in previous paragraph, (a) rapid gain first half then moderate, and (b) moderate gain first half, and then rapid.
maximum skeletal and muscular development occurs. They also suggested that beef calves must be full-fed during this growth period if maximum marbling and carcass grade are to be attained.

Winchester et al. (51, 52) found no bad effects on beef quality as a result of under-nutrition of beef calves less than one year of age. Also, a California experiment (43) found no difference in tenderness, juiciness or flavor between steers fed an adequate ration or a protein deficient ration. (These experimental animals were fed for five months beginning at about age one year; then they were subsequently fattened.) Beef from steers fed the adequate ration was darker and redder and the carcasses were heavier, although not significantly so. Pinney et al. (39) also found that calves under-nourished prior to weaning were lighter in weight at 17 months than those which had been well fed early in life.

The effect of winter feeding upon quality beef production has been studied at the Missouri Experiment Station. In 1955 it was reported (37) that steers wintered on a sub-maintenance ration and subsequently fattened produced carcasses which graded lower, had less marbling, less lean and more separable fat than steers wintered to gain 1.5 lb. per head daily. Various levels of protein and energy in wintering rations fed prior to fattening produced differences in carcasses (44, 45). Steers wintered on rations adequate in protein and energy made the most efficient gains and produced the most desirable carcasses. A full feed of corn with adequate protein increased gains and carcass grade. However, efficiency was lower and fat trim higher than in the case of steers wintered to gain about 2 pounds per head daily.

**Corn silages.** Two of the major feeds fed to fattening cattle in the corn belt are corn grain and corn silage. Well-eared corn silage is unsurpassable in pounds of beef produced per acre of cropland. Thus, a number of experiment stations have conducted experiments to determine the optimum combination of corn and silage for economical gains and carcass values. Neumann et al. (34) at the Illinois Experiment Station fed corn silage for various lengths of time, followed by a liberal ration of shelled corn, to steers fed to similar final weights. In these experiments, as silage was fed longer, the dressing percentage decreased, external fat decreased, marbling increased and the yield of trimmed retail cuts increased. Slaughter grades were lower with the longer silage feeding, but, carcass grades were higher. The highest average carcass grade was obtained from steers fed silage for 224 days but corn for only 63 days.

Young et al. (53) fed steers and heifers corn silage without corn grain for 98 days, and then they full fed corn. They compared these animals to those fed a limited amount of corn with silage for the entire feeding period. All cattle were fed to a similar slaughter grade. No differences were found between these two methods of feeding with regard to total gain, feed efficiency, yield, quality of carcass or amount of fat in the 9-11 rib cut.
Three experiments at the Michigan station with various levels of corn grain and corn silage have been summarized by Deans and Newland (8). In these experiments, steer calves and yearlings were fed to final weights of 1000 pounds and heifers to 900 pounds. When fed to the same final weights steer calves graded choice and yearlings graded good. Whether this difference in grade was due to differences in age, method of feeding or breed is not known. Increased amounts of concentrates in the ration tended to increase the rate of gain, dressing percentage and amount of external fat. Higher levels of corn in the ration raised the quality grade of steer carcasses slightly but did not increase the grade of heifer carcasses. Within treatments, negative correlations were found between the rate of gain and the quality grade. With a high level of concentrates, increases in rate of gain were much greater than increases in marbling. The researchers concluded that increasing the level of corn grain in a corn silage ration is not a reliable method of increasing marbling scores in light weight beef. These results may have been influenced by feeding each animal to a constant weight. That is, the negative relationship between gain and quality grade might not have occurred had all animals been fed for the same length of time.

Two experiments have been conducted at the Ohio Experiment Station (25,27) to determine the effect of full feeding corn silage or ground ear corn at various stages during growth and fattening. Two rations—a full feed of corn silage and no grain or a full feed of ground ear corn and limited silage—and three periods were studied. In the first experiment, time constant periods were used; in the second, steers were fed for similar gain in each of the three periods. In both experiments, average daily gains were significantly increased by feeding the corn ration in either of the three periods. The increases were similar whether corn was fed in the first, middle or latter part of the feeding period. The dressing percentage was also significantly influenced by feeding corn in each of the three periods. Moreover, the later the corn was fed, the higher the dressing percentage. The area of rib eye and edible portion tended to decrease the earlier the corn was fed. However, the marbling score appeared to increase slightly with the early feeding of ground ear corn.5/ These differences were not great.

4/ Percentages of edible portion in the second experiment were estimated by the following prediction equation, as reported by Klosterman, Cahill and Kunkle (29).

Predicted edible portion = 76.31 - 3.65 (fat thickness) - 1.844 (percent kidney fat) + .430 (rib eye area) - .0084 (carcass weight)

Edible portion, as predicted by this equation, was found to be significantly correlated, 0.85 - 0.96, with actual values of various groups of cattle as determined by physical separation. This equation and a USDA equation based on the same traits were found to be of approximately equal value in predicting either percentage edible portion or boneless, retail trimmed round, loin, rib and chuck.
Robertson and Baker (42) studied differences in the microscopic structure of the muscles of steers fed a full feed of corn, a half feed of corn or a full feed of silage and no corn. They found the muscle fibers of the steers full-fed corn were greatest in diameter, those of the silage fed steers were the smallest and those from the half-fed were intermediate in size. They found no true fat within the muscle fibers. These observations likely have no relation to the negative correlation between tenderness and muscle fiber diameter of cattle of different breed and age as reported by Brady (3).

Pasture. Longwell (31) reported that brightness of the lean of beef was related to the degree of finish and that grass, per se, did not produce dark lean beef.

Bull, Snapp and Rusk (6) reviewed the literature and compared cattle fed on pasture and in dry lot. Cattle fed on pasture without grain dressed and graded lower because of less finish. When full-fed grain to a similar degree of finish, pastured cattle dressed as high and were as palatable as cattle fed in dry lot. Moreover, their carcasses shrunk no more. However, pastured cattle often graded lower because of yellow fat, a reduction in grade which the authors concluded was not justified.

A South Carolina experiment (13) compared steers fattened to a grade of U.S. good in dry lot or on winter pasture with various grains. They found no differences in carcass grade, yield, percent fat, lean or bone, area of rib eye or percent moisture or fat content of the rib eye as a result of the method of feeding. The iodine number of the fat of cattle fattened in dry lot was significantly lower than that of cattle fed on pasture without grain.

McCampbell et al. (32) found carcasses from cattle fed on winter pasture to have less external finish, lower conformation grades and a tendency toward yellow fat as compared to carcasses from cattle fed in dry lot. Cattle fed grain on pasture had higher conformation grades but not higher finish grades than cattle on pasture without grain. These cattle were fed 4-6 pounds of grain per head daily (2), an amount apparently sufficient to produce superior muscular development without increasing the deposition of fat.
Age

Hiner and Hankins (21) studied tenderness of several beef cuts from animals varying from 10-week-old veal calves to 5 1/2-year old cows. Tenderness decreased as the animals aged and differences between the extreme ages were highly significant. However, differences between veal and beef from 500 pound steer calves were not statistically significant.

Bray et al. (4) reported that the moisture and ash content of connective tissue decreased and the fat content increased with the age of beef cattle. They posulated that factors other than fat within the connective tissue are responsible for tenderness.

A number of reports on the effect of animal age upon carcass composition and quality have been published by the Oklahoma Experiment Station (46, 47, 48). They have studied carcasses from Hereford steers and females varying in age from 6 to 90 months. Tenderness of rib eye steaks decreased significantly with increasing age. The greatest difference between 18, 42 and 90 months was between the 18 and 42 month age groups. Tenderness and marbling were not associated in the 18 month cattle but were in those 42 and 90 months of age. Taste panel flavor and juiciness did not appear to be related to age or marbling. The color of rib eye steaks became a darker red with advancing animal age.

Muscle fiber diameter increased with animal age (48) and tenderness decreased with fiber size. However, within age groups there was little relationship between fiber diameter and tenderness. The average fiber diameter was significantly related to the area of rib eye and to the total carcass lean. However, when the effect of animal age was removed these correlations were no longer significant. Chambers (7) has stated that variations in tenderness of cattle slaughtered at about 13 months of age are small and of little real importance. A similar observation has been made from unpublished data at the Ohio Experiment Station.

Hendrickson et al. (20) have reported the following effects of animal age upon carcass composition when marbling levels were similar at all ages. The dressing percent increased, the percent of hind quarter and round decreased, fat increased and the percent of lean decreased with advancing age. The rapid increase in the percentage of fat indicated that the total fatty composition of the carcass was not directly associated with marbling. They indicated that maximum muscular development occurs between 12 and 18 months of age.

Weight

The effects of methods of feeding, age and weight are difficult to separate. Animals fed differently are likely to be of different age or weight, and animals of

6/ Correlation of 0.83
7/ Correlation of 0.73
different ages will vary in weight, etc. In many instances there were differences in weight of animals in the experiments discussed above.

Ewing et al. (10) started with steers one year of age. One group was fattened on a full feed of corn, a second group was fed to gain 1.5 lb. daily for 155 days and then fattened and a third group was fed a maintenance ration for 221 days and then fattened. All groups were fed to the same degree of outside finish as determined by ultrasonic equipment. Carcasses from steers in the first group tended to grade and yield lower, had significantly less intra-muscular fat, less separable fat, and more separable lean than carcasses from steers in the other two treatments. Moreover the shear test values of the cooked steaks were significantly lower. These results were verified by a second experiment reported in 1962 (11).

Goll, Kline and Hazel (14) studied relationships between carcass grade, weight, yield of wholesale cuts and carcass measurements. Three weight groups within each of the choice, good and standard grades were investigated. The researchers found that grade or finish had the greatest influence on yield of wholesale cuts and that carcass measurements were influenced the most by differences in weight. There were large and consistent differences among carcasses of the same grade and weight.

Sex

Steers vs. Heifers. Many experiments have been conducted to compare the performance and carcass quality of steers and heifers. Many of these have been reviewed by Morrison (33). In general, heifers gain a bit slower and fatten at a younger age and lighter weight. If fed to the same degree of finish there is little difference in rate of gain, cost of gain, dressing percentage, retail value, tenderness and palatability. However, since heifers fatten at younger age and lighter weight they are frequently fed to a higher degree of finish than steers. Under these conditions, gains of heifers will be slower and more costly and their carcasses will contain more waste fat. Previously unpublished data from the Ohio Station are given in the following table.
COMPARATIVE CARCASS DATA OF YOUNG STEERS AND HEIFERS SLAUGHTERED AT SIMILAR AGES

<table>
<thead>
<tr>
<th></th>
<th>Steers</th>
<th></th>
<th>Heifers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Average</td>
<td>Number</td>
<td>Average</td>
</tr>
<tr>
<td>Live wt., lb. ¹</td>
<td>105</td>
<td>810</td>
<td>92</td>
<td>728</td>
</tr>
<tr>
<td>Chilled carcass wt., lb.</td>
<td>&quot;</td>
<td>487</td>
<td>&quot;</td>
<td>438</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>&quot;</td>
<td>60.1</td>
<td>&quot;</td>
<td>60.2</td>
</tr>
<tr>
<td>Carcass grade²</td>
<td>&quot;</td>
<td>10.5</td>
<td>&quot;</td>
<td>10.3</td>
</tr>
<tr>
<td>Edible Portion, %</td>
<td>&quot;</td>
<td>69.8</td>
<td>&quot;</td>
<td>67.4</td>
</tr>
<tr>
<td>Fat trim, %</td>
<td>&quot;</td>
<td>14.8</td>
<td>&quot;</td>
<td>18.5</td>
</tr>
<tr>
<td>Bone, %</td>
<td>&quot;</td>
<td>15.4</td>
<td>&quot;</td>
<td>14.1</td>
</tr>
<tr>
<td>Area rib eye, sq. in.</td>
<td>&quot;</td>
<td>9.87</td>
<td>&quot;</td>
<td>8.79</td>
</tr>
<tr>
<td>Area rib eye per cwt. carcass</td>
<td>&quot;</td>
<td>2.03</td>
<td>&quot;</td>
<td>2.01</td>
</tr>
<tr>
<td>Kidney fat, %</td>
<td>&quot;</td>
<td>2.9</td>
<td>&quot;</td>
<td>3.7</td>
</tr>
<tr>
<td>Fat thickness, in.</td>
<td>74</td>
<td>.50</td>
<td>68</td>
<td>.58</td>
</tr>
<tr>
<td>Marbling score³</td>
<td>63</td>
<td>6.5</td>
<td>54</td>
<td>6.7</td>
</tr>
<tr>
<td>Tenderness⁴</td>
<td>28</td>
<td>6.1</td>
<td>27</td>
<td>5.8</td>
</tr>
</tbody>
</table>

1 Off feed and water overnight minus 3 percent.
2 Low choice, 10; average choice, 11.
3 Modest, 6; Moderate, 7.
4 1, very tough to 10, very tender.

The data presented in the previous table were obtained over a period of years from a breeding project in which steers and heifers were fattened immediately following weaning and slaughtered at about 14 months of age. These results are in general agreement with other experiments in which steers and heifers were fed for similar periods of time but to heavier weights.

Steers vs. bulls. In the past, bull carcasses have been discriminated against. This has most likely been due to the lack of quality of aged bull beef and the thought that these traits are more or less characteristic of all bull carcasses.

A number of experiments (1, 12, 5, 22, 23, 24, 50, 30, 38) have shown that bull calves gain more rapidly and efficiently and produce carcasses with a higher proportion of lean than steers. These differences were found to be highly significant. Bull carcasses have generally graded lower because of less marbling and external fat. In some experiments no differences were found in tenderness and palatability and in others steers were found to be slightly more tender than bulls. No undesirable flavors or aroma of bull beef have been reported.
In interpreting results of beef cattle feeding experiments it is important to consider the controls applied to each experiment. Cattle may be fed to a constant age, weight, grade, fat thickness, date, etc. Tests may also be on the basis of individual animals or on lot averages. All methods have their advantages and disadvantages, and the one selected by an investigator is based upon the primary objective of the experiment to be conducted. However, in considering the results obtained, the reader must remember the conditions imposed upon the experiment. Different methods may lead to different results. For example, in an Ohio experiment (26) in which cattle were fed to a constant age, there was a positive relationship between rate of gain and amount of fat in the carcass. However, when cattle were fed to a constant weight in a Missouri report (15) the opposite relationship was found.

There is not complete agreement in the literature on the effects of levels of feeding upon subsequent carcass value. However, it appears that young animals should be fed liberal rations in order to attain maximum muscular development. It is well agreed that tenderness decreases as age increases. Tenderness is apparently the trait of most importance to the consumer. Amounts of external finish or waste fat also increase with advancing age. Waste fat is the major complaint of the retailer. It would thus appear that young beef animals which are known to be destined for ultimate slaughter should be grown and finished at as young an age as possible. As soon as such animals have attained the desired finish they should be slaughtered and not held for heavier weights. Live beef cattle should be considered a perishable product and sold when ready for market.

When total feed costs of beef production are considered (including that required to maintain a cow herd), the production of young slaughter cattle also appears to be the most economical (28). Even under the best of performance, maintenance requirements are high and hence costly. The younger that cattle can be brought to market weight and condition the lower their total maintenance needs.

Marketing cattle at young ages does not necessarily mean that they need to be fed high energy, expensive rations. Productive dams and high quality roughages are key factors as well as efficient fattening rations. Post weaning gains should be the maximum which are compatible with the economy of the ration. In the corn belt, such a ration will include liberal amounts of corn silage. In other areas it may or may not include other good quality roughages depending upon availability and hence relative feed costs.

You have to maintain a beef cow for a year to produce a calf. Fortunately, her nutrient requirements for production are not high during much of the year. Therefore, it is advisable to utilize low quality roughages with a cow herd rather than through cattle destined for market. It is true that certain ranges and farms are not adapted to cow-calf operations, and in some areas young cattle must be used as a buffer.
against changing weather conditions and carrying capacities. However, the further the industry can move toward the using of poor quality feeds by cows and the marketing of slaughter cattle at young ages the more profitable the industry as a whole will become. With an ever increasing demand for feeder cattle, it is likely that numbers of cows in farming areas will continue to increase in order to utilize efficiently corn stover and other low quality forages.

More and more meals are being eaten in hotels and restaurants. Thus, there will be a continued market for highly finished cattle. However, as related to total beef production, this market is likely to remain limited. With the present emphasis on marbling, sufficient numbers of such cattle will be produced. Most likely, too many producers will continue to aim for the top of the market, whereas, a slightly lower selling price with considerably lower costs of production would be more profitable.

The dressing percentage, although a desirable trait, may be misleading and can be over-emphasized because of its positive relationship to fat. The fatter the carcass the higher the dressing percentage, but the lower the percentage of edible beef that carcass will yield. Except for the inaccuracies of live cattle weights caused by differences in fill, live weight should be more closely associated with weight of edible beef than carcass weight. That is, the opposing effects of fat are cancelled when weight of edible beef is related to live weight rather than to carcass weight.

With regard to sex, steers, heifers and bulls will all produce highly desirable beef. Of these, steers are the most versatile and can be adapted to the widest range in management, methods of feeding, weight and age at slaughter. Heifers are somewhat more limited by age and hence systems of management. They are best adapted to a short feed and slaughter at light weights. Bulls are definitely limited by age and should be fattened shortly after weaning. If fattened at a young age, bulls will produce the most lean beef of desirable quality with the lowest cost of production.

The following table is based on average results of five experiments which involved a total of 190 steers and bulls conducted at the Ohio Experiment Station (24). In these experiments choice grade feeder steer and bull calves of the same age and quality were compared. These results suggest that, with a narrow spread between good and choice grade carcass beef, it should be possible for all segments of the beef industry to profit from feeding bulls rather than steers.

If feeder calves were not castrated they would be the same quality as steers and hence worth as much per pound. Bulls tend to gain more from birth to weaning and hence the feeder calf producer would receive about $5.00 more per head.

Bull calves will gain more rapidly in the feed lot with a lower feed cost per hundredweight of gain than steers. Even though a feeder paid $5.00 more per head, the final cost of the bulls at the end of the fattening period would be nearly $1.50
a hundred less than the steers. Dependent upon sale price, bulls could, therefore, show more profit than steers for the cattle feeder.

The biggest advantage in favor of bulls appears in the carcass. Bulls yield a slightly lower percentage of carcass but the carcass will contain a much higher proportion of edible meat. Hence, fat, young bull carcasses would also be profitable to the packer and retailer. The preceding table shows that bulls will produce a pound of edible meat for nearly five cents less than steers. Competition in the beef industry should eventually pass part of this advantage back to the producer and feeder and part to the consumer.

These advantages of bulls are based on fattening and slaughtering at a young age, under 18 months. Obviously, mature bulls would not produce carcass beef comparable to that from steers. When bulls are fattened immediately following weaning their carcasses will be nearly as tender as steer carcasses and they can be liberally fed without producing excess, waste fat.

Some of the advantages of feeding bulls could be realized by feeding steers only to good grade rather than choice. This, however, would necessitate feeding a less efficient ration to an older age or slaughtering at considerably lighter weights. Generally speaking, young animals make more efficient gains than older animals. The most efficient rations are those that produce maximum rates of gain. Bulls can be fed to a desirable weight at a young age with lower feed costs and less waste fat.
# COMPARATIVE COSTS OF EDIBLE BEEF AS PRODUCED BY STEERS AND BULLS

<table>
<thead>
<tr>
<th></th>
<th>Steers Average</th>
<th>Cost</th>
<th>Bulls Average</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight, lb.</td>
<td>440 @ .25</td>
<td>110.00</td>
<td>460 @ .25</td>
<td>115.00</td>
</tr>
<tr>
<td>Average daily gain, lb.</td>
<td>2.06</td>
<td>2.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final wt., 250 day feed, lb.</td>
<td>955</td>
<td></td>
<td>1075</td>
<td></td>
</tr>
<tr>
<td>Feed per cwt. gain, lb.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn and Supplement</td>
<td>564</td>
<td>485</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roughage</td>
<td>201</td>
<td>174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed cost per cwt.1</td>
<td>$ 13.78</td>
<td></td>
<td>$ 11.88</td>
<td></td>
</tr>
<tr>
<td>Feed cost per head (gain x cost)</td>
<td></td>
<td>70.97</td>
<td></td>
<td>73.06</td>
</tr>
<tr>
<td>Total cost per head</td>
<td>$180.97</td>
<td></td>
<td>$188.06</td>
<td></td>
</tr>
<tr>
<td>Total cost per cwt. (cost/wt.)</td>
<td>18.95</td>
<td></td>
<td>17.50</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>Choice</td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>61</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass wt., lb.</td>
<td>583</td>
<td>645</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass cost per cwt. (cost/wt.)</td>
<td></td>
<td>31.04</td>
<td>29.16</td>
<td></td>
</tr>
<tr>
<td>Edible portion, %</td>
<td>72.7</td>
<td>77.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edible portion, wt. lb.</td>
<td>424</td>
<td>497</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edible portion cost per cwt. (cost/wt.)</td>
<td></td>
<td>42.68</td>
<td>37.84</td>
<td></td>
</tr>
</tbody>
</table>

1 Concentrates $40.00 and roughage $25.00 per ton.
References


BREEDING BEEF CATTLE FOR IMPROVED PRODUCTIVITY AND MARKET DESIRABILITY

by E. J. Warwick

Potential progress in breeding beef cattle depends upon the basic hereditary nature of important traits and the effects of various breeding systems upon their expression. In this presentation we will attempt to summarize research results of recent years, apply them as far as possible to practical situations and discuss application currently being made in industry. It should be recognized that no presentation of this kind can be freed completely from the personal observations and opinions of the reviewer.

Selection in Outbred or Mildly Inbred Populations

This breeding system is essentially one of breeding the "best to the best" without regard to bloodlines. In practice, breeders operate within a breed and may also try to stay within some general bloodline, thus following a mild line breeding program. The breeding program essentially consists of breeding the best available bulls to the available selected cows. It has historically been the most universally used breeding system and present evidence strongly indicates that a good selection system will be basic to breeding programs of the future. It is often termed "mass selection."

Progress which can be made with a mass selection system depends upon (1) the heritability of the traits being considered, (2) their genetic relationships, (3) the number of traits being considered in selection, (4) the intensity of selection which can be practiced, and (5) the reproductive rate.

Put simply, heritability is a statistical estimate of the relative influence of heredity and environment on a trait. In the broad sense, heritability includes all effects of hereditary factors. In usual practice, however, we calculate and think of heritability in the narrow sense. This means that, for the most part, we include the additive gene effects only. Heritability in this sense can be thought of as an index of probable response to selection. It can range from zero to 100 percent for different characters and can vary from herd to herd or from one environment to another for the same character. In spite of the fact that heritability can theoretically reach 100 percent, very few if any quantitative characters in any farm animal have been found to be over about 60 percent. Thus, for practical purposes, we often think of heritabilities of 40 to 60 percent as high, from 20 to 40 percent as medium and below 20 percent as low.

1/ Dr. Warwick is Chief, Beef Cattle Research Branch Animal Husbandry Research Division, ARS, U. S. Department of Agriculture, Beltsville, Md.
Table 1. Heritability Estimates of Some Economically Important Characters of Beef Cattle. 1/

<table>
<thead>
<tr>
<th>Character</th>
<th>Heritability</th>
<th>Character</th>
<th>Heritability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving Interval</td>
<td>10</td>
<td>Conformation Score:</td>
<td></td>
</tr>
<tr>
<td>Birth Weight</td>
<td>40</td>
<td>Weaning</td>
<td>25</td>
</tr>
<tr>
<td>Weaning Weight</td>
<td>30</td>
<td>Slaughter</td>
<td>35</td>
</tr>
<tr>
<td>Cow Maternal Ability</td>
<td>40</td>
<td>Carcass Traits:</td>
<td></td>
</tr>
<tr>
<td>Cow Mature Weight</td>
<td>60</td>
<td>Carcass Grade</td>
<td>30</td>
</tr>
<tr>
<td>Feedlot Gain</td>
<td>45</td>
<td>Rib Eye Area</td>
<td>50</td>
</tr>
<tr>
<td>Efficiency of Feedlot Gain</td>
<td>40</td>
<td>Thickness of Fat Cover</td>
<td>30</td>
</tr>
<tr>
<td>Pasture Gain</td>
<td>30</td>
<td>Tenderness of Lean</td>
<td>50</td>
</tr>
<tr>
<td>Final Feedlot Weight</td>
<td>60</td>
<td>Cancer Eye Susceptibility</td>
<td>30</td>
</tr>
</tbody>
</table>

1/ Summarized from many published sources with dependence on summaries by Gregory (1961), and Warwick (1958 and 1960).

Table 2. Estimates of Potential Progress in 10 Years with Natural Service in Large Beef Populations When Selection is For One Trait Only.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Selection Only 1/</th>
<th>Selection Plus Progeny Testing 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning Weight</td>
<td>43 lb.</td>
<td>47 lb.</td>
</tr>
<tr>
<td>Feedlot Daily Gain</td>
<td>.43 lb.</td>
<td>.48 lb.</td>
</tr>
<tr>
<td>Feed Required per 100 lb. Gain</td>
<td>84 lb.</td>
<td>92 lb.</td>
</tr>
<tr>
<td>Area of Rib Eye</td>
<td>.29 sq. inch</td>
<td>.40 sq. inch</td>
</tr>
<tr>
<td>Tenderness (Shear force required for 1&quot; core)</td>
<td>.88 lb.</td>
<td>1.20 lb.</td>
</tr>
</tbody>
</table>

1/ Five percent of bulls selected solely on basis of own performance and that of half sibs. Bulls used at two and three years, then replaced.

2/ 5.6 percent of bulls selected for progeny testing on basis of own performance, bred as yearlings to 20 cows each for progeny test and the 20 percent having best progeny returned to service at four years and survivors used for five years, then replaced.
Heritability of many beef cattle traits has been studied at experiment stations in the United States and some approximate averages for several characters are shown in Table 1.

The estimates on birth weight, weaning weight, feedlot gain and final weight are based on enough data to give us considerable confidence in their general applicability. Weaning weight is moderately heritable. Feedlot gain and cumulative measures of growth, such as final feedlot weight and mature weight, are rather highly hereditary. Pasture gains are somewhat less hereditary than those in the feedlot.

Estimates on cow maternal ability, i.e. the ability to wean heavy calves, and efficiency of feedlot gain are both based on fewer data. However, these factors appear to be at least medium in heritability. Generally speaking, heritability of measures of growth and maternal qualities appears to be high enough to permit important progress from selection.

Conformation scores appear to be moderate in heritability.

Heritability estimates of carcass characteristics are based upon fewer data. We therefore have less confidence in the applicability of the average figures to beef cattle populations in general. However, all indications are that carcass characteristics are moderate to high in heritability and should respond to selection if means can be devised of putting on selection pressure.

The heritability given for the calving interval is based on only a few estimates but these estimates were generally consistent and also consistent with similar studies in dairy cattle. (Johansson, 1960, and Casida, 1961). The heritability of gross reproductive efficiency is low. Thus we would not expect appreciable progress in improving the genetic capacity for reproduction by the usual selection or culling practices such as culling non-pregnant cows and selecting herd bulls only from cows having had consistent calving records.

Apparently, for most environments at least, automatic selection occurring over long periods of time has nearly exhausted genetic variability in fertility. This could occur because sterile or relatively infertile breeding animals leave none or only a few offspring and thus their germ plasm is effectively culled from the population.

The foregoing statements, which suggest that little or no progress can be expected from selection for fertility, must be taken with some reservations. Knox (1957) found a difference in calf crop of 12.2 percent in favor of large type Hereford cows as compared to smaller, more compact kinds under rigorous range conditions in New Mexico. He hypothesized that the larger cows were better adapted to these conditions and were thus better able to maintain normal reproductive rates. Further evidence that, at least under certain conditions, fertility may be related to type of cow comes from Stonaker (1958), who found that cows of conventional size weaned an 8.4 percent higher calf crop than Comprest type cows under Colorado range conditions. Observations on cow herds in other areas having suboptimum environmental
conditions have led to the suggestion that heritability of fertility may be relatively higher. However, these observations have not yet been buttressed with scientifically acceptable proof. Studies of heritability of various components of reproductive capacity under suboptimum conditions could give different results.

Heritability is an academic concept until we combine it with what we know about variability and the intensity of selection possible and from this material derive estimates of potential improvements in productivity.

Table 2 gives some estimates of potential progress possible over a 10-year period for several traits under natural breeding and two systems of sire selection if selection were entirely for each trait individually. An 80 percent calf crop has been assumed with 60 percent of the heifers put in the herd for breeding. Half of these are culled after two calf crops.

While selection for one item at a time will not normally be a practical procedure, this table has several items of interest:

First, the potential progress in weaning weight and feedlot gaining ability is large. It may not seem large to some of you in view of the reports which keep appearing in the popular press and promotional releases about individual breeders who have increased their weaning weights by 40 lbs. or more in a single year just by getting the right bull. Probably, in most of these cases, the breeder also improved his management and confused the effects of such improvement with bull effects. In some cases, the effect may be truly genetic due to a fortunate sire selection, but for every such case there is probably also an unreported case in which a breeder made little or no progress due to an unlucky sire selection. These things will happen whenever heritability is less than 100 percent. We are interested here, however, in what can be expected on the average in an industry or in a large herd.

Second, the potential progress in reducing feed required per 100 lb. gain is also large but is probably less attainable under practical conditions since it is based on the assumption that every calf would be individually fed so that efficiency could be evaluated. It isn't difficult to get a weaning weight on every calf and to get a post-weaning gain record on every individual, but individually feeding a whole population is another question.

Third, the progress which can be made for carcass traits is disappointingly small because all selection pressure has to be indirect and based on slaughtered animals. (The two traits used are for illustration only; the same principles would apply to others). Relatives of those having the best carcasses are used for breeding. Again, here we've tended to be a bit unrealistic in our assumptions since we've assumed that all animals not needed for breeding were slaughtered and their carcasses evaluated. In the case of the "Selection Only" group, it was assumed that two bulls were selected at random from among the bulls by each sire, the others slaughtered and the bulls used whose half-brothers had the best carcass traits. This is an
inaccurate and not very intense selection procedure. In the "Selection Plus Progeny Testing" group, bulls were initially selected in the same fashion, and all their progeny of both sexes in the progeny test phase were slaughtered. This would give more accurate and intense selection but even then the potential progress would be low due to the fact that the generation interval is necessarily increased.

The examples given may be useful estimates of progress possible in cases where marked deficiencies in one trait make it advisable to select for it alone for a time. Usually, however, concurrent selection will be practiced for several traits. Progress for individual traits will depend upon their heritabilities, the relative emphasis put on each and on the genetic relationships among them. If equal emphasis is put on selection for each trait and if the traits are genetically independent, progress for any one of several traits should be reduced to the progress expected in one trait if it were the sole object of selection divided by the square root of the number of traits being selected for. Thus, if selection were for four independent traits, progress for any one would be reduced by half. However, if all were equally important, total progress or improvement in overall merit would be substantially greater than if all selection were directed to one character. This relationship emphasizes (1) the necessity of avoiding selection for unimportant traits in order to put maximum selection pressure on the important characters, and (2) the desirability of giving attention to all the important traits.

If, in selection, a breeder followed the reasonably practical procedure of giving equal attention to weaning weight, postweaning gaining ability, conformation score and rib eye area, the potential progress over a 10 year period would be 21.22 lb. per day, 1/3 of a grade and .14 sq. inches, respectively. The improvements for weaning weight, gaining ability and conformation score would all be important and could mean much to the industry. Further, there is a relationship between rate of gain and efficiency of gain which makes it probable that the increase in gaining ability would be accompanied by a reduction of 7 to 8 percent in feed required per cwt. gain. Unless the improvement in conformation score were more closely related to carcass value than would appear probable, improvement in carcass value would be disappointingly small.

The problem of selecting for improved carcass quality requires further discussion. Three facts are clearly established:

(1) There are large hereditary differences among beef cattle in ability to produce tender, juicy, palatable beef with a minimum of waste fat.

(2) Past judging standards have failed to identify those animals with high lean content and indeed apparently have favored those with ability to lay on fat smoothly regardless of lean content or muscling.

(3) So far as we know, there are no external indicators of lean tenderness and palatability independent of fatness.
A fourth factor which might be mentioned is that even among highly finished carcasses grading choice or prime there is a small fraction, perhaps 5 percent or less, which are enough lacking in tenderness and palatability to be objectionable to at least some consumers.

If we can't accurately estimate potential carcass quality in the live animal, the only alternative in selecting for it is to breed prospective herd sires to equivalent samples of commercial cows, feed out and slaughter 6 to 10 progeny per sire, evaluate the carcasses, and select the bulls having progeny with superior carcasses for use in seedstock herds. This process is slow, expensive, and the number of bulls which can be progeny tested is limited. It is, however, reasonably accurate and in the absence of better procedures is being used to an extent and will be used more in the future.

What are the alternatives? Improved standards for visual appraisal of live animals are perhaps the most appealing. Studies are under way relating live animal appearance to carcass traits of finished cattle. To date, predictions of lean and fat content have not been highly accurate but some studies show correlations of .3 to .4 between estimates and actual cutouts of closely trimmed rib, loin, round and chuck. These may be high enough to be useful even though much lower than we'd like to have. High cutability seems to be associated with width of shoulder, loin and rump, depth of twist and thickness in arm region. Extreme shortness and depth of body are negatively related. Much remains to be done and visual selection will doubtless always be far from perfect, but I am hopeful we may be able to do a lot with it if our standards are right.

Another possibility is the use of ultra high frequency sound waves to estimate thickness of fat and lean tissues in live animals. Experimental work is promising and these devices are being used to a very limited extent by breeders today. However, much research is still needed on how best to use them. Moreover the machines are expensive and require skilled operators. Other techniques are under investigation.

Since eatability of lean tissue can apparently not be estimated from external appearance, other methods must be used. Taking small biopsy samples of lean from living animals and estimating their potential eating quality is a possibility which comes immediately to mind. Nothing is ready for use as yet but possibilities are being studied. Another real possibility is that the chemist and meat processor will take care of the problem so breeders won't have to worry about it.

In the foregoing material we have given estimates of probable progress through selection. It should be emphasized that these are estimates based on basic facts developed to date. Short-time observations support their probable validity -- actually some of the heritability estimates are based on a one-generation response to selection. However, insufficient time has passed for long-term selection experiments to confirm the validity of estimates.
Genetic correlations are defined as genetic relationships in which genes affecting one character also have effects on others. The effect may be either positive or negative on the second character. If two characters have a positive genetic correlation, selection for one will indirectly result in improvement in the other. Conversely, if negatively related, selection for one will indirectly result in damage to the other.

Accurate estimates of genetic correlations require very large volumes of data. In only a relatively few cases have genetical relationships been adequately studied. However, the following summarizes our present knowledge:

1. There is a positive genetic relationship between growth during different periods of an animal's life. Thus, for example, selection for weaning weight will also result in indirect improvement in postweaning gain. The relationship is not so close, however, that selection in one period is adequate for both.

2. There is a positive genetic relationship between growth rate and efficiency of gain. This relationship is far from perfect, and research workers are not in agreement on whether it is strong enough that selection for rate of gain is adequate for improving efficiency of gain through indirect effects. Presently, few breeders or experiment stations are feeding cattle individually in order to select directly for efficiency. It is possible we will do this in the future.

3. One study strongly suggests there is a negative genetic correlation between maternal qualities of cows and inherent ability to grow to weaning. Selection for weaning weight pertains both to growing ability of the calf and the milking ability of the mother. The study referred to above indicated that selection for weaning weight would result in improvement in both characters—but at a slower rate than would have been possible had these factors not been negatively related. Most importantly this means that if calves are selected for growth under systems such as intense creep feeding or on nurse cows, so that the milking ability of the dam is less important to growth, there may be rather intense indirect selection for poor milking ability. One cannot help but speculate on whether the widespread practice of raising herd sire prospects on nurse cows may be responsible, at least in part, for the poor milking ability of far too many beef cows.

4. Genetic correlations between measures of performance such as weaning weight, postweaning daily gains, and efficiency of gain on the one hand and carcass characteristics such as grade, marbling, proportions of fat and lean, yield of various cuts, tenderness and flavor on the other, are so low that for practical purposes it appears they can be considered independent. This is true at least within the ranges of performance and carcass characteristics usually found in the British breeds of cattle. Thus both performance and carcass traits must be considered in selection. Cattle with
superior performance can have superior carcasses but do not necessarily have them. The reverse is also true.

If it is to prosper, the beef cattle industry must (1) produce a product consumers like, and (2) produce it at a price that consumers are ready and willing to pay. Recognition of this and the foregoing facts has led during the past few years to widespread performance testing of beef cattle. Records have been kept privately by breeders, as well as programs organized under the auspices of State Agricultural Extension Services, breed associations and an organization, Performance Registry International.

In 1961 in Extension programs, weaning records were obtained on the calves of 308,000 cows in 4200 herds, and gain records were obtained on 15,000 young bulls on farms and in central test stations. Also carcass data on progenies of herd sires were collected by 191 breeders. Twenty States now have organizations of breeders working with the Extension Services in organizing and guiding these programs.

For several years a number of the newer beef breed associations have had performance testing programs, and in one association an acceptable growth record is a prerequisite to registration. More recently one of the two largest associations developed a comprehensive plan for evaluating pre- and post-weaning gains and conformation or classification scores. During the past year the two largest associations have announced programs which will aid breeders in getting carcass evaluations of samples of herd bulls' progenies.

It is not our purpose here to discuss specific methods of evaluating performance and carcass desirability in beef cattle. I believe it is appropriate to say, however, that initially performance testing programs in most cases recorded specific information on only a few items. With the passage of time, and with the accumulation of knowledge and the development of procedures and facilities, the techniques used are tending to become more inclusive. This is desirable since, as pointed out earlier, it is no more logical to assume that cattle selected solely for rate of gain will automatically have desirable carcasses than to assume that those selected for conformation standards based on empirical ideas will automatically be economical to produce and have desirable carcasses.

The trend in merchandising breeding stock is unmistakably in the direction of showing objective evidence of inherent ability to economically produce quality beef. This evidence includes:

1. Heavy weaning weights in relation to cow weight.
2. Rapid and economical gains from weaning to slaughter.
3. High carcass content of tender, palatable lean meat with a minimum of waste fat.
All these are of obvious economic importance, and cattle failing in any one just won't fill the bill in the future.

That performance testing can be profitable is indicated by the records of several herds basing their selling program in large part on performance records. Within the past year, a Texas Angus herd sold 123 yearling bulls at auction for an average of $935. An Oklahoma Polled Hereford herd sold 21 1/2 bulls for an average of $1781.

**Genetic-Environmental Interactions**

Genetic-environmental interaction is the term applied to situations in which different strains, types or breeds of animals rank differently in productivity in different environments. For example, if we had two breeds of cattle, A and B, and if A was most productive in Iowa but B was most productive in another section of the country, a genetic-environmental interaction would be evident. The same interpretation would be made if in Iowa, A for instance, was better on a high nutritional regime while B was more productive on a roughage regime.

We do not know the extent or importance of genetic-environmental interactions in beef cattle. The question is of potential importance to the industry in view of (1) the currently almost universal practice of using the same breeds and the same bloodlines almost on a nationwide basis, and (2) the general practice of raising and evaluating seed stock herds under more intensive feeding regimes than those in which their commercial descendants will be raised.

One experiment has been run with hogs and several experiments have been conducted with laboratory animals in which selection was practiced for growth rate (and sometimes other characters too) for several generations in closed lines kept on either high or low planes of nutrition. After several generations, representatives of each strain were switched to the other nutritional level and their performance compared with that of animals whose ancestors had been maintained at that plane of nutrition. In some cases there were no appreciable differences in performance related to the plane on which the animal line was developed. In several cases, lines developed on low planes performed as well or better on the high plane as lines developed on the high plane. However, those developed on the high plane had very poor performance on the low plane - markedly poorer than those developed on it.

In all such experiments with which I am familiar, the lines selected on low planes were as good and often markedly better than those selected on the high plane.

We can't say dogmatically what is the case with beef cattle, but it seems that all logic and the results of experiments with other animals strongly suggest that there would be nothing to lose and possibly much to gain by maintaining seed stock herds in the same type of environments and at relatively the same nutritional levels as will be maintained for their commercial descendants.
Under usual commercial conditions this means a beef cow must be able to exist on pasture or range forage and raise a calf to weaning. After weaning, the bulls should usually be evaluated on a fairly high plane of nutrition since in beef cattle we need ability to perform well in the feedlot as well as adaptation to pasture or range.

**Hybrid Vigor in Beef Production**

Technically, hybrid vigor or heterosis is defined as the amount by which performance of a cross exceeds that of the average of the parental types. From a practical standpoint, the performance of a cross of two breeds must exceed that of the better breed if the cross is to be useful.

Evidence from many species of plants and animals indicates that hybrid vigor is likely to be most pronounced if the strains, lines or breeds crossed are as distantly related as possible and if the types entering the cross are themselves inbred. The latter is probably important principally, at least, because performance of inbred strains is likely to have been reduced and crossing results in regaining the lost performance.

In cattle, the simplest type of cross is a breed cross. Since the three British breeds of beef cattle - the Hereford, Shorthorn and Angus - represent the predominant influence on beef production in the United States, it is fitting that we first examine the evidence for the existence of hybrid vigor in crosses among them.

Table 3 gives in summary form the results of four experiments in which data for several important performance characters are available on both parental breeds and their crosses. Also, results are included of one experiment in which data are available on only one parental breed.

More complete material on fertility and calf survival is available from some experiments than for others, but from the table it is apparent that improvement in both items has occurred with the net result being an increase in percent calf crop ranging from 5.1 to 12.0 percent in the experiments where this information is available. It will be recalled that these traits are low in heritability and unlikely to be improved greatly by selection within breeds or herds. They are apparently significantly affected by hybrid vigor. In one experiment, another reproductive character, age of puberty or first estrus, was significantly younger in crossbred heifers.

In four of the five experiments, growth, both before and after weaning, was more rapid in crossbreds by amounts ranging from 2.4 to 7.8 percent. Thus, in spite of its medium to high heritability, growth seems to exhibit heterosis to a degree. It should be noted that this was not true in the Louisiana experiment. Numbers were small in this study and it may be that only sampling errors are involved. It may be, however, that expression of heterosis depends upon parental stocks.
Table 3. Studies with British Breeds - Advantages of Crossbreds over Straightbreds

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Straightbred Matings</th>
<th>No. of Crossbred Matings</th>
<th>% Diagnosed Pregnant</th>
<th>% Calving</th>
<th>Calf Death Loss</th>
<th>% Calves Weaned</th>
<th>Weaning Weight (Both Sexes)</th>
<th>Age of Puberty (Heifers)</th>
<th>Postweaning Gain (Both Sexes)</th>
<th>TDN per 100 lb. Gain</th>
<th>Yearling or Slaughter Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Robinson, Neb. (Unpub.)</td>
<td>430</td>
<td>452</td>
<td>4.8%</td>
<td>2.8%</td>
<td>--</td>
<td>5.6%</td>
<td>4.7%</td>
<td>13.5%</td>
<td>2.4%</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Virginia, Ohio</td>
<td>145</td>
<td>141</td>
<td>--</td>
<td>9.0%</td>
<td>3.6%</td>
<td>12.0%</td>
<td>3.6%</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Miles City, Louisiana</td>
<td>195</td>
<td>196</td>
<td>4.8%</td>
<td>2.8%</td>
<td>3.6%</td>
<td>5.6%</td>
<td>5.1%</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Damon et al (1961)</td>
<td>139</td>
<td>119</td>
<td>--</td>
<td>--</td>
<td>3.6%</td>
<td>--</td>
<td>5.1%</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Virginia, Gerlaugh, Mont. Knapp</td>
<td>54</td>
<td>53</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<tr>
<td>Damon et al (1951)</td>
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<tr>
<td>Damon et al (1949)</td>
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<td></td>
</tr>
<tr>
<td>Louisiana, Neb. (Unpub.)</td>
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<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
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<td></td>
</tr>
</tbody>
</table>

1/ -- indicates data not available or not reported.
2/ Angus, Hereford, Shorthorn in all possible crosses.
3/ Angus, Hereford and reciprocal crosses. In both studies, figures of matings are for cows actually calving.
4/ Straightbreds were Herefords, crosses were Shorthorn x Hereford.
5/ Fertility data on four breeding seasons, weaning data on three calf crops, and postweaning data on two calf crops.
Table 4. Studies with Brahman and Charolais-British Crosses - Advantages of Crossbreds Over British Types in Average Daily Gain, Birth to Weaning, Expressed as Percentages 1/

<table>
<thead>
<tr>
<th>Sires</th>
<th>British</th>
<th>Brahman-British Cross</th>
<th>Brahman</th>
</tr>
</thead>
<tbody>
<tr>
<td>British</td>
<td>0</td>
<td>15.0%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Brahman</td>
<td>10.8%</td>
<td>15.6%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Charolais</td>
<td>8.4%</td>
<td>18.8%</td>
<td>22.2%</td>
</tr>
</tbody>
</table>

1/ Data from several Southern stations. Adapted from Kincaid (1962).

Table 5. Some Growth and Carcass Characteristics of British and Brahman Steers, Their Crosses, and Crosses with Charolais 1/

<table>
<thead>
<tr>
<th></th>
<th>50% British</th>
<th>50% Brahman</th>
<th>50% Brahman</th>
<th>50% Charolais</th>
<th>50% Charolais</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slaughter age (days)</td>
<td>429</td>
<td>422</td>
<td>405</td>
<td>429</td>
<td>405</td>
</tr>
<tr>
<td>Carcass wt. per day age (lbs.)</td>
<td>1.03</td>
<td>1.15</td>
<td>.98</td>
<td>1.15</td>
<td>1.12</td>
</tr>
<tr>
<td>Dressing percent</td>
<td>57.2</td>
<td>60.1</td>
<td>59.1</td>
<td>58.9</td>
<td>60.2</td>
</tr>
<tr>
<td>Carcass grade 2/</td>
<td>11.1</td>
<td>10.2</td>
<td>8.4</td>
<td>9.3</td>
<td>7.7</td>
</tr>
<tr>
<td>9-10-11 rib cut</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% fat</td>
<td>30.6</td>
<td>28.5</td>
<td>20.6</td>
<td>26.2</td>
<td>17.5</td>
</tr>
<tr>
<td>% lean</td>
<td>52.1</td>
<td>53.7</td>
<td>58.3</td>
<td>56.0</td>
<td>60.2</td>
</tr>
<tr>
<td>% bone</td>
<td>17.3</td>
<td>17.8</td>
<td>21.1</td>
<td>17.8</td>
<td>20.3</td>
</tr>
<tr>
<td>Warner-Bratzler shear 3/</td>
<td>13.8</td>
<td>15.6</td>
<td>20.2</td>
<td>13.6</td>
<td>15.5</td>
</tr>
</tbody>
</table>

1/ Data from several Southern stations. Adapted from Kincaid (1962).
2/ On scale in which 13 = Choice; 10 = Good; 7 = Standard.
3/ Pounds of force required to shear a 1 inch core of cooked meat. Smaller figures indicate more tender meat.
Carcass grades have shown little or no evidence of being affected by crossing. Likewise, in the two experiments in which it has been reported, efficiency of feed utilization was not appreciably or consistently improved.

It should be emphasized that results shown in Table 3 were all of crosses between straightbred parents. It may well be that crossbred females will express hybrid vigor in fertility and calf raising ability. Critical results on this point will be forthcoming from the Ft. Robinson, Virginia, and Louisiana experiments during the next five years. In other species, notably swine, and in crosses with Brahmans (to be discussed later), this has been the most important heterotic response. The Miles City, Montana, experiment did include the use of crossbred cows and they proved superior to one parental breed in performance. Unfortunately, cows of the other parental breed were not included in the experiment. Preliminary results on maternal performance favored crossbred cows in the Louisiana experiment.

The American Brahman is of the Zebu type and thus much less closely related in origin to the British breeds than they are with each other. Tables 4 and 5 give in summary form some of the more significant results from Southern experiment stations on Brahman-British crosses. It can be seen that in gains from birth to weaning straight Brahms are only slightly above British types but that crosses made either way result in considerably higher gains, thus demonstrating substantial amounts of hybrid vigor. Crossbred Brahman-British type cows exhibited heterosis in maternal qualities and their use resulted in a further increase in calf gains. Fertility data were not reported in the Southern summary but a Texas report on a herd with rather low average fertility and calf survival showed that Brahman-Hereford crossbred cows were superior both to Brahms and Herefords and raised a net calf crop 24 and 15 percent better, respectively. In an experiment in Georgia Brahman-Hereford crossbred cows showed better reproductive rates than straight Herefords.

Table 5, on slaughter steers, confirms the existence of heterosis in growth, expressed as carcass weight per day of age, but generally shows the crossbreds to be intermediate in all carcass traits studied except dressing percentage. In this characteristic they exceeded the better parental type by a small margin.

Based on a smaller volume of data, results on crosses of the Charolais with British and Brahman cattle are also given in Tables 4 and 5. These data, and results of limited tests to date at the Ohio Station and at Miles City, Montana, show that Charolais crosses grow rapidly and produce carcasses high in lean and low in fat with lean of acceptable tenderness. By present grade standards, their carcasses grade lower than those of British type cattle. Cow herds of this breed are included in the Ohio and Montana tests and in Texas studies. Thus further experimental evaluation of the breed should be possible within the next few years.

This brief review indicates that heterosis exists in beef cattle breed crosses. If further research and experience with crosses of British breeds confirms the net calf crop increase of five percent or more, coupled with three to five percent faster
growth rate and the production of carcasses of equal quality, it is highly probable that commercial cattlemen in the future will follow crossbreeding systems to a much greater degree than presently. Much additional research needs to be done on the productivity of crossbred cows and on the development of rotational or crisscrossing breeding systems which will permit continuous systematic programs.

The most striking indications of hybrid vigor in beef cattle are from work involving crosses between British types and two breeds, the Brahman and Charolais, of very diverse origins. This suggests the need to intensify research on disease control and quarantine procedures permitting the importation of additional breeds and cattle types. Such animals could be tested as potential beef producers in this country, particularly for use in crosses.

Several experiments on inbreeding beef cattle are under way in which the lines will eventually be evaluated in crosses. Presently, 48 lines closed for five years or more and having inbreeding levels of 10 percent or higher are under study at state and federal experiment stations in the United States. These studies are consistent in showing average decreases in productivity as inbreeding levels increase. The most serious reductions are in fertility and viability, traits which we have already seen are low in heritability and which generally show heterotic responses with crossing. In spite of average reductions in fertility it has proven possible to maintain closed inbred lines at reasonably good levels of performance for long periods of time - in two cases over 25 years.

It is certain, however, that inbreeding depresses performance too much to make it advisable to use inbred lines themselves for commercial production. If they prove useful it will be in crosses.

Due to the long-time nature of experiments with inbred lines, few results on crosses are available as yet. Preliminary results from the Colorado Station and the Miles City, Montana, station show promising performance among crosses of selected inbred lines. It is, however, too early to more than hazard a guess as to whether performance of crossline and topcross animals will be superior to that which could be expected from populations in which an equivalent amount of effort had been expended in mass selection programs.

Artificial Insemination and Estrual Cycle Control

From an industry-wide standpoint, there can be no doubt that genetic improvement could be greatly speeded by artificial insemination programs making widespread use of sires proved outstanding by progeny test. The possible rates of improvement shown in Table 2 could be nearly tripled for carcass traits, doubled for weaning weight, and increased by over 50 percent for gain and efficiency of feed use.
I should emphasize that these potential gains would apply only to large populations. In single herds or small segments of a breed, extensive use of one or a few sires could lead to inbreeding and indirectly to reduced performance.

If artificial insemination is practiced on a wide scale, adequate progeny tests should be made to be sure that the sires used are truly superior in their transmission of performance traits and free of factors for deleterious recessive hereditary defects. If an inferior sire is used the possibility of harm is magnified just as is the possibility of progress through the use of outstanding sires.

Artificial insemination with beef cattle is increasing and has been generally successful in herds where four conditions are satisfied:

1. Semen of good quality is available.
2. Workers skilled in detection of heat are available.
3. Skilled insemination technicians and proper physical equipment are available.
4. Pastures are adequate to maintain the cow herd in a fairly restricted area during the breeding season to facilitate heat detection and minimize distance cows must be moved for insemination.

Where one or more of these conditions has not been met, low conception rates have been encountered.

Artificial insemination with beef herds would be greatly simplified if some method could be developed for bringing entire herds into heat at a single, predictable time with normal conception rates when bred.

Much research is currently being done on this and results at several stations during the past year seem to hold real promise. If and when these are completely successful, artificial insemination in commercial beef herds can be expected to increase greatly.

Summary

Direct selection of beef cattle for traits of economic value should be effective and if widely and systematically practiced could potentially improve several traits important in economical production by from 5 to 10 percent over present averages in a ten year period. Concurrent improvement could be made for carcass traits but at a slower rate since most selection for these traits has to be on a sib and progeny test basis.
Trends in the beef cattle industry appear to be in the direction of intensive selection for characters important in economical production of quality beef. This will involve comprehensive performance testing programs in seed stock herds regardless of the breeding programs used in them and regardless of whether animals from seed stock herds are used commercially in grading, crossbreeding or linecrossing programs. In order to develop cattle with maximum production potential in the areas where their commercial progeny will be raised it seems likely that (1) beef cattle seed stock herds will be raised and evaluated under conditions similar to those in which their commercial descendants will be raised, (2) seed stock herds will be larger, (3) more technically trained people will be involved, and (4) increasing use will be made of technical evaluation methods.

Evidence is accumulating that crossing the British breeds results in considerable hybrid vigor, particularly in fertility and calf survival and to a lesser degree in growth. Carcass traits appear to be little affected by crossing. Preliminary results indicate that crossing inbred lines results in considerable hybrid vigor but the economy of the formation and use of inbred lines as compared to use of stocks developed by selection without intensive inbreeding is not yet established. It appears likely that in the future commercial producers will make increasing use of crossing systems in order to take advantage of hybrid vigor.

There is marked evidence of heterosis in fertility, viability and growth in crosses between British and Brahman type cattle. Carcass characteristics tend to be intermediate with the crosses having higher dressing percentages, more but less tender lean, and less fat than straight British types. In limited experiment station tests crosses of the Charolais with British types have achieved faster growth and carcasses having less fat and more lean of about equal tenderness as compared to British types.
References


Kincaid, C. M., Breed Crosses with Beef Cattle in the South. Southern Cooperative Series Bulletin No. 81, 1962. (published by Texas Agricultural Experiment Station, College Station, Texas).


LOOKING AHEAD AT BEEF CATTLE HEALTH

by John B. Herrick

Universally beef constitutes the biggest part of the livestock industry. In the United States 80 per cent of our capital investment in livestock is tied up in the cattle enterprise. However, with this tremendous program there are problems, problems of health and parasites that reduce the efficiency of the enterprise and in some cases present public health hazards.

Parasites and diseases take an annual toll of more than $2,000,000,000 (billion). The magnitude of this figure is underscored by such losses from individual diseases as mastitis, $250,000,000; leptospirosis, $100,000,000; footrot, $2,000,000; brucellosis, $20,000,000; anaplasmosis, $90,000,000; and cattle grub, $100,000,000. Losses from internal parasites alone amount to over $400,000,000 annually. The magnitude of these losses is incomprehensible and to the average producer probably meaningless.

Losses such as represented by the death of two or three calves out of every 10 before weaning; 70-85 per cent calf crops and 40 per cent of all cows with mastitis are more realistic to the livestock producer. Infertility studies show that every repeat service costs a dairyman $1 per day, and it is well known that a barren beef cow will cost from $20 to $50 per year. An 80 per cent calf crop is meaningful to a beef producer, particularly if he knows that an 85 per cent calf crop may be the break-even point.

Despite these figures the United States has made a sizeable contribution toward production of quality meat and milk in the form of sound disease control programs. Fortunately the philosophy of disease control in the United States is eradication of disease instead of mere control. Eradication of tick fever, pleural pneumonia, foot and mouth disease and now brucellosis is evidence of the contribution that the cattle industry of the United States has made towards plentiful meat and milk. Other countries envy this position and many are trying to mimic it. To realize its significance one has only to consider the condition that would have prevailed in the beef industry had we not eradicated foot and mouth disease.

The brucellosis eradication program is ample indication of the value of such programs. A program that is only 10 years old has reduced the annual losses in the United States from $100,000,000 to $20,000,000. With the program continuing we will eventually eradicate the disease. More than 25 states are officially "modified certified," and six states are fully "certified" as being free of brucellosis. This achievement is worthy of note to the meat consumer public. Such achievements are made only by the cooperation of the producers.

Dr. Herrick is professor of veterinary medicine at Iowa State University.
Diseases that are looming as candidates for similar action are anaplasmosis, leptospirosis and vibriosis. Grub control is the chief candidate for similar effort in the parasite field. In the last decade diseases such as infectious bovine rhinotracheitis, virus diarrhea, and mucosal disease have presented problems to breeders and feeders. These diseases fall into the mucosal disease complex classification and loom as threats to the cattle industry. They will bear further research and observation. Concerted effort should be made by the cattle industry to keep constant programming of disease control on a national basis. However, cooperation by each individual producer is necessary for complete implementation of such programs.

Projected Programs

Continuation of the brucellosis eradication program is imperative. The current complacency in tuberculosis eradication indicates a need for further intensive effort and research. Plans for control programs in anaplasmosis are now under way. The National Association of Artificial Breeders has a sire health program in effect, and studies are under way for regulations on all semen-producing units. During the last decade recognition of the part the bull plays in a calf crop has generated a broad program on fertility evaluation of bulls. This phase of cattle production has assisted in establishment of sound economic calf crops. Coupled with this is the program for determination of which animals are pregnant following breeding. These two programs should be employed in every herd for sound cattle production.

Self Help Programs

It is my opinion that more than 85 per cent of the diseases of cattle can be controlled by the integrated applied techniques in breeding, feeding, management and disease control. Our greatest losses in beef production are from everyday neglect. The majority of our losses are hidden from the unobservant eye. The loss in weight, feed utilization and daily gain caused by lice, ticks, grubs, internal parasites and diseases is incomprehensible. Losses caused by breeding problems fall in the same category. As a result, a great share of the inefficiency in beef production comes from mismanagement of the herd. This involves mismanagement of factors that only the cattlemen himself can control. A great share of these losses and problems can be prevented by the application of practices and principles already known.

Livestock Health Programming

It has been estimated that farm losses from disease and parasites average from $1,500 to $2,000 a year. It has also been estimated that there exists sufficient knowledge, technicians and other factors so that 85 per cent of this loss can be prevented. Essentially these losses can be prevented only by the integrated application of breeding, feeding, management and disease control on a programmed basis. Disease control
and fertility management aimed at "rescue of the perishing" is not the correct approach; yet it is used by too many cattle producers.

Disease can be prevented by taking a good overall look at the livestock enterprise. Then the disease incidence and the factors that contribute to these losses should be determined. Veterinary service and counsel are important at this point in mapping out a prearranged program aimed at eliminating the losses from diseases and parasites.

Program for a Cow-Calf Project

It is known that approximately 10 per cent of all heifers and cows may present breeding problems and that 15 to 20 per cent of all bulls may affect fertility levels because of their low fertility. Therefore these factors must be kept in mind when attempting to obtain a 90 per cent calf crop (which should be the minimum) and a sound disease control program.

1. Brucellosis and tuberculosis control are mandatory. Calfhood vaccination of all replacements plus periodic checking for incidence of the disease in a herd is imperative. Periodic tuberculosis testing must be continued.

2. Immunization for blackleg, leptospirosis and other diseases peculiar to a given area should be conducted at a time chosen to give maximum protection to the herd.

3. Internal and external parasite control programs must be continuing affairs.

4. In all herds the fertility of bulls should be evaluated before service. Pregnancy should be checked 60 days after the breeding season. Virgin bulls, artificial insemination or herd bulls that have been thoroughly tested and found free of disease should be used for breeding.

5. Management provisions should assure calf liveability and normal growth. In many cases management factors that lessen the mortality rate in calves must be substituted for "nature's way."

Control of Diseases in Feed Lot

The disease mortality and morbidity of feed-lot cattle is, in a sense, directly related to management programs that prevail on the farms or ranches where the cattle are produced. However, many of the disease problems in feed lots are different from those in the cow-calf production programs.

The following are suggestions for preventing disease loss in the feed lot.
1. To prevent many of the diseases; secure healthy animals and transport them from production sites to feeding sites with minimum stress.

2. Observe cattle upon entering the yard for early recognition and treatment of disease. This is imperative to minimize losses.

3. Immunize cattle against leptospirosis, mucosal disease complex and other diseases only when the cattle are in a good health. Have them immunized instead of merely vaccinated.

4. Control internal and external parasites according to a programmed scheduled procedure.

5. Provide facilities to keep the cattle comfortable. This also includes proper restraint for handling the cattle.

Summary

1. We should continue disease control programs involving effort at the national level aimed at eradication as well as control.

2. Regulations involving movement of cattle between states should be uniform.

3. Disease prevention programs should be integrated with breeding, feeding and management.

4. Reliable veterinary service and counsel are available for all cattle producers in the United States. These resources should be used to reduce the losses from disease and parasites.
Changes have taken place in the processing as well as in the production and consumption of beef. In this chapter two points are emphasized:

1. The changes that have occurred at the packer level are significant.

2. In the general handling of beef, particularly the better grades of beef, the packer has the product for a very short period. His costs represent a small proportion of what the consumer pays for beef. Thus even spectacular cost-reducing efforts have very little effect on what the producer gets for his livestock or what the consumer pays for his beef.

I. Changes Outside the Plant

The United States has about 2,000,000 farms that sell cattle, about 3,000 commercial packing plants which process these cattle, and about 250,000 stores that sell the resultant beef to the 185,000,000 U.S. residents. The time required for processing and merchandising choice table beef averages about 18 months for the producer, and about 1 week (each) for the packer and retailer. The share of the consumer's meat dollar going to each of the components, averages about 58% for the farmer and 14% for the packer, and 28% for the retailer.

<table>
<thead>
<tr>
<th></th>
<th>Farms Selling Cattle</th>
<th>Commercial Cattle Plants</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2,000,000</td>
<td>3,000</td>
<td>250,000</td>
</tr>
<tr>
<td>Time Required to Process and Merchandise</td>
<td>18 Months</td>
<td>1 Week</td>
<td>1 Week</td>
</tr>
<tr>
<td>Cost of Processing &amp; Merchandising Choice Beef, Per Lb. Retail Weight, 1961</td>
<td>46.3¢</td>
<td>10.3¢</td>
<td>22.6¢</td>
</tr>
</tbody>
</table>

---

1/ Mr. Erikson is Economic Advisor, Oscar Mayer & Co., Madison, Wis.
Marketings. Cattle marketings are heaviest in the Central part of the United States. These marketings, as reported by the USDA, include stockers and feeders, and consequently marketings exceed the numbers of slaughter cattle. 3/

There is a tendency for cattle to be slaughtered reasonably close to where they are fed. The Northeastern United States, however, markets only about one-half as many cattle as it slaughters, and we can assume that the difference represents those shipped in. California and the rest of the West Coast also slaughter more cattle than are marketed in those states. Part of their cattle move out of the Pacific states; thus we can assume that the number of shipped-in slaughter cattle is somewhat greater than the difference between the number marketed and the number slaughtered. (See Fig. 1.)

Commercial Slaughter. Commercial slaughter of cattle increased in all regions of the United States between 1948-50 and 1961. But the North Central, N. W. had by far the largest increase, an advance of over 3 million head, or about 40% of the total U. S. increase of 7 1/2 million head. (See Fig. 2.)

Reporting by districts somewhat camouflages the changes going on in the states. For example, New England and New York show declines between these two periods of time, but these declines were more than offset by a doubling of slaughter in New Jersey and a substantial increase in Pennsylvania. The increase is small for the North Central-East due to the fact that Illinois alone showed a decline of 26%.

In 1961 the largest cattle slaughter states in the union were Iowa, California, Nebraska, Texas and Minnesota, in that order. These five states accounted for about 40% of the total commercial slaughter in 1961 and almost certainly a bigger percentage of the total federally inspected slaughter. (Figures on federally inspected slaughter (FIS) are not available by states.)

2/ USDA "Marketing & Transportation Situation," May 1962. Figures for 1961 reported in February 1962 (converted to retail weight) would be 49.2 for the producer, 5.1 for the slaughterers, and 24.9 for the retailer. These figures appear more realistic than those shown in the May 1962 release and included in the table above.

3/ There are no data available showing the current number of cattle, by districts or states, marketed directly for slaughter.

4/ Commercial slaughter includes all slaughter except farm slaughter.
MARKETINGS AND COMMERCIAL SLAUGHTER
OF U.S. CATTLE, 1961
(In thousands)

M = marketings
S = slaughter

Total U.S. cattle marketings ------------------ 34,378
Total U.S. cattle commercially slaughtered ---- 25,610

Regional Areas:
A - Pacific
B - Mountain
C - South Central
D - North Central, S.W.
E - North Central, N. W.
F - North Central, East
G - North Atlantic
H - South Atlantic
INCREASE IN COMMERCIAL CATTLE SLAUGHTER
1948-50 to 1961
(in thousands and in percentages)

Total U.S. slaughter, 1948-50 18,100
Total U.S. slaughter, 1961 25,610
Increase, 1948-50 to 1961 7,510
Percentage increase 41%
The three contiguous states—Iowa, Nebraska and Minnesota—did 27% of the total commercial slaughter, and probably about 33% of the total FIS. (See Fig. 3.)

The three illustrations referred to show total slaughter and changes in the slaughter. What has been taking place with respect to the number of plants, their locations and average size?

**Number of Cattle Plants.** In 1960 there were 2,967 commercial plants which slaughtered cattle. Of these plants, 513 slaughtered only cattle and calves; the rest handled other species of livestock in addition.

About one-sixth of the total cattle plants (486) were federally inspected. The area locations of the commercial and the federally-inspected plants are shown in Fig. 4.

In the period 1955 to 1960, the total number of commercial cattle plants decreased by 144 units, while the federally-inspected plants increased by 66. All districts except the Mountain States, Kansas and Missouri, showed a decrease in the total number of commercial plants. All districts showed an increase in federally-inspected plants. The biggest increase in the number of federally-inspected plants was in the North Central, N.W. and in the South Central. (See Fig. 5.)

**Size of Cattle Plants.** The average size of all commercial cattle plants in 1961 was 8,600 cattle per year or about 165 cattle per week. The large plants tend to be located in the North Central, N.W. where the average size is about 43,000 cattle per year. (See Fig. 6.)

On the average federally-inspected plants are, of course, much larger than the commercial plants, and the largest FIS plants are located in the Cornbelt area. Note, too, that the average size of federally-inspected plants in all areas has decreased in the last five years. (See Fig. 7.)

**Ownership Decentralization.** While cattle slaughter plants have been increasing in numbers and decreasing in average size, there has been also a decline in the proportion of the total beef business handled by major packers. Data on cattle slaughter are not available for individual packers since 1955. However, the following figures show the change from 1947 to 1955:

---

5/ A commercial plant is defined by USDA as any plant which processes annually 300,000 pounds, or more of meat, live weight. In the case of cattle, this would mean a volume of about 300 head per year, and the definition would include almost all plants except some of the small locker plants, small retailer slaughtering, and farm butchering. Commercial plants include federally-inspected plants.
Slaughter of Cattle by Major Packers

1947 and 1955

<table>
<thead>
<tr>
<th></th>
<th>1947 (000) Head</th>
<th>% of Total</th>
<th>1955 (000) Head</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Largest</td>
<td>8,225</td>
<td>39%</td>
<td>7,915</td>
<td>31%</td>
</tr>
<tr>
<td>5 Through 8</td>
<td>956</td>
<td>4%</td>
<td>1,597</td>
<td>6%</td>
</tr>
<tr>
<td>Total of 8</td>
<td>9,181</td>
<td>43%</td>
<td>9,512</td>
<td>37%</td>
</tr>
</tbody>
</table>


Part of this decentralization of ownership is indicated by the loss of slaughter at principal terminal markets.

Changes at terminal markets. While it is not possible to generalize, the importance of some of the terminal markets as cattle slaughtering points declined sharply. Chicago, for example, handled almost 10% of the commercial slaughter of cattle in 1940. By 1960, it had a volume of less than 3% of the total. St. Louis National Stockyards' proportion of the total slaughter in 1960 was only one-fifth of what it was in 1940. The proportion for Cincinnati, Fort Worth and Indianapolis dropped to about one-half of what it was 20 years earlier.

On the other hand, some of the terminals located close to the big cattle feeding areas have increased their relative importance in cattle slaughtering: Omaha, St. Joseph, Sioux City and Denver increased their shares of the total cattle volume between 1940 and 1960. (See figures on the following page.)
Fig. 3  COMMERCIAL CATTLE SLAUGHTER IN KEY STATES

Million Head in 1961 and

Percent Change from 1948-50

<table>
<thead>
<tr>
<th>State</th>
<th>Million Head</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>25.6 million</td>
<td>41%</td>
</tr>
<tr>
<td>Top 10 states</td>
<td>16.2 million</td>
<td>46%</td>
</tr>
</tbody>
</table>

U.S. slaughter, 1961  25.6 million
Top 10 states slaughter, 1961  16.2 million
U.S. change from 1948-50  41%
Top 10 states change from 1948-50  46%
Fig. 4

TOTAL NUMBER OF COMMERCIAL AND FEDERALLY INSPECTED CATTLE PLANTS, 1960

C = commercial
F = federal

Total U.S. commercial cattle plants 2,967
Total federally-inspected cattle plants 486
CHANGE IN NUMBER OF COMMERCIAL AND FEDERALLY-INSPECTED CATTLE PLANTS
1955 to 1960

Total Commercial Plants:
1955 ........ 3,071
1960 ........ 2,967
Decrease ...... 104

Total F.I.S. Plants:
1955 ........ 420
1960 ........ 486
Increase ...... 66

C = commercial
F = federal
SIZE OF COMMERCIAL CATTLE PLANTS

Average Number of Cattle Slaughtered Per Plant, 1961 and Percent Change from 1956

U.S. Average ........... 8,640
% Change ............... -1
Fig. 7

SIZE OF FEDERALLY-INSPECTED CATTLE PLANTS

Average Number of Cattle Slaughtered Per Plant, 1961
and Percent Change from 1956

<table>
<thead>
<tr>
<th>State</th>
<th>Average Number</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Average</td>
<td>41,088</td>
<td>-15%</td>
</tr>
<tr>
<td></td>
<td>29,904</td>
<td>-10%</td>
</tr>
<tr>
<td></td>
<td>43,528</td>
<td>-3%</td>
</tr>
<tr>
<td></td>
<td>97,662</td>
<td>-11%</td>
</tr>
<tr>
<td></td>
<td>66,133</td>
<td>-12%</td>
</tr>
<tr>
<td></td>
<td>33,761</td>
<td>-27%</td>
</tr>
<tr>
<td></td>
<td>32,030</td>
<td>-35%</td>
</tr>
<tr>
<td></td>
<td>17,143</td>
<td>-16%</td>
</tr>
<tr>
<td></td>
<td>23,192</td>
<td>-16%</td>
</tr>
</tbody>
</table>

U.S. Average: 41,088
% Change: -15%
### Cattle Slaughter at Selected Terminal Markets

**Compared with Total Commercial Slaughter, 1940 vs. 1960**

<table>
<thead>
<tr>
<th>Market</th>
<th>Thousand Head</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1960</td>
<td>1940</td>
</tr>
<tr>
<td>Chicago</td>
<td>723.7</td>
<td>1,336.9</td>
</tr>
<tr>
<td>S. St. Paul</td>
<td>790.7</td>
<td>549.8</td>
</tr>
<tr>
<td>St. Louis NSY</td>
<td>186.5</td>
<td>535.2</td>
</tr>
<tr>
<td>Omaha</td>
<td>1,430.7</td>
<td>749.3</td>
</tr>
<tr>
<td>Kansas City</td>
<td>687.5</td>
<td>544.2</td>
</tr>
<tr>
<td>Sioux City</td>
<td>748.7</td>
<td>372.8</td>
</tr>
<tr>
<td>Denver</td>
<td>581.2</td>
<td>175.2</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>306.8</td>
<td>175.0</td>
</tr>
<tr>
<td>St. Joseph</td>
<td>649.8</td>
<td>231.5</td>
</tr>
<tr>
<td>Cleveland</td>
<td>244.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Detroit</td>
<td>243.0</td>
<td>179.4</td>
</tr>
<tr>
<td>Fort Worth</td>
<td>224.3</td>
<td>256.3</td>
</tr>
<tr>
<td>Oklahoma City</td>
<td>226.1</td>
<td>158.8</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>184.7</td>
<td>190.4</td>
</tr>
<tr>
<td>Indianapolis</td>
<td>159.6</td>
<td>174.3</td>
</tr>
<tr>
<td>Memphis</td>
<td>73.2</td>
<td>118.0</td>
</tr>
<tr>
<td>New York</td>
<td>35.0</td>
<td>25.7</td>
</tr>
</tbody>
</table>

The Mix of Cattle. The mix of cattle has also been changing. In 1944 cows and bulls represented about 30% of our bovine supply. By 1961 they had fallen to 17%. Steers and heifers moved from 34% to 63% in the same period. To meet the needs of retailers many slaughterers established direct contact with feeders or set up their own feed yards.

FEDERALLY-INSPECTED SLAUGHTER OF CATTLE & CALVES: 8/

By Kind, % of Total Numbers

<table>
<thead>
<tr>
<th></th>
<th>1944</th>
<th>1961</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>27%</td>
<td>16%</td>
</tr>
<tr>
<td>Bulls</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Calves</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>Steers</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>Heifers</td>
<td>7</td>
<td>18</td>
</tr>
</tbody>
</table>

The number of steers increased by 91% in this 15-year period, and heifers by 188%. Calves, cows and bulls all declined on an absolute basis and declined even more in relative terms. Of particular significance is the fact that the 15% increase of F.I.S. bovine animals represented an increase of 68% in total beef and veal supply, and gives an indication of the tremendous increase in efficiency at the farm level.

FEDERALLY-INSPECTED SLAUGHTER OF CATTLE & CALVES: 8/

By Kind, No. of Head & % Change

<table>
<thead>
<tr>
<th></th>
<th>1944 (000)</th>
<th>1961 (000)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steers</td>
<td>5,860</td>
<td>11,164</td>
<td>+ 91</td>
</tr>
<tr>
<td>Heifers</td>
<td>1,568</td>
<td>4,521</td>
<td>+188</td>
</tr>
<tr>
<td>Calves</td>
<td>7,770</td>
<td>5,005</td>
<td>- 36</td>
</tr>
<tr>
<td>Cows</td>
<td>5,824</td>
<td>4,033</td>
<td>- 31</td>
</tr>
<tr>
<td>Bulls &amp; Stags</td>
<td>708</td>
<td>250</td>
<td>- 65</td>
</tr>
<tr>
<td>Total</td>
<td>21,730</td>
<td>24,973</td>
<td>+ 15</td>
</tr>
</tbody>
</table>

8/ "Annual Livestock and Meats Statistics," Agricultural Marketing Service, USDA
Factors Behind the Changes. Now for a moment, let's consider quickly why some of these changes have occurred.

1. Slaughter has moved out of some of the former major centers because of difficulty of procuring cattle and the relative shift in the transportation costs of moving cattle vs. meat.

2. Labor situations in some of the big centers have also been a factor. Packers have built smaller plants in smaller population centers to utilize high grade labor.

3. The higher incomes of an ever-increasing population have increased the demand for high grade beef. The type of cattle now in demand tend to be found primarily in the large surplus feed-producing regions of the United States and plants have been located close to the supply of fed cattle because of the economics mentioned.

4. Federally-inspected plants have increased relative to the total number of plants. This has happened not because of greater efficiencies or because such plants could perform more work at a lower average cost but because of the economics of locating plants in the surplus beef producing areas. The beef moves from these plants to deficit producing areas, and to cross state lines it must be produced in federally-inspected plants.

Actually, federally-inspected plants probably tend to have somewhat higher operating costs than non-federally inspected plants. There are several reasons:

a. FIS plants have more costly structures and equipment. (Such are required by government standards.)

b. Being larger in size, they are more likely to be unionized, with higher pay scales.

c. Smaller plants, even if unionized, are more likely to have a lower wage scale than large ones. (Comprehensive data on this point, however, are lacking.)

5. The average size of federally-inspected plants has tended to decline in recent years.

a. Some of the other plants, which on the average are smaller than the inspected ones, have acquired inspection.

b. Obsolescence factors and resulting high costs have induced some owners of large beef slaughtering plants to discontinue operations.
or to curtail volume sharply.

c. Many new plants have been built in recent years. But because there appears to be no major economies in very large size and because large plants are vulnerable to a shift in cattle supplies, these new plants have tended to be smaller on the average than many of the plants which have gone out of business.

6. Ownership decentralization has occurred because of several factors:

a. Government grading, which gives a new firm an acceptable and highly recognizable brand, makes for ease of entry.

b. World War II controls tended to bear somewhat more heavily on the large firms and thus provided an opportunity for small and new firms to expand relatively.

c. Because of low margins, there have been no special incentives for large packers to attempt to hold their relative volume positions during the period of rapidly expanding beef production.

II. Changes Within the Plant

Packers have promoted research in the beef area largely to reduce costs rather than to increase product demand. This has probably happened because there have been many opportunities to reduce costs through new layouts, improved machinery, and new plant designs, whereas demand-inducing research is difficult and the results less sure. The rapid rate at which wage costs have advanced in the postwar period has provided a strong incentive to substitute capital for labor. Also to increase the output per employee or per work hour through the establishment of work standards and incentive pay.

And the industry has made progress! This is attested by the fact that from 1947 to 1961 meat output increased by 29% while the number of production workers decreased by about 13%. It is difficult to determine, however, if these percentage changes reflect the improvement in efficiency. A major part of the increase in meat output has been in the production of beef. But beef requires relatively little labor in the meat packing plant. On the other hand, there has been a large increase in the volume of processed products and in consumer packaging, both of which require increased labor inputs.

Data compiled by the Agricultural Marketing Service, USDA, show that between 1947-49 and 1958, the relative increases in efficiencies in various food industries were as follows:
Percentage Increase
In Efficiencies
1947-49 to 1958

<table>
<thead>
<tr>
<th>Industry</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proc. Fruits, Vegetables</td>
<td>141</td>
</tr>
<tr>
<td>Sugar</td>
<td>139</td>
</tr>
<tr>
<td>Manufactured Dairy</td>
<td>131</td>
</tr>
<tr>
<td>Grain Mill</td>
<td>131</td>
</tr>
<tr>
<td>Confectionery</td>
<td>126</td>
</tr>
<tr>
<td>MEAT</td>
<td>124</td>
</tr>
<tr>
<td>Bakery</td>
<td>118</td>
</tr>
<tr>
<td><strong>Avg. All Foods</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

Regardless of how much efficiency has increased in the meat packing industry, the wage cost has undoubtedly advanced more rapidly. The following figures show the percentage change in meat production and total wage costs, 1947 to 1961:

<table>
<thead>
<tr>
<th>Indexes of Commercial Meat Production and Total Production Workers' Wage Costs, 1947 to 1961</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meat Production</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>1947</td>
</tr>
<tr>
<td>1954</td>
</tr>
<tr>
<td>1958</td>
</tr>
<tr>
<td>1961 (Est.)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Just a year ago, the U. S. Department of Labor stated: "Production workers in meat packing plants are among the most highly paid in manufacturing, with weekly earnings in the industry about one-fourth more than the average manufacturing level." 9/

Rail dressing. One attempt to offset the increasing labor cost is the rail system of dressing cattle. This has been one of the most noteworthy technological advances in processing beef in many years. Data released by the Meat Inspection Division of the USDA gave the following information for 1961:

- 19 plants have the hide pulling system
- 2 plants have skinning conveyors
- 40 plants have on-the-rail dressing
- 428 plants have the conventional system

489 total plants

More recently several additional rail dressing systems reportedly have been installed. New plants designed to handle 20 or more cattle per hour would, with few exceptions, provide for rail dressing.

How big are the savings from the rail dressing system compared with the old bed system? Probably not as large as most people would think. The total amount of labor expended in dressing beef is relatively small, running in the range of 50 to 70¢ per live cwt., depending on wage costs. The rail dressing system is designed to reduce the labor force by about 15-20%. Thus, we would not expect the labor cost of dressing to be reduced by more than 10-15¢ per live cwt., and for most plants probably no more than 5-10¢.

In order to make this small reduction in labor costs possible, a company with a conventional bed system must undertake a substantial investment, amounting to perhaps as much as a quarter million dollars, to switch from one system to the other at a slaughter rate of about 40 cattle per hour. For new plants being built, the additional costs of the rail system would naturally be considerably lower. Now, if the net decrease in cost from the rail dressing system is 10-15¢ per live cwt., this would amount to less than three-tenths of a cent a pound at the retail level, certainly not large enough to have any big effect on the demand for beef.

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10/ In this presentation, a short movie film produced by Canada Packers and showing the Can-Pak system of rail dressing was presented. In general, rail dressing provides for conveyors which move the cattle carcasses to work stations. The complete system also provides for hydraulic lifts, worker platforms which can be elevated, hydraulic hide pullers, automatic washers, and moving viscera conveyors. (The film noted above is obtainable through the Allbright-Nell Co., Chicago.)
III. Possible Future Trends

Consideration of the trends which have been developing in the procurement and processing of beef indicates that the industry may move as follows:

1. Because of economies of transportation, slaughtering plants are likely to move still closer to the cattle supply. This means closer to the feed producing areas.

2. Federally-inspected plants are likely to become more important relative to the total number of plants because of the increasing need to move beef across state lines and because of government pressure for better inspection of the food supply.

3. Direct buying of cattle will naturally increase as more plants are established in the areas of cattle feeding.

4. There will probably be an increase in informal integration between the packer and feeder. Slaughterers will depend more and more on the same suppliers for their livestock, and these suppliers will know the specification requirements of the slaughterer and will produce for his needs. Specification requirements will probably cause some increase in packer feed lots and in contract feeding.

But it is doubtful that there will be any major increase in the near future in that type of integration under which feed companies or slaughterers supply capital and management to present cattle feeders. These cattle feeders are not in need of either of these resources from feed or processing companies.

5. Carcass buying of cattle can be expected to increase in importance. This is because yields in live cattle are difficult to estimate and grading can be more effectively done in carcasses than in live animals. Also the general trend of American business is toward more confidence. As large feeders of cattle identify themselves more and more with the one or two or only a few slaughterers they will see the merits in obtaining what their livestock are really worth rather than a buyer's estimate of the finished value based on inspection of the live animal.

6. There is likely to be more fabrication of beef in the packing plants because:
   a. This will reduce the total amount of product shipped and thus have a bearing on cost.
   b. By-products should be better utilized at the packing centers.
   c. The packer will see that his only opportunity to widen his margins
is to produce consumer-identified items.

d. The government--federal or state or both--is going to insist on better inspection of meats. Inspection is much more readily accomplished at 3,000 packing plants than at 250,000 retail stores.

7. Decentralization of ownership is likely to continue. But this trend will be slowed and reversed if packers succeed in developing packer identification which carries through to the consumer.

8. The spread between what the producer receives on the one hand and what the retailer pays on the other will increase. The packer will be performing more functions, and he is not likely to have any big breakthrough in reducing costs of present functions.

Sources of material other than those previously indicated:

1. Data for Figures 1 and 2 from "Livestock and Meat Statistics," USDA.

2. Data for Figure 3 from "Commercial Livestock Slaughter and Meat Production," USDA.

3. Data for Figures 4 and 5 are from "Number of Livestock Slaughter Plants," March 1960, USDA.

4. In calculating the average size of plants, the number of plants in 1955 and 1960 were used in conjunction with slaughter in 1956 and 1961.
PRODUCT DEVELOPMENT IN BEEF

by Elliott S. Clifton

No real world shaking changes have occurred in product development in beef yet some products have been developed and others are in the developmental stage which may have some great implications for the beef industry.

Product development takes place by developing a product for which consumers already have a demand, or by developing products for which a demand can be created. It makes little difference whether there is a physical change in the product or whether the image of the product in the consumer's mind is changed. A product that the consumer thinks is different is just as important and effective as a product which is physically or chemically different. For example, I strongly suspect that the continued increase in the per capita consumption of sausage items is largely due to the ability of the processors to create a demand for the product rather than an inherent taste for sausage items by the consumer.

I want to make this explicit because changes in the attitude of consumers that are currently taking place or may be made to take place will play a very important part in future product developments in beef.

Recently there has been increased effort in research and development in beef products. This has been brought about by the fact that beef is experiencing increased consumer demand relative to other meats. In the past, processors felt that they could best expand their businesses and profits by pushing their brand items. Since beef is sold fresh and cut at the store, there is little possibility for packers to maintain a brand identification through to the consumer. The activities of the government and others have been directed toward keeping beef a commodity. Such things as grade standards, dual grading, price quotations and outlook information tend to give everyone in the market equal information. The effect is to prevent beef from having any great potential as an item in which a brand franchise can be developed.

I am not voicing an opinion about the desirability of improving both the pricing and the operational efficiency of beef marketing. I am merely stating why I think that product development efforts in the past have been centered in areas other than beef.

Nevertheless, as we look at the future and realize that beef is to constitute a larger proportion of the meat business, we are going to expend a lot of additional research time and money to pull beef out of the commodity class. If the large packers are to exist in the beef business, they must do this.

Mr. Clifton is associated with John Morrell & Co., Chicago.
I think anyone familiar with the meat packing industry would agree that the larger firms stay in business only because of advanced technology. This progress must be substantial to offset higher wage rates and fringe benefits, and more governmental regulations, which affect larger processors more adversely than smaller ones. Thus, continued technological progress is required if the larger firm is to have a profitable future.

Now let us turn to what is being done.

**Product Developments**

**Cutting or breaking the carcass.** Our general belief that beef was a commodity and would remain so may have led us to a false sense of security about the product. The specifications we have been using for trading are extremely inaccurate.

With the changes in beef merchandising now taking place there is a sharp increase in the number of cattle broken into wholesale and retail cuts at the packer level. This has prompted study of which carcasses to cut and how to cut them. It has long been recognized that carcasses of equal weights and grades have different values depending upon the conformation of the carcass and the relative value of the cuts. There has not been a general realization, however, of how great those differences are when each carcass is cut so as to give the largest return for that carcass.

Those who have done research in this area know that the differences in the retail value of cuts from carcasses of equal weight and grade may vary as much as 10¢ per pound for the total carcass, or $100 on a 1,000 pound carcass.

With linear programming and the electronic computer, it is now possible to take the price of the cuts and determine the relative values of carcasses. Thus, those can be selected that will give the greatest difference between the value of the cuts and the purchase price of the carcass. Moreover, any carcass which has been purchased can be cut so that the total value of the cuts from that carcass is maximized. All that is required is knowledge of the conformation of the carcass, the relative value of the cuts and the possible ways that the carcass may be cut.

While this operation is being used in a very limited manner at the present, there probably will be some very rapid developments in this area in the future.

I do not think that we will measure the conformation of each carcass and decide on the optimum way to cut that carcass, but I do expect a much different and more severe form of grading to take place. If this practice is developed, there will be a great incentive to cut large quantities of beef at a single location, as the cutting procedure might need to change with each grade, weight and conformation classification. Labor contracts with retail stores may have a retarding effect on this development since it would reduce the need for the butchers at the retail stores. These butchers most likely would object to this change in operations.
We should not end our discussion of this potential development without mentioning that if it occurs it will cause severe changes in our current system of marketing cattle. The present grades, price quotation and market information systems would be quite inadequate. New trading procedures would need to be developed.

**Specification beef.** Changes in merchandising are leading to a closer coordination between beef producers and beef merchandisers. One recent development in this area is the production of "specification beef"—that is, beef for a specific final use and market. While this may not be a specific change in merchandising, it is closely related. The age, weight, grade, conformation and related factors are controlled to fill the needs of a specific merchandising program. Currently the merchandiser is contracting with individual producers to provide specification beef. In some cases the merchandiser actually becomes involved in the production process.

There is little doubt in my own mind that this practice will develop very rapidly in the future. It will be interesting to see whether contracts or vertical integration predominate in the production of specification beef.

**Prepackaged frozen meat.** Many unsuccessful attempts have been made to sell meat in a frozen state. There may be many reasons why this practice has not been successful. Our market research indicates that consumers feel freezing destroys the quality of the meat. Also, there has been a fear by some that meat is frozen to prevent spoilage or to preserve a product already partially spoiled.

In recent years films have been developed that permit products to be vacuum packaged and frozen. This development has led to a large business in prepackaged frozen cuts of beef among the institutional trade. When meat is frozen in the absence of oxygen, it discolors very badly. This discoloration disappears when the meat is thawed and the vacuum is removed. Due to the discoloration not much effort has been made to sell products in this manner.

Apparently consumer demand can be created for the product. The housewife is rapidly becoming adjusted to buying food items in a frozen state, and the stigmas of the past are disappearing. Our research indicates that a consumer education campaign and promotional efforts now would overcome many of the past objections. We probably will see some real attempts to sell frozen meats to consumers. In addition to consumer resistance there is the problem of selling prepackaged meat to retailers who have labor contracts with butchers who want to cut the meat.

**Tenderization.** Most of the early research in tenderizers was based on using an enzyme to digest the connective tissues of the meat. At first the enzyme was primarily used on portion-controlled frozen products. This practice did not work out on a commercial scale because the meat was not handled according to instructions. The product was usually prepared by the packer in a manner which required the housewife to thaw the product for 30 minutes prior to cooking. If she thawed it for too long a period, it was over tenderized; if she cooked it while frozen, it was tough.
Most research programs next tried to fractionate the enzymes into heat sensitive portions which would not digest the connective tissue at low temperatures nor become ineffective at high temperatures. The object was to make each piece equally tender, but this technique has not been perfected.

Swift has perfected and patented a tenderization process to inject the enzyme directly into the animal's bloodstream. Supposedly there are some drawbacks to this process. Certain offal items are destroyed. Also, with continued cooking a piece of meat may become over tenderized. We have not tested this product, so I am not in a position to verify these statements. Whatever the disadvantages, if any, of this method of tenderization, it has permitted Swift to differentiate its product and to carry its brand through to the consumer.

An attempt to upgrade beef has been made by injecting fat to make the product more tender and tasty. As is generally known, this process has been tried in many ways in recent years. Supposedly, the technique has been developed to the commercially feasible stage at Texas Tech.

I have not investigated this method, since the addition of fat to the food of an already obese society has some negative connotations. There has even been some question of whether adding water is compatible with "consumer expectancy." More seriously, our market research indicates that housewives will not knowingly buy the product if they know that fat has been added. This seems to be true even though the total quantity of fat in the tenderized product may be less than that which would be found in a piece of meat of a higher grade and equal tenderness. It is doubtful that this innovation can become useful to large packers who ship interstate. They would have to use a label such as "fat added" or some similar type label.

I am sure that tenderization of beef on an economical basis is just around the corner. There is too much research time, effort and money being expended in this area for the solution to the problem to evade the researchers over a very long period of time. The solution to this problem will probably cause violent changes in production methods and areas. We probably will shift from cattle being fed to the top good or choice grade as at present to producing cattle to the standard or commercial grade. The cattle industry will shift from a high energy diet to a roughage diet. We will probably see a shift from a grain consuming industry to a grass consuming industry. Cattle production will probably be concentrated in the roughage producing territories.

**Asceptic canning.** One possible way to develop new products is through additional processing. Beef is one item that is usually not canned. The reason for this is that beef processed in cans to a sterile product usually has a metallic taste, which is undesirable. Some progress has been made in this direction with a process known as asceptic canning. The meat is sterilized and then canned in a sterile atmosphere so that the final product is sterile. With this process the undesirable taste resulting from cooking the meat in the can to sterilize it is avoided.
To date the process is still too expensive to be used on a commercial scale, but it may become commercially feasible in the future.

**Freeze drying.** A process which has received a lot of publicity in recent years is freeze drying. Under this process moisture is removed from the meat while it is frozen. Since bacteria require moisture to reproduce, the product remains sterile until moisture is added. The process is still relatively expensive and is being used primarily for items which offer relatively large profit margins per unit of weight. However, there is some indication that the process may become commercially feasible on a large scale for such things as beef.

**Irradiation.** Irradiation is one method of extending the shelf life that has been widely studied. Irradiation of the product destroys bacteria and spores and leaves the product sterile. However, recently most meat items developed off-flavors and odors. Recently reports by the armed forces indicate that most of this problem may have been solved. The process is still expensive and it is unlikely that it will become a major marketing innovation in the near future.

**Summary**

In concluding I would like to reiterate these major points.

1. Increased emphasis is being placed on research and development in beef. This is because there has been a continued increase in the demand for beef relative to other meats. Processors seeing this development realize that a larger portion of their business will be in beef in the future and are preparing to attempt to capitalize on it.

2. As beef has become increasingly important it has become obvious that present trading specifications do not describe a homogenous product of relatively equal value. The cutability of different carcasses may vary as much as 10¢ per pound on the carcass even though they are of equal weight and government grade.

3. Technological developments in mathematical techniques and electronic computers make it possible to cut and merchandise beef based upon its value characteristics.

4. Because of this and other developments, there is need for carcasses with the same characteristics. This need is leading to the development of "specification beef."

5. Consumers are slowly losing their aversion to frozen and canned items. With this development we can expect some expansion in the quantity of beef merchandised in this fashion.
6. Swift has made some progress in the tenderization of beef with its "Pro-ten." Beef also has been tenderized by injecting fat into the meat. A lot of time and effort are being spent on tenderization. It is highly probable that someone will solve this problem satisfactorily.

7. Other developments which may become commercially feasible are irradiation, freeze drying and aseptic canning.

Implications

What does this all mean to the future of the industry? Your guess is probably as good as mine. Here is what I think.

1. More and more cattle will be fed to exacting specifications.

2. Cattle carcasses will be closely sorted and cut according to their cutability and prices of the cuts.

3. This will lead away from government grading, or government grading will become much more precise.

4. The quantity of frozen beef being merchandised will increase sharply.

5. This beef will be portion controlled and tenderized.

6. There will be a shift to lower grade cattle using more roughage and less grain.

7. Cattle production and feeding will tend to shift to roughage producing areas and away from grain producing areas, or grain producing areas will shift to the use of more roughage and better use of roughage that is being produced. We probably will get some combination of both trends.
TRENDS AND TECHNIQUES IN RETAILING MEAT

by Lewis Milkovics

General Trends in Retailing. Beef, of course, is the product we are primarily interested in. It is the main sales item in the supermarket. Iowa alone produces 12% of the nation's beef, and Iowa corn has long been associated with finer flavored meat.

On the average, beef accounts for 8% of store sales and 36% of meat department sales. In dollar profits it accounts for a healthy 7% of the gross store profits and 28% of the gross meat profits.

Each year for the past 29 years Progressive Grocer has made a nationwide survey of independent stores. In recent years we have extended our research into the chain and wholesaling fields. The findings and observations that follow are based not only on our studies of 1961 operations but also on the invaluable information and background that comes only from our continuous research over many years.

Chain Store Sales Shift. Chain store sales have been shifting slowly from the big to the medium and small companies, an observation supported by this analysis.

Broadly speaking, the smaller the chain, the bigger the sales gain. This trend has been apparent for several years and is documented by studies of the U. S. Department of Commerce and Progressive Grocer. It dramatizes the great strength of the more localized operator. Such an operator generally enjoys greater flexibility, moves with more speed and often more ingenuity in merchandising and pricing, and possesses many of the same advantages held by the independent supermarket. Major chains are aware of this -- as indicated by their recent moves to grant more operating authority to field supervisors and store managers.

Affect on Independents. On the whole, independents have adjusted remarkably well to this trend toward dominance of food retailing by larger units.

In this discussion independents are defined as operators of 10 or less stores; chains, 11 or more stores. In 1941 independents did an estimated 63% of U. S. sales. During World War II their share went up to 69%. Post-war 1949 saw it revert to the pre-war 63%, and, in the 13 years between 1949 and 1962, the independent share of total sales has declined by 3 percentage points.

Lewis Milkovics is associate editor, Progressive Grocer.
The independents' loss stems from two factors: (1) they did not open enough new supermarkets, and (2) they underestimated the sales potential of their new supermarkets and therefore made them too small.

"New Distributor." In the six years since 1955, sales of all chain and independent food stores have increased 39%. Yet, over the same period, sales of wholesale grocers have gone up 59% -- a growth almost entirely due to wholesale grocers who have allied themselves closely to the retailers they serve. This type of wholesaler is often thought of as the "new distributor."

Although the term "new distributor" has never been specifically defined, there is a common understanding of what it means. In short, it is the wholesaler who has built new efficiency into his business, pioneered in adding new and wanted lines of merchandise, become a bigger and better customer of major suppliers, and reduced merchandise costs to retailers. The "new distributor" offers professional store planning services, acts aggressively in securing sites for new stores and in financing them and handles for the retailer scores of functions that he can perform better than the retailer can himself. He encourages and guides the retailer in many ways -- yet strengthens rather than weakens independence of thought and action at the retail level.

Structure of Wholesaling. As a result of the wholesaler's spectacular growth, the structure of grocery distribution through wholesalers has become very similar to the structure of grocery retailing.

One sees here that the voluntary group wholesalers represent 23% of the total number of wholesalers and do 43% of wholesale sales. Cooperative group wholesalers account for 9% of the firms and do 29% of sales. Together, voluntary and cooperative wholesalers make up 32% of the firms and do 72% of total wholesale grocer sales.

Discount House Supermarket. Of all the developments in food retailing in 1961, not one kicked up as much controversy or uncertainty as the so-called discount house. Called everything from a dire threat to a golden opportunity, viewed with alarm, shrugged off as a fad, a phony or called a revolution in retailing -- the discount house unquestionably made its presence felt in every state of the Union.

How many are there? How many operate supermarkets? What are their sales? Where do they obtain their food stocks? How are they affecting sales and prices in existing supermarkets that compete directly with them?

In short, what does the discount house mean to food distribution -- today and in the future?

Firm, definitive answers to these questions are not possible at this
stage of discount house development. There is still no acceptable definition of a discount house -- and, therefore, no precise measurements can be made. However, some observations can be offered.

There is general agreement that 2500 to 3000 discount houses are now in operation in the U.S. From reports, trade sources and personal investigation by our research staff, it is apparent that 480 of these discount houses include supermarkets.

Considerable publicity is given to the huge discount houses maintaining correspondingly huge supermarkets. But a careful examination of nearly 300 discount supermarkets reveals that such markets are neither larger nor smaller than the average new conventional supermarket. Their sales average about $1,800,000 a year.

Their total annual sales approximate $800 million -- or about 1 1/2% of the total sales of U.S. chain and independent food stores.

Affect on Conventional Supers. How have conventional supermarkets been affected by this new kind of retailer?

Of all conventional supermarkets surveyed, about one-third say they compete directly with new discount supers. Conventional supermarkets competing with discount supers do as well as other conventional supermarkets. This is indicated by the fact that only 26% enjoyed sales increases compared with 71% for all conventional supers. On the whole they do not appear to have suffered sales losses. But they did not realize the solid gains reported generally by conventional supermarkets surveyed. In other words, supers competing with discounters seem to hold their own while those not competing showed substantial gains.

What does the future hold for discount supers? We hesitate to predict. However the enormity of food retailing, the high degree to which it has been developed and perfected and the time that is needed to effect change all suggest that the food retailing industry will absorb this new version of "total retailing" without great difficulty. It probably will find stimulation in doing so.

What of the other extreme -- the drive-in or the bantam market?

In sharp contrast to the super general store are the small drive-ins and convenience-type bantams. The drive-in bantam in a neighborhood or edge-of-town location, with parking, is a scaled-down version of the supermarket and usually is located in crowded areas.

Why this new interest in small stores? First, desirable sites for full supers are less plentiful and operators in areas fully stocked with supers see these small stores as a partial solution to their expansion problems. Others
feel that a scientifically designed small store with a brand-new look, fast-shopping, all product lines but only fastest selling brands has a strong appeal for a great many shoppers.

Our recent nationwide survey showed how these vest-pocket stores were doing. Collectively they reported 3500 in operation -- and almost without exception all doing "very well." Sales in the future are predicted to hit 10% of total food store sales.

Super of Future. Now what about the supermarket? What do retailers themselves say about the stores they expect to be building throughout the 1960's? Will they be bigger, smaller or the same as those built today?

Perhaps the most interesting answer that came from our retailer and wholesaler interviews was in response to this question of size of future supermarkets.

Their answer? "Tomorrow's supermarkets will not be bigger; and in many areas and localities they will be smaller than today's average-size supermarket." When asked for the average size their firms and customers would build those interviewed gave answers ranging between 10,000 and 24,000 square feet overall. It appears that the growth in size of the supermarket has ended, at least for several years to come. Operators will build less hastily, will design and size the supermarket to the trading area more carefully.

Let's turn now to the number of items and the new lines that retailers expect to carry in the 1960's.

Since 1928 the number of different items handled by the typical food store has increased more than six fold. But what about the future?

We believe we can shed some light on this. The Retailing Research Division of Progressive Grocer made a special continuous study of the decisions made by buyers and buying committees in 150 chains and wholesale headquarters throughout the country. When we eliminate all deals and seasonal items we find that the average company is adding 6.8 new items and dropping 4 items each week.

And so in the years between now and 1965, for example, a typical warehouse will have added about 2,500 new items -- and dropped approximately 1,500 items -- for a net gain of 1,000 items.

Which of the major classes of merchandise are expected to show the greatest sales gains in the 1960's?

Considering the store inventory in terms of broad classes of goods,
here are the categories that retailers and wholesalers say will show the highest rate of gain. Frozen foods are in the No.1 spot. Frozen fresh meats, in spite of their many problems in pricing and customer and retailer education, are No. 2, followed by soft goods, groceries, and health and beauty aids.

The subject of distributor headquarters is a vital one for manufacturers in the period ahead.

How many buying offices must be called on at distributor level in order to make products and promotions available to retail stores?

As this review indicates, the number of buying offices increased in the top three categories (voluntaries, cooperatives and chains) and declined sharply among unaffiliated wholesalers between 1950 and 1959. We expect that trend to continue but at a more moderate pace during the 1960's.

**Meat Retailing Trends**

With this broad background let us now turn to the subject of meat retailing trends and the economy under which it operates. Two factors largely affect these trends: changes in consumer demand and changes in technology.

What are the important changes taking place in consumer demand? By 1975, for example, total meat consumption is predicted to run between 50 to 60% greater than the 1955-1960 period. Population increases, no doubt, will be the reason for most of the increased consumption, as per capita meat consumption is expected to rise very little.

Beef, you will be happy to know, will remain the number one meat product. Pork consumption will continue high. Pork will maintain its position, with a decrease in pork prices, relative to beef prices.

The expected increase in total meat consumption means that companies at all levels must expand. In particular -- more meat warehouses, distribution centers and supermarkets will be needed to handle the greater quantities of meat.

Changes in meat technology certainly are not to be overlooked. Refrigeration and transportation methods have greatly improved. For example, we now have piggy-back facilities for truck and rail. Meat packers and processors have adopted new methods and packages designed to keep pace with the increase in self-service meat departments. Then, too, there are many technological improvements in the home, which are more and more influencing the kind, quality and form of products demanded by modern consumers.

Examples of this are more freezers and mail order buying by consumers
of frozen meats, also more frozen meat and food plans being offered by supermarkets.

Technological developments will increase in importance in the next decade and new ones will appear. For example, the market for fresh frozen cuts and packages of meat will certainly get bigger when problems are solved. There are already improved ways of identifying meat quality, both in the live animal and in meat in carcass form.

Processes will be perfected to increase shelf-life of fresh meats with treatment of antibiotics, radiation and freeze-drying. And new packages or processes will be developed that allow the meat cutting and processing now done at the retail level to be satisfactorily transferred to the grocery warehouse and/or the meat packing and processing plant. The USDA is doing considerable work along this line. For example, a recent article in Progressive Grocer points out the economies of a centralized meat prepackaging plant.

What about those factors affecting our meat economy due to other forces?

The major motivating force, of course, is to increase volume, net profits and return on investment. The ensuing competition results in an endless search for different or new products and ideas to increase efficiency. We are, therefore, witnessing spectacular and significant changes in the retail sector of the meat economy. Consider, for example, the chain stores' share of the market, which has continued to increase, but at a decreasing rate. There has been a tremendous growth in the proportion of sales by voluntary and cooperative organizations. The group movement, as you well know, is designed to give independent stores the same advantages and economies that the corporate chains enjoy.

The most significant development shaping up is increased purchases of meat by voluntary and co-operative groups. It is predicted that, by 1975, most meat will be purchased by some kind of group buyer. This means that fewer people will be buying, but buying larger quantities. This trend will give the retail buyer increased bargaining power.

Much thought, too, is being given to moving processing operations out of the store to a central plant and/or having the meat packer perform all processing functions and distribute the product. The speed with which this will be pushed will depend upon the technology now being developed.

One major change has been the decline in the number of branch house operations and an increase in the quantity of meat shipped directly to retail stores and warehouses. In recent years, there has been an increase in the importance of independent meat wholesalers who confine their
activities to a small select market. Their chief customers, however, are hotels, restaurants and other institutional trade outlets.

Perhaps the biggest change to improve efficiency and service noted among the large packers is the closing of obsolete packing plants. In general, there has been a decentralization of the industry taking place in Chicago, which makes that city less important as a meat packing and processing center. Smaller, more specialized plants have been put into operation throughout the country. Most of these plants are located fairly close to livestock suppliers, because of the freight advantage of meat over live animals.

The continued fierce competition in the meat industry will put a premium both on technological and marketing research. On the whole, marketing research will be carried on by outside research firms and individual companies or groups of companies through trade organizations.

**New Techniques in Retailing**

Permit me now to discuss techniques more specifically. Mainly, these are meat warehousing and storage by chains and affiliated groups, specification buying, centralized processing and packaging, the revolution in cattle breeding as it pertains to leaner beef, and retail merchandising ideas employed by the industry today.

On all fronts we see a sharpening interest on the part of chains and affiliated groups in warehouse-operated, distribution-center meat buying and handling programs. About every major chain and affiliated wholesaler is now operating such a warehouse or buying program in order to achieve better control of quality, freshness, trim, boning and inventory. The economy of mass purchasing and processing is the order of the day.

To best understand the modern purchasing, storage and handling of a beef warehouse program, let us examine the policy of a leading voluntary group.

The meat warehousing and specification set up of Super Valu, Minneapolis, was explained to Progressive Grocer by Marty Sandberg, Super Valu meat director, specially for this conference.

Super Valu experts believe that meat warehousing must either be done through a full scale centralized supply depot, with a beef breaking and trimming operation and possibly a beef grinding operation -- or it must be relegated to the position it now occupies in seven Super Valu Divisions. Presently the Super Valu meat warehouse serves merely as a convenient source of supply for retailers not able to make enough tonnage to order direct from Super Valu packer suppliers. It is also a means of distribution for company brand items such as Good Valu sliced bacon and Super Valu sliced luncheon meats. It is also a distribution system for major promotional items where large quantities can be bought at a saving and distributed on company-owned trucks more economically than by the packer.
Furthermore, their beef selectors are buying "Valu Selected" beef and "Thrifty Valu" beef to specification in the packers' coolers. It is the buyers' judgement and his alone as to whether the carcass meets the specifications. These "specs" are fairly broad but do control to a good degree the type, size and quality of beef to be merchandised under company brand. Super Valu also has specifications set up for company brand sliced bacon - "Good Valu." This bacon is being packed by several suppliers strategically located to more economically service each division warehouse. The quality and "specs" of all meats are checked by each division meat merchandiser, and periodically by Sandberg himself to insure conformation.

A meat merchandising program and Service are also offered to member stores. Super Valu offers a complete advertising program developed at the home office. A mat service carries the lead item, art work, descriptive copy, etc. Each division selects a given number of meat items each week and mails bulletins to retailers advising them of the items, the retail price, the cost and profit projection based on product movement anticipated. The bulletin is a two-part form, part of which is returned as an order for the store by a given date. This practice allows buyers to place orders with suppliers in advance to obtain guaranteed supply and price protection.

Super Valu also provides supervisory service through general field representatives. These are all meat-oriented men who attend frequent meat seminars to keep them posted on latest developments in the meat industry, as well as a bi-weekly sales meeting at which the meat merchandising manager presents upcoming promotions and programs. Super Valu also provides market news, cutting test information, merchandising ideas, display ideas, etc. in a weekly bulletin called the "Meat Merchandiser."

A complete store engineering service is also provided to which the meat merchandising department contributes greatly. Sandberg specifies equipment and layout to the home office engineering department, which prepares layouts for all new stores. A comprehensive study has been made of latest trends in this respect and a store engineering meat department specification check list has been provided to all people in the company concerned. Super Valu also provides specialized assistance to a store with meat department problems. Each division has a meat specialist qualified to put a special program into effect to correct situations causing low gross profits, high labor rates or low distribution rates.

Super Valu has two training seminars available to retailers. One is designed primarily to acquaint new retail meat personnel with SVT (Super Valu Trim) cutting methods and merchandising policies. The other is an advanced meat merchandising seminar for the retail meat manager.
In addition to keeping the field representatives appraised of new programs, policies and merchandising methods, each division meat merchandising manager holds group meetings with retail meat men in selected areas as time permits. These meetings are designed to review each phase of their program and to re-acquaint each retail meat man with Super Valu's programs, aims and objectives, and the assistance available to them under the Super Valu meat program.

Centralized meat processing. The following information on centralized meat processing is presented to this meeting through the courtesy of Jim Stimpson of Meat Operations Advisory Service, Chicago.

Here is the thinking of several meat operators regarding central meat distribution centers.

A large chain of more than 30 stores - large supermarkets - is interested in the possibility of entering into a centralized distribution program at warehouse level. This would entail a research program to study automatic packaging equipment, refrigeration facilities, distribution equipment and physical layouts for proper building facilities. A meat executive of this chain envisioned the possibility of breaking down a carcass into retail cuts, packaging the carcass and then loading the meat directly into a pre-cooled, refrigerated truck placed on a ramp leading directly into the delivery room.

A second chain of more than 30 stores is using a packing plan to supply all of its stores. This chain raises its own cattle, slaughters and processes them.

A packing plant has been thinking for some time about the possibility of breaking down its beef into primal cuts. Breaking down into primal cuts would require additional meat cutters as well as more truck drivers and equipment to deliver the meat to the markets.

Supplying primal cuts would necessitate more manpower to load the trucks with so many additional cuts. Plans for the future include the possibility of breaking rounds, tips and loins on hindquarters.

If the practice were successful, the packer would break down carcasses to retail cuts and then try packaging at the warehouse level. It is felt, however, that more research will be required to develop better refrigeration facilities for store and truck, also that research in chemistry is needed to prolong the life of red meats from warehouse to consumer.

Centralized buying, decentralized distribution. The last and most recently contacted food chain uses a totally different approach to the problem. It has little interest in central meat distribution centers, and is now operating quite differently. For example, buyers select beef at the packer level and instruct the packers as to quantities they wish shipped to packers' plants in various locations. From there, meat managers place orders with the
packers and obtain their requirements. Whole carcasses are sent to the stores and all breakdown and cutting are done at the store.

This chain feels that its method eliminates double handling, aging, storing and shipping of meat. For the moment, it is not considering any changes.

Preliminary studies lead many to believe that there should be considerable economies to scale in a centralized operation. Several firms have done some experimenting in this area, but most of them have found the problems insurmountable.

In a centralized fresh meat operation, one of the most important factors to consider is color. Here, sanitation, temperature and time are of the utmost importance. Under ideal conditions, it takes about eight days before discoloration sets in. Under store conditions it only takes two or three days.

Another important problem is transparency. Most films are quite transparent, but if temperature is permitted to vary we get fogging.

The package, both film and backing, will probably have to be stronger because of the extra handling and transportation. This is a factor that would add to the cost of a centralized operation.

Inventory control, shrinkage and rewraps are additional problems that could be improved considerably through personnel training and improved management.

Frozen meats appear to lend themselves to a centralized operation better than fresh meats. However, there are some serious problems here, too. One of the foremost is consumer acceptance. Studies at Michigan State University indicated that consumers are not adverse to frozen meats. They are willing to buy fresh meat and freeze it at home. They are, however, adverse to buying commercially frozen meats, partly because they have had bad experience with it, and partly because of their prejudices.

Another big problem with frozen meats is the package. Most housewives want to see the product, therefore several people have experimented with a transparent package. Some problems encountered with this type of package are discoloring because of light, stacking too high in cases, interior frosting, labeling and pricing.

The recent retailer demand for a uniform carcass of beef that can be fabricated into standardized cuts is not falling on deaf ears. Not only will it please customers, but also it will simplify mechanical wrapping since sizes and shapes would not vary as much as they do now. In other words, meat merchants value the labor-saving aspects of handling meat.
that is consistent in weight as well as tenderness.

In his book, "Beef Production and Distribution," University of Oklahoma Press, De Graff notes that one of the major packing companies has started on a program for improving the beef animal. This packer found it increasingly difficult to satisfy the rigid specifications of retail buyers. The company came to the conclusion that its future success depended on narrowing down all the variations that nature produces in present types of cattle. The job was to find the right strains and breed accordingly.

The company stated its objective in these words: "We hope to develop an animal which will be ready for slaughter at one year of age, weighing 1,000 pounds, yielding 60 per cent plus, producing a carcass of consistent meaty conformation, furnishing a high percentage of trimmed retail cuts and providing desirable characteristics of tenderness, color, marbling and the like." This, in essence, is the so-called meat-type beef.

Perhaps the topic of meat-type beef and the need for it can best be summed up by Bob Braunschweig, meat director of Kroger. He told Progressive Grocer that meat buyers are being forced to look at too many 600-800 pound heifers and 700-800 pound steers to be good for business.

What retailers really need in beef is a carcass that will yield 78% salable cuts which is what retailers were cutting out 10 years ago. With this kind of yield beef could be priced more realistically at retail and its use could be increased.

Beef is the most expensive item retailers process into retail cuts. In many cases, retailers actually sell beef at a loss when overhead is figured. Actually retailers subsidize the beef selling cost by over-pricing other items to balance out gross margin. This is not healthy and cannot continue for long.

What retailers would like to see producers shoot for is young cattle, 16 to 18 months old, that will weigh 900-1100 pounds as steers and 800-900 pounds as heifers, with at least 48% hindquarters, thin rind (maximum of 1/2 inch) over loin and rib, finely dispersed fat marbling of the rib, rib eye of at least 2 square inches per 100 pounds of dressed weight and a kidney and fat weight not to exceed 3% of dressed weight.

The Kroger Company recognizes this is quite an order. But it feels that if the beef business is to grow the industry must breed cattle to stay competitive with other foods.

The big, horsey, two and three year old steers that have been traded several times, hauled all over the country and then warmed up 30 to 90 days will not make consumers want more beef. These cattle may make a fast buck or eat up moldy corn but won't really build business for the future.
With our population growth at home and abroad and nothing in sight to change this, those in the cattle and meat business must build a sound beef program if all people are to be fed.

Of course, nature doesn't work like a factory to produce the cattle required. It will take time. It will also take continued pressure to bring leaner beef about. The forces to insure better beef are already at work and are gaining more and more power.

Chain buyers, whether corporate or voluntary, are making the market for meats what it is. By demanding packer commitments as to quantity of supply and quality of supply they are providing the leverage which will reshape the meat industry and the cattle industry. And this is not being done simply as some kind of an "educational" program. The dictates of the consumer make it necessary.
PRODUCER SPONSORED PROMOTIONAL PROGRAMS

by Peter L. Henderson

In the history of the American economy, promotion has long been used as sales aid in creating demand. Its role in building and maintaining markets for hundreds of products has received wide acclaim—in fact so much that it is frequently overlooked that promotion is only one of many factors which help to establish and expand markets for particular products.

The decision of the consumer to buy a given commodity also involves the interactions of many other factors. These include consumer incomes, price, actions of competitors, quality of the product, availability and quality of substitute commodities, behavior of marketing institutions and that most elusive element—psychological whims of the consumer. When demand creation or expansion is viewed within this framework it is clear that promotion cannot be looked upon as a magic phenomenon capable of solving all problems of market expansion.

The now familiar experience of the Edsel motor car illustrates this point. Even though millions of dollars were spent on promotion, a successful market could not be established. The success of promotion is not spontaneous or automatic. Thus a critical and searching analysis of its possibilities is a necessary prerequisite to activating a program.

In looking at the possibilities for promoting beef, I shall emphasize two aspects of the problem—(1) beef consumption patterns as they relate to promotional possibilities and (2) the promotional relationships between the producer group and the marketing institutions involved in distributing beef. This approach does not provide a complete analysis of the potential for promoting beef. But it considers two of the very important factors which bear on successful promotion.

Characteristics of Beef Consumption

During the past 30 years consumer acceptance of beef has grown at a phenomenal rate. Over this span of time, the per person consumption of beef has almost doubled, increasing from approximately 48 pounds per person in 1930 to 88 pounds in 1961. On the expenditure side, growth in consumer acceptance of beef has been equally impressive. In 1930 consumers spent about 2 percent of their income for beef products. In 1960 this percentage had grown to 2.5 percent. On first appraisal this increase may appear unimpressive. But on close examination this represents a 25 percent increase in the portion of consumer incomes spent for beef.

In addition when Engel's universally accepted law of consumption is recalled, this increase takes on added significance. Engel found that as incomes rise consumers tend to spend a smaller proportion of their incomes for food. This law, although formulated many years ago from analysis of European consumption habits,
has generally held for total food expenditures of U. S. consumers. Yet we see that rather than decreasing the proportion of their income spent for beef, consumers have increased it as their incomes rose.

Studies on the promotion of several commodities have shown that this favorable trend in demand appears conducive to effective promotion. This, of course, should not be taken as an absolute requirement. An upward trend in demand for a product suggests that there are no strong social economic or technical forces in conflict with consumption. Furthermore, it is said that when a favorable trend exists, advertising can be used to strengthen the preferences existing for the commodity and accelerate the rate of consumer acceptance. If we accept these premises, the rising trend in demand for beef would appear to be a plus factor from the promotional viewpoint.

In reviewing consumption data for meats, it also becomes immediately apparent that consumers have much preferred beef to other red meats. The growth in consumption of beef has, by far, exceeded that of each of the other red meats. The implication, of course, is that beef is a product which enjoys a high status position in the minds of consumers. This is viewed by many to be favorable from the promotional viewpoint.

What then, are the particular attributes of beef that differentiate it from other meats in the minds of consumers? Economists frequently have noted the speeded up growth in consumption of beef relative to other red meats. But they have not offered an adequate explanation of why this is so. They point out that there has been a migration of farm people to urban areas, and that people in urban centers tend to eat more beef. But this explanation does not go far enough. It is too general and does not pinpoint with precision the basic attributes of beef that differentiate it from other meats. Such information is important to know if the product is to be most successfully exploited in a promotion program. Perhaps some form of market research could help provide the necessary answers. The fact that consumers do view beef as a distinctive product and not just meat lends support to the view that it has a promotional potential.

Moreover other meats and other food should not be looked upon as the only competitors of beef. Beef is a high resource-using food and occupies a place in the consumer budget comparable to many nonfood items. That is, it may be looked upon to some extent as a luxury item whose sales are sensitive to changes in consumers expendable income. Therefore, in the event of a squeeze on the family budget it would not be surprising if beef were one of the first items to suffer as consumers reduce their spending.

An analysis of sales shows that consumer income is a significant factor in the consumption of beef, and tends to substantiate this observation. Over the past 30 or so years, a 1.0 percent increase in personal disposable income has been associated with about a 0.5 percent increase in the quantity of beef consumed. Since the 1935-40 period, consumer incomes have been rising and beef consumption has
increased correspondingly.

When we look to the future, further increases in consumer incomes appear to be in prospect. Economists estimate that by 1975, consumer incomes will be 20 to 25 percent above 1960 levels. This means more consumer discretion in determining how their incomes will be spent. Consumers do upgrade their diet, both in quantity and in composition, as their incomes increase. But it does not appear logical that the present rate of increase in beef sales in relation to rising incomes can be maintained. The chief reasons for this expected development are the relatively low level of beef consumption in previous years and the increasing competition for the consumer's dollar from other food and nonfood items. Nevertheless the level of consumer income will continue to be a significant factor in the consumption of beef. And since prospects are good that incomes will be rising over the next decade, it appears that promotion might be employed effectively to influence consumers to allocate part of this newly-achieved discretionary spending power to buy beef.

Price is another factor significantly affecting consumers' purchases of beef. Studies have shown that a given change in the price of beef causes a proportionate change in sales. In the language of the economist, this is described as unitary elasticity.

There has been some controversy as to whether the relationship between price and sales of a product is of any significance from the viewpoint of the product's promotional potential. Some argue that where sales of a product change considerably in response to price changes consumers do not purchase fixed quantities, but exercise considerable choice in determining how much of the product is bought. Thus, promotion tends to be more effective in influencing consumers to purchase such products.

On the other hand, where sales remain about the same regardless of price, it is said that consumers evidently exercise no choice in determining the quantity purchased. Therefore, there is likely to be less response to promotional activities.

Others have argued that there is absolutely no relation between promotion effectiveness and the elasticity of demand for a product.

At present we do not have enough research findings to make a definitive statement about the relation between promotional response and the elasticity of demand of agricultural products. However, the findings of our research do tend to substantiate the findings of Professors Borden and Marshall. These researchers state that "a study of products will show that generally, though not always, products possessing an elastic demand are responsive to advertising and selling effort." If we assume this statement is generally correct then the approximate unitary elasticity of demand for beef can be interpreted to be a factor favorable for promotion.
Another attribute which should be considered is quality of beef and its implications for promotion. All available data on the consumption of beef clearly indicate that with rising incomes, consumers have been eating a higher and higher quality of beef including both better grades of carcasses and more desirable cuts. Data from the 1955 USDA household food consumption survey indicate that as income rises, families buy more of the expensive cuts of beef such as steaks and roasts and less of the cheaper cuts such as stewing and boiling beef. Further evidence of emphasis on quality by both consumers and producers is indicated by figures on the U.S. beef supply. The proportion of the beef supply in the top three grades—prime, choice and good—increased from 51 percent in 1947 to 69 percent in 1961.

What is the promotional significance of this great emphasis on quality? It would seem to mean three things. First beef producers must plan their operation to provide the consumer with the quality of beef they desire. Second, different quality levels should be differentiated so that the consumer can identify the quality he is purchasing. Third, quality is one of the internal attributes that can be successfully exploited in the promotional program.

Relation of Producer Groups to Distributive Trade

Our brief analysis so far indicates beef has several attributes which give it a favorable promotional potential. This, however, does not say that any promotional attempt by producers will be successful. Whether or not a specific program will be successful hinges upon many other factors such as a clear-cut definition of the objectives to be attained, the caliber of personnel operating the program, the magnitude of promotional funds available and, most importantly, the behavior or cooperation of the distributive trade.

Our research shows that marketing institutions connected with the distribution of the product play a critical role in the success of producer-sponsored promotional programs. It is not enough to execute a well designed program directed to the consumer. The product must be available and properly displayed at an attractive price at the place where the consumer finally decides whether to buy or not to buy.

We have found also that the success of a commodity promotional campaign is further enhanced if the retailer supports the program in his advertising. This does not mean that distributors and retailers are eager to cooperate with commodity groups in their promotional activities. In fact the distributive trade may wait until after the commodity group's campaign is over before actively merchandising and promoting the product. This seems to be especially true of products with limited sales.

In this respect it is well to review the current promotional activities of marketing institutions for beef and other meats. At retail the magnitude of these promotional expenditures is not known precisely. However, estimates by trade sources indicate media expenditures for all meat products in 1961 were between 130 and 140 million dollars, and expenditures for beef between 75 and 85 million dollars. Based
on a recent survey of retailers' newspaper advertisements, these estimates appear to be conservative. Audits of newspaper advertising space reveal that from 25 to 30 percent of the average retail food store advertisement is devoted to the meat department, that about half of that space or 10 to 15 percent of the advertisement is devoted to beef. When it is considered that most supermarkets advertise once or twice per week, it is obvious that beef is given substantial publicity.

There also is considerable promotion at the packer and processor levels. One reference source places the magnitude of promotional expenditures for all meat at $80 million annually. Although no detailed breakdown is given, it seems safe to assume that a considerable part of the expenditures is allotted to beef.

Producer organizations have also been active in some form of beef promotion. In 1957 estimated promotional expenditures for all meat by producer-supported organizations were approximately $3.4 million. Again it is likely that beef promotion played a prominent part in these expenditures.

These questions seem logically to flow from such expenditures.

(1) What are the goals of the marketing institutions making these expenditures?

(2) How do they compliment, supplement, contrast and compete with each other?

(3) What common interest can producer groups exploit to obtain greater cooperation with their promotional efforts?

This latter consideration is extremely important. Our research has constantly shown that a key requirement for successful promotion by commodity groups is cooperation of the trade.

In looking at the goals of promotion by the various middlemen, I would like to distinguish between two types of promotion--direct action and indirect action. The major objective of direct action promotion is to obtain an immediate response to the promotion. An attempt is made to motivate the consumer to take action immediately. On the other hand, indirect action promotion seeks no immediate response from the consumer. Its objective is to build a reputation and to enhance the consumer's latent desire for the product by building mental associations.

At the retail level most beef promotion is of the direct action type although some firms engage in both. The purpose of the retailer's beef ad is to attract patronage to the store. The primary appeals are price and quality. Where consumers are already acquainted with the product the effect of promotion of this type may be suspected of being primarily of short life.
However, this type of promotion preceded and backed up by the indirect-action type can be quite effective. Also beef advertising by large retailers probably aids in building a favorable image of the product, especially if the promotion is repeated frequently over long periods of time and emphasizes quality characteristics of the product.

For example, in its promotion one large chain emphasizes the juicy and tasty characteristics of its beef without reference to price. One merchant describes his beef as western-fed and still another alludes to the tenderness of his beef. All of these types of advertisements probably aid in building a favorable mental image of beef in the minds of consumers and enhance the desirability of the product. To that extent they benefit beef growers. Even the direct-action types, primarily advertising price, are beneficial in helping to move temporarily heavy supplies into consumption.

Most promotion by packers is done on a brand basis and falls into the indirect action category. Packers' primary interest is to increase sales of their brand and only incidentally to increase sales of all beef. Nevertheless, it is likely that their advertising has an effect on the total demand for beef. Even though the appeal of an advertisement is directed at a brand, it may attract the attention or heighten the interest of consumers who purchase other brands, or are even indifferent to beef.

Producer groups, it would seem, might engage in both types of promotion, depending upon overall objectives and industry supply conditions. Where the market is temporarily burdened with unusually heavy seasonal supplies, the direct-action type of promotion might be employed to induce consumers to immediately purchase the product. On the other hand, where supplies are running at normal levels the indirect action type of promotion might be initiated in which the main objective is to build a more favorable mental image and educate consumers as to how they might benefit from the use of beef. There may be still other occasions in which both types of promotion can be used in combination.

Thus, it is seen that the promotional objectives as well as the types of promotion for beef differ at different levels of the distribution system.

The problem commodity groups face is to find a common interest which they and the various marketing institutions may jointly promote. Logically this common interest is increased profits. Therefore, in planning and soliciting trade support for their promotional program producer groups must consider the profit motives of individual firms throughout the distribution channels. More specifically, they must be prepared to demonstrate how their promotional program will contribute to the profit goals of the firm.

For beef it would appear that such a rationale can be convincingly established. At the retail level we have indicated that the firm attempts to increase
profits by generating increased store patronage and traffic. Because of the prominence of beef in the consumer budget it is an excellent traffic builder. Furthermore, a good part of the retailer's sales dollar is derived from the sale of beef. It generates more sales per customer than any other of the approximately 6,000 items the retailer stocks. One study showed that 8 percent of every dollar spent in food stores is spent for fresh beef. These facts should provide sufficient appeal for the retail trade to cooperate in a producer-sponsored promotional program for beef.

We have also indicated that the primary interest of packers and processors in promotion is to enhance profits by increasing sales of their brand. Producer-sponsored programs contribute to the profit objectives of individual packers by increasing the total size of the market to be shared. Thus, even though the firm's share of the market may remain constant, if the total market expands profits will be increased. And it is on this basis that their cooperation with the producer program can be solicited.

Our abbreviated analysis has pointed to a number of factors which suggest a favorable potential in promoting beef. But this is a far cry from actually executing a successful promotional program. There are a number of additional complex questions we have not discussed and which must be considered.

For example, what size of budget will be required in order to exploit the attributes of beef? While we cannot provide a definitive answer on this question we do know that some organizations' budgets are too modest to register an impact on demand of any practical significance. And we also know that there are other organizations who have sizeable budgets in absolute terms but obviously are trying to cover too many markets.

Equally important, assuming adequate funds can be obtained, what is the optimal level of expenditures? To answer this question, economic information of a most complex nature is required. We must measure the demand and supply curves. We must estimate the promotional elasticity of beef--that is, determine how much beef sales will increase with a given investment in advertising.

Another important set of questions relates to the management of the proposed organization. First, can experienced, well qualified marketing people be obtained to operate the promotional program? And second, assuming such persons can be secured will they be free to make decisions which are in the best interests of promotion or will they be inhibited by internal political strife and interference?

These are important considerations. Cases are known where persons have been chosen to operate such programs on the basis of their stature in production rather than on the basis of their marketing know-how. Also, there have been instances where even though qualified persons were selected to operate the program, optimal promotional decisions could not be made because of internal political conflicts.
Another important factor to be considered is detailed information about the characteristics of consumers of your product. Such information should include frequency and size of purchases according to size of community, income, family composition, education, age of housewife, occupation of wage earners and ethnic background. This information is necessary to identify weakness and strength in the total marketing program. The greatest value of this information is to identify segments of the market that offer the greatest potential for exploitation and to provide a basis for defining specific objectives of promotional programs.

In considering the various factors connected with commodity promotional programs too much emphasis cannot be placed on defining specific objectives of the program. Defining and stating objectives in such general terms as "expand the demand," "expand the market," "promote orderly marketing," "raise prices," etc. express noble sentiments, but are worthless as a guide in executing an effective program. Such statements specify the overall objective or purpose of the group. But to be most useful, objectives should be stated in specific terms indicating where, how or what is to be done in achieving the overall objective, such as the segment of the market to be developed or the sales level to be attained in selected areas. Time goals also should be specified for attaining these objectives.

These are but a few of the factors which have a bearing on the ability successfully to promote beef. Demand creation is a difficult and complex task. There is no magic in promotion. It requires skill, planning and judicious execution. We should take a long, hard look before embarking upon such an undertaking.
SOURCES AND MOVEMENT OF FEEDER CATTLE

by Robert L. Rizek

Cattle feeding is and has been a rapidly expanding business. It is literally growing in all directions at once—in the number of cattle being fed, in size of operations and in geographical location. For example, in the past 30 years the number of fed cattle marketed has nearly quadrupled. Cattle feeding has become intensive in the West, primarily California, Arizona and the Southwest. This has resulted in an increased demand for feeder cattle. However, I am sure this is not a surprising statement to you people that have been buying and feeding cattle during recent years.

In looking at the increased demand for feeder cattle, it is necessary to review what has occurred in the demand for beef, of which a substantial part is for fed beef. As shown in Table 1, beef consumed per person increased from 54.9 pounds in 1940 to a new high of 88.0 pounds in 1961. The primary factors responsible for this phenomenal upsurge in the demand for beef are income, the rural to urban movement and several technological and institutional factors.

With respect to income, the retail value of beef consumed, which is an approximation to expenditures, has increased 97 percent as fast as has disposable personal income (with correction for influence of price level). This is a remarkable rate of growth compared with pork. The retail value of pork has increased only 18 percent as fast as disposable income.

Shifts in distribution of population, rural to urban and east to west, as well as changes in the meat eating habits of farmers have added to demand for meat and especially to the demand for beef. It is estimated that these changes added 1.2 billion pounds or 5 percent to the consumption of all meat from 1920 to 1955. This increase was made up of a gain of 2 billion pounds or 15 percent in beef and a loss of 1 billion pounds or 9 percent in pork plus small increases in veal and lamb.

Technological and institutional factors have also contributed to the increased demand for beef and other meats. These include such factors as the expanded use of refrigeration in homes, increased retailing of meat in supermarkets and use of self-service in meat display, more advertising and promotion, and greater use of federal grading.

Last but far from the least important factor in terms of the increase in the demand for beef has been the increase in population. On the basis of an average beef consumption of 76.2 pounds per person from 1950 to 1960 the increase in total U. S. population during this period resulted in an increased demand for

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1/ Dr. Rizek is regional coordinator, North Central Regional Livestock Marketing Committee, Economic Research Service, USDA.
Table 1. Meat, Beef and Pork Consumption and Ratio to Disposable Personal Income Per Person, 1940-60.

<table>
<thead>
<tr>
<th>Year</th>
<th>Meat consumed per person</th>
<th>Beef consumed per person</th>
<th>Pork consumed per person</th>
<th>Disposable personal income per person</th>
<th>Retail value of beef and pork consumed as percentage of disposable income</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pounds</td>
<td>Pounds</td>
<td>Pounds</td>
<td>Dollars</td>
<td>Beef</td>
</tr>
<tr>
<td>1940</td>
<td>142.4</td>
<td>54.9</td>
<td>73.5</td>
<td>576</td>
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<tr>
<td>1945</td>
<td>145.2</td>
<td>59.4</td>
<td>66.6</td>
<td>1,075</td>
<td>1.3</td>
</tr>
<tr>
<td>1950</td>
<td>144.6</td>
<td>63.4</td>
<td>69.2</td>
<td>1,369</td>
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<tr>
<td>1955</td>
<td>162.8</td>
<td>82.0</td>
<td>66.8</td>
<td>1,660</td>
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<tr>
<td>1960</td>
<td>161.3</td>
<td>85.2</td>
<td>65.3</td>
<td>1,969</td>
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</table>

1 Carcass - equivalent weight.

Compiled from Livestock and Meat Situation, U.S.D.A.

Table 2. Beef Cattle: Number on Feed and Fed Cattle Marketed, 1930-61.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of cattle on feed January 1, 1,000 head</th>
<th>Number of fed cattle marketed during year, 1,000 head</th>
<th>Fed cattle as percentage of all cattle slaughtered</th>
<th>Fed beef as percentage of all beef produced</th>
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<tr>
<td>1930</td>
<td>3,113</td>
<td>3,675</td>
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<tr>
<td>1940</td>
<td>3,633</td>
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<td>1945</td>
<td>4,411</td>
<td>6,936</td>
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<tr>
<td>1950</td>
<td>4,390</td>
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<tr>
<td>1960</td>
<td>7,535</td>
<td>13,200</td>
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<td>1961</td>
<td>8,007</td>
<td>14,050</td>
<td>53.1</td>
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</table>

beef of approximately 128 million pounds per year.

As I indicated earlier, the number of fed cattle marketed nearly quadrupled from 1930 to 1961. In addition, as shown in Table 2, the percentage of fed cattle slaughtered to all cattle slaughtered has increased from 30 percent in 1930 to over 53 percent in 1961. Fed beef now accounts for 60 percent of all beef produced.

The statistics clearly indicate that the cattle feeding industry has been undergoing constant change. The most prominent of these changes has been the loss in dominance experienced by the Corn Belt. It is true that this area is first in rank. Of the 7.9 million cattle reported on feed in 26 states on January 1 of this year, 67 percent were in the North Central states (Table 3). However, in the early 1930's these states accounted for 83 percent of the total.

In the 12 North Central states, the number of cattle on feed January 1 has slightly more than doubled the past 30 years, while in the other 14 states for which data are available the number of cattle on feed has increased by five times. Up to 1957, the Eastern Corn Belt had more than doubled its feeding since the early 30's. The expansion in the Western Corn Belt was slower--around 60 percent. However, since then the Eastern Corn Belt has remained relatively stable, while the Western Corn Belt has increased its feeding by a third. States experiencing this expansion are Kansas, Nebraska, Iowa and the Dakotas.

Over five times as many cattle were on feed in the West January 1, 1962 as 30 years ago. The expansion in some states is almost unbelievable. In Washington, the number is more than 16 times what it was in the early 1930's, California 12 times, Arizona eight times and Colorado almost four times. However, the number on feed January 1 does not tell the complete story of the expansion that has occurred in the West, because the feeding programs in the West are relatively short compared to those in the Corn Belt. Feeding there is faster, more intensive and fed cattle are sold at a slightly lower grade than in the Corn Belt. Consequently, the turnover is greater in the West. For example, animal marketings are about three times the January 1 inventory in California as compared to one and three-fourths times in the Corn Belt.

While cattle feeding in the South is relatively insignificant at the present time, there is some indication that the tempo of feeding in this area will increase. Because of improved transportation and reduced cost of midwestern grains. The Mississippi delta and Tennessee valley areas are fattening more of their home-raised cattle. This trend is also apparent on the Atlantic Coast and in the Appalachian region. As we will see later, this area is significant in the production of feeder cattle. An increase in feeding in this area would bring about repercussions throughout the industry.

It is quite evident that with the increased demand for feeder cattle, the Corn Belt feeder has been and will be faced with more competition in obtaining his feeder
Table 3. Cattle and Calves on feed January 1, 1930 to date

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<td></td>
<td>1,000 head</td>
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R. L. R. 12-62
calves, not only from fellow Corn Belt feeders but also from Western and Southwestern feeders.

Production Trends

Although the adjustments that have occurred in beef cattle production have not been as spectacular as those in the feeding sector, there have been some rather important changes in feeder calf production in the country. Adjustments in crop production and dairy enterprises coupled with the increased demand for feeder cattle have encouraged a general increase in beef cows and have brought beef cow-calf herds to new areas of the country.

If relative and absolute changes in the number of beef cows (cows other than milk cows) are an indication and a prelude to feeder calf production—as I believe they are—then you may be surprised to learn as I was when my recent analysis was completed, that feeder calf production as such is moving eastward and southward.

In the 12-year period, 1949-1960, the number of beef cows, 2 years old and over, increased 65 percent. As shown in Fig. 1, the most rapid growth, except for the Lake states and the Northeast, which are relatively unimportant in total numbers, occurred in the Southeastern states—149 percent in the South Central and 119 percent in the Southeast. During the same period, the Central Corn Belt states, (Iowa, Missouri, Illinois, and Indiana) almost doubled their numbers of beef cows. The expansion in beef cattle came somewhat at the expense of dairy enterprises in these areas, since the number of dairy cattle was decreased by 1.2 million head in the Central Corn Belt and 1 million head in the Southern states during this period.

The increase in the Plains states was slightly less—56 percent in the Northern Plains and 41 percent in Texas and Oklahoma. The Mountain states also increased their number of beef cows during this period, but the rate of growth was much less than any other section of the country—only 26 percent. In general, the Southern Plains and Mountain states are not as well adapted to expansion in numbers as the Southern and Corn Belt states.

This trend in the number of beef cows is important to the supply of feeder cattle. In Fig. 1, the upper, middle and lower left-hand figures represent, respectively, the number of beef cows in 1949 and 1960 and 1966 projections. The right-hand figures represent the percent increase. You will notice that the Plains area, Northern and Southern, is producing the largest number of feeder cattle, approximately 40 percent of the national total. However, one of the most important aspects of this trend in beef cow numbers is that the 12 states in the Southeast currently have more beef cows than the 11 Western states.

In addition, the increase in beef cow numbers in the Southern states does not entirely depict the increase in feeder calf production. Historically, a third to a
Fig. 1 Number of Beef Cows (000) by Regions for 1949, 1960 and 1966 (Projected).

Legend: Figures shown above are totals for regions. In each case top figure is for 1949, middle figure is for 1960 and bottom figure is for 1966 projected.
half of the cattle production in the Southern states went into the production of fat slaughter calves which are marketed in slaughter condition at weaning time. However, in recent years there has been a trend away from this practice and consequently, the supply of feeder cattle has increased relatively more than beef cow numbers.

The Central Corn Belt is certainly no exception to the increase in beef cow numbers and the production of feeder cattle. In fact, many people seem to believe that we are seeking to become more self-sufficient in supplying our feeder cattle needs. The statistics appear to fortify this belief. Although the rate of growth experienced has not been as great as in the South, this area now has over 3.3 million head of beef cows. Missouri, Illinois and Indiana have more than doubled their number of beef cows since 1949, while Iowa increased its beef cows by about 75 percent. Missouri and Iowa currently rank sixth and eighth, respectively, in total number of beef cows two years of age and older.

I am sure that all of us have some general notions about the quality of cattle produced in different areas; however, I am aware of little objective evidence on this subject. One thing we do know is that the bigger feeders, in particular, like to go back to the same rancher year after year—provided the calves are of good quality and fast gainers in the feedlot. Of the total number of feeders shipped into the Corn Belt from 1955 to 1961, direct shipments increased from 40 to 63 percent. States from which the percent increase has been relatively larger than average are Kansas, South Dakota, Colorado and Montana. This would lead one to believe that Corn Belt feeders are well satisfied with the quality of the cattle from these states.

It is often stated that the quality of feeder cattle coming from the South is not suitable to Midwest feeders. However, there is some indication that Southern beef herds have been and are being upgraded. Several livestock marketing economists of the South have indicated that the readily apparent upgrading of the quality of the feeder cattle produced in their states is heartening. But they have readily admitted that there still is considerable "running room" in that department.

Potential Production

The demand for beef and feeder cattle is expected to continue to grow, although probably not at the rate we have experienced in recent years. Consequently, future production potentialities of the different sections of the country are important to cattle feeders. In research being carried on at Iowa State University, beef cow numbers have been projected to 1966 using variables such as demand for feeder calves, demand for beef, feeder calf prices, range conditions, past number of beef cows and number of beef heifers. Research results project an increase in beef cow numbers of 16 percent for the U. S. In regard to specific areas, the projections show, for example, only slight increases in production in the Mountain states—1 percent. For the Plains states, a 9 percent increase in the Northern Plains and a 13 percent increase in the Southern Plains, while for the Corn Belt the results indicate a slight decrease—2 percent. Consistent with the trend of recent years,
the projections indicate the greatest increase in the Southern states--30 percent increase for the South Central area and a 50 percent increase in the Southeast.

At this time we might ask ourselves why there has been this marked increase in the number of beef cows in the Corn Belt and Southern states in past years and the projected future increase in the South. There are a number of reasons, but some of the more important are as follows:

1. The fundamental influence has been the expanded demand for fed beef and, consequently, for feeder cattle. Competition from expanding feeder areas reduced the number of feeder cattle available to the Corn Belt. This led to higher prices for feeder cattle in relation to fat cattle and created a favorable market for local feeder cattle. Native feeders have an additional advantage, since transportation charges are at a minimum and losses from shrinkage and death are minimized.

2. Modern research has shown that many low-quality roughages once regarded as waste feeds (cornstalks and corncobs as examples) can have considerable nutritional value for beef herds.

3. There has also been considerable change in the production of forage in recent years. On some farms there has been increased forage production due to soil erosion problems. At the same time forage yields have been increased through fertilization and new and improved varieties.

4. Cow herds are in some instances quite complementary with other enterprises. They are attractive to part-time farmers and are an enterprise that can be grown into.

5. Another major factor that has assisted in the shift to beef production has been the feed-dairy price relationship of recent years plus the capital and labor requirements needed by dairying.

6. Federal farm programs have also had a significant influence in beef expansion. For example, in the South Central area, most of the expansion in cattle herds has occurred in those areas where their three major stable cash row-crops--cotton, rice, and sugar cane (and particularly the first two)--predominate. Acreages of all three of these crops have been curtailed under governmental programs in recent years. One can only conclude that the farmers in these areas have adjusted to acreage controls by converting their "excess" resources into feeder cattle production. However, it should be added here, that this trend was initiated long before production controls. Cotton receipts--though still the largest source of farm income in these areas (as a percentage of total farm income) have shown a steady downward decline since 1924, while cattle receipts have increased steadily by almost exactly the same percentage--the sum of their percentages have remained
Fig. 2

Direct Shipments of Stockers and Feeders into Selected North Central States 1960, 1,000 head.

* Circled numbers indicate direct intrastate shipments within these states.
amazingly stable over the years. However, with the advent of production controls, this expansion of cow herds was greatly accelerated.

Movement of Feeder Cattle

In studying the movement of feeder cattle, one conclusion is readily apparent: except for data on direct shipments into eight North Central states, the data available are insufficient to draw any firm conclusions. Some states have no data at all on cattle movements, while others try to keep some track of their exports. Only a few states, like California, keep detailed records of cattle movement. The issue is further confused by the fact that movements of stockers and feeders are not separated. Stocker movements vary considerably from year to year as a result of weather and feed conditions. This results in considerable distortion of data on feeder cattle movements, because cattle originating elsewhere as stockers may move as feeders from the Plain states on to the Corn Belt feedlots. However, to the benefit of researchers, the stocker movement is becoming less important.

As might be expected, feeder cattle flow from the areas of original production to feedlot concentration areas—the Corn Belt, Central Plains and the Southwest. This flow of feeder cattle creates a distinct clockwise flow from the Northern Rockies and Plains eastward to the Corn Belt and Central Plains and from the South Central and Southern Plains states westward to Arizona and California feedlots.

In the area of Texas, Oklahoma, New Mexico, Colorado and Kansas there is a resultant whirlpool effect. For instance, Oklahoma exported approximately 460,000 head of feeders in 1961 and fed out 163,000. However, of those fed, nearly 50,000 were imported from surrounding states. A similar situation is found in Colorado, which exports approximately 150,000 head of feeders to the Corn Belt states as well as a large number to Kansas while at the same time it imports large numbers of feeder cattle from New Mexico, Texas and the Southeast. New Mexico exports approximately 650,000 feeders, of which over half go to Texas, Oklahoma, Kansas and Colorado. Only about 10 percent of its exports go to California, while over 550,000 head of feeder cattle from Texas, Mississippi and Louisiana and other Southeastern states pass through New Mexico going to California.

Fig. 2 depicts the direct shipments of feeder cattle into eight North Central states in 1960. Direct shipments of feeder cattle in 1960, 3.7 million head, accounted for 62 percent of the stocker and feeder cattle moving into this area. The largest exporters of feeder cattle to those states were Montana, Texas, Kansas, North Dakota, Wyoming, Missouri, Colorado and Oklahoma; less than 120,000 came from the remaining eight Mountain and Pacific Coast states. Within this eight-state area the main sources of feeder cattle were South Dakota and Nebraska, 497,100 and 372,900 head respectively. The three states receiving the largest direct shipments of feeder cattle were Iowa (1,300,000), Illinois (850,000) and Nebraska (606,000). The origins of these shipments are many. More than 35 states exported feeder cattle to Iowa, the quantity exported varying by states,
from approximately 240,000 to less than 10 head. The main sources of feeder cattle shipped to Iowa were Montana (18 percent), Nebraska (17 percent), South Dakota (12 percent) and Texas (9 percent). For Nebraska, the main sources were Kansas (27 percent) and Wyoming, South Dakota and Texas, each with approximately 13 percent. Texas (16 percent) and Montana (15 percent) were the main exporters to Illinois, while Missouri, Nebraska and Kansas each supplied about 10 percent of the shipments to Illinois. Although the magnitude of shipments from the Southern states is relatively small when compared with the Plains and Mountain states, they are substantial sources for the Eastern Corn Belt--Ohio, Indiana and Illinois. For example, the Southern states supply about 20 percent of the feeders shipped direct to Indiana and about 10 percent of those going into Ohio and Illinois, of which the majority originate in Kentucky, Tennessee and Mississippi.

Western Competition

A great deal has been said about the growth of Western feeding and the increased competition for feeders from the Plains and Mountain states that Corn Belt feeders face as a result of this growth. It is quite evident that the growth in feeding in the Western states cannot be discounted, but the demand of this area for feeders from the Mountain and Plains states is probably overated. With the exception of Nevada and Texas (which exported 42 and 21 percent respectively) none of the Mountain or Plains states exported more than 12 percent of their total shipments to the West Coast states. Several states--Wyoming, Nebraska and New Mexico--even decreased the number of feeders shipped to California from 1940-41 to 1960-61. Colorado, Idaho, Montana, Arizona and Nevada increased their shipments to California but the increase in shipments was less than the increase in beef cows for the same period. However, Oregon ships approximately 80 percent of its exports to California and there is some indication that Utah exports to California are increasing. Except for these two states, the primary sources of feeders for California and Arizona feedlots appear to be Texas and the South Central states. Unless there is a change in the type of feeding operations and a rapid increase in the number of cattle fed in these states, it does not appear that West Coast feeding has or will be a major outlet for feeder cattle from the Mountain and Northern Plains states.

Economic Patterns of Shipments

In research being carried on by Richard Crom here at Iowa State, economic patterns of interregional shipments of feeder cattle have been estimated for 1955 and 1965. Fig. 3 portrays the shipment pattern derived fro 1965 based on projections of transportation rates, level of production, feeding, etc., by regions. The total projected movement of feeder cattle for 1965 was approximately 10.5 billion pounds (live weight equivalent) of which 39 percent was received in the Central Corn Belt. When we compared these projections with the data presently available on feeder cattle shipments, we notice several major changes. With the expansion of the feeder cattle industry in the South, a substantial part of the movement into
Fig. 3

Estimated Least Cost Pattern of Interregional Shipments of Feeder Cattle 1965.
the Corn Belt would originate in the South—27 percent from the Southeast and South Central states and 21 percent from the Southern Plains. Another major change derived by the least cost model was that no cattle would be shipped from the Mountain states to the Central Corn Belt. The majority of the shipments originating in this area went to the Northern Plains and the West Coast.

The patterns of shipments as depicted in Fig. 3 were derived from a mathematical programming procedure wherein the total interregional transportation bill is minimized. These patterns are not exactly forecasts of what will happen. No distinction is made as to the quality of the feeder cattle produced in any region or to the quality demanded by any region. It's hoped that shortly we will be able to include in the programming models restrictions relating to quality. In this way, we could estimate the cost (transportation) of demanding a certain quality of cattle in any one area.

At the present time, a number of studies are under way concerned with the production and movement of feeder cattle as well as the entire livestock marketing area. In conjunction with the North Central Regional Livestock Marketing Project, Iowa State University is currently working in the feeder cattle area. The publications from these studies will be forthcoming shortly. Additional studies are being carried on in the Southern and Western regions as well. It is hoped that studies such as these will help to provide some of the insights that are necessary to make rational decisions in an industry that is changing and expanding as rapidly as the present cattle feeding industry.
STATUS OF TRANSPORTATION RESEARCH FOR THE LIVESTOCK AND LIVESTOCK PRODUCTS INDUSTRY

by David E. Moser

There are few major areas of economic and industrial management inquiry in which we are more limited in solid research results than in the field of transportation. In amount of effort, and to some extent in direction of inquiry and quality of results, our transportation research leaves much to be desired. This is perhaps partly explained by the administered price characteristics of the common carrier segment of the industry. In this segment pricing has been only loosely related to costs, and both management and government agencies have been much preoccupied with regulatory considerations.

This is an industry in which typically the allocation of resources to research activities of all types has been dangerously low. U. S. Department of Commerce estimates suggest that transportation research expenditures by all agencies, both private and public, in 1960 represented only seven tenths of 1 percent of net sales. This includes efforts devoted to technological, marketing and economic problems—the entire range of research and development activity.

According to the same source, 1960 research expenditures for industry generally represented 4.2% of net sales, or six times the percentage allocation in transportation. The real growth industries were spending as much as 7 to 10 percent of net sales on research and development, or 10 to 14 times the percentage devoted in transportation.

Against this background, it is not surprising that physical distribution has been described as "the last great frontier of industrial waste and inefficiency." Nor is this a matter of small consequence. Estimates of the U. S. Department of Agriculture place the nation's annual transportation bill for agricultural products alone at more than 4 billion dollars.

A recent study reported by Distribution Age indicates that for the entire food and food products industry, transportation costs are equal to 17.5% of total net sales. If we include, as we should, all physical distribution costs (including warehousing, materials handling, shipping room and loss and damage expense, but not including sales and merchandising costs), the percentage jumps to 34.4%.

This is a segment of costs which we can no longer afford to pass over lightly, a segment in which, according to one specialist, no more than 15% of the possible economies are now being realized.

Here are some of the reasons why all of us who are concerned with decision-making in agricultural industry need to take a close look at this rapidly changing

1/ Mr. Moser is Associate Professor of Agricultural Economics and Extension Specialist in Marketing and Transportation at the University of Missouri.
function of physical distribution:

1. There are encouraging signs of the possible introduction of new transportation pricing methods more closely related to costs. Increased use of proprietary trucking fleets has provided a yardstick for judging cost-price relationships not previously available to shippers. The President's recent transportation message favored legislation to extend to all modes of transportation the present agricultural and bulk commodity exemptions from rate regulation. This would have the effect of making transportation rates more sensitive to supply and demand factors. Increasingly economists have criticized time-honored value-of-service and fully-allocated-cost principles of rate making as inappropriate to transportation pricing needs. The possibilities for greater flexibility in transportation pricing make it especially important for us to concern ourselves with the determination of true costs and their relationship to pricing in a freer transportation market.

2. There are more choices open to the shipper among competing modes of transportation and systems of physical distribution than ever before. Not only are services more varied, but there are multiple combinations of cost service relationships which may not be apparent or seem significant to the shipper accustomed to simpler rate relationships. To make intelligent choices among services of varying efficiency and value in terms of his need the shipper needs to be better informed and more discriminating than ever before.

3. Technological innovations and the development of more integrated and closely coordinated physical distribution systems have increased the cost spread between operators of high and average efficiency, and this trend seems to be continuing. This development has increased the incentive toward improvement in transportation and ancillary services; at the same time it has increased the threat from competitors who might undertake similar improvements.

At the University of Missouri, we are currently engaged in a two and one-half year study, under contract with the U. S. Department of Agriculture. This study deals with the educational needs of agricultural transportation and the possible role of Extension programs in meeting these needs. In this connection we recently undertook a survey of the research completed and currently under way in agricultural transportation.

To date, the preponderance of such research has been conducted by the Transportation and Facilities Division and the Market Quality Division of the Agricultural Marketing Service, USDA, and has dealt with physical and biological aspects of transportation and handling.

Some economic research dealing with transportation has been undertaken in the Marketing Economics Division of the Economics Research Service and in the Management Services Division of the Farmer Cooperative Service, USDA State experiment stations have undertaken some work, dealing primarily with problems of more limited
Significant regional livestock transportation studies are currently under way in the Southern, Western, and North Central regions. These research projects represent integrated and coordinated state contributions to regional undertakings. Seven states are participating in an analysis of livestock and meat movement in the Southern region. This analysis involves a study of meat and livestock movements and takes into consideration the volume, direction, seasonal variations and inefficiencies in such movements, as well as the role of transportation costs and their implications for the location of production and processing facilities.

In the West, eight states are participating in a regional project titled, "Economics of Transportation of Livestock and Meats in the Western Region." This study is concerned with an examination of the structure of rail and truck rates which prevail in the movement of livestock and meats, the equity of rates on inter- and intra-state movements, the costs and efficiency of shipping livestock and meats by truck and rail, and the effect of transportation costs on location of production areas and processing centers. The North Central region is undertaking a similar study under the title "Adjustments in Livestock Marketing in the North Central States to Changing Patterns of Production and Consumption." An effort will be made toward combining forthcoming results of the research in the South and West with the North Central region research, with some Northeastern states cooperating.

These regional research efforts certainly represent a stride forward in investigating the economic impact of transportation upon the structure of the livestock and livestock products industry. The results of these studies are being awaited with a great deal of interest.

Most of the economic research by the transportation industry or by the various segments of the livestock and livestock products industry appears to be related to particular problems of individual companies. For the most part, the results are confidential and do not become a part of the general body of research findings. The agricultural community has relied mainly on USDA economic research, and secondarily on that of the state experiment stations and their regional committees for information and recommendations concerning transportation.

While progress is being made in applying research to the problem areas in agricultural transportation, a review of past work indicates that we need to exercise especial care to avoid the following deficiencies and weaknesses in future research activities:

1. The segmented character of the research often limits its application and usefulness. Traffic flow patterns and economic interrelationships of origin and destination points do not recognize the artificial geographic boundaries often set up for data collection and analysis in studies conducted by state, and even by regional agencies. Such studies may also be complicated by...
divided responsibility for research design and execution. This may result in conflicting or divergent objectives and methods, thus weakening the results achieved.

Certainly, some research objectives may be satisfactorily achieved in state and regional studies. But projected studies should be carefully scrutinized to determine whether they can properly be fitted within the artificial geographic limits imposed by state and regional boundaries.

Conversely, the temptation is great to impute broader applicability to results achieved from a limited sample. In a recent review of certain transportation studies conducted in the New England and Middle Atlantic states, we noted that the researchers apparently assumed equal applicability of their findings in the Midwest and Far Western sections of the country, where operating conditions and problems are in some respects significantly different.

2. Research results are sometimes questionable because they are based upon unrealistic and inappropriate assumptions. Researchers may err because of lack of first-hand knowledge of the transportation industry and inadequate homework. For example, I have noted researchers have assumed freight rates are directly related to the distances commodities are hauled in instances where such a relationship did not, in fact, exist.

An elaborate study may be built around published rail rates (presumably because they are easy to obtain and remain relatively constant) while the researcher ignores the fact that, in the area studied, the product in question generally may not move by rail but by exempt truckers, at rates which have a considerable seasonal range of fluctuation, depending upon equipment supply and demand.

Researchers sometimes err in assuming that decision-makers are motivated solely by economic considerations and on the basis of full and accurate information. I am reminded of one study of two terminal markets with overlapping territories. A review of comparative trucking rates and ancillary charges drew the researcher to the conclusion that a shipper in that territory would incur significantly lower costs by shipping to the smaller and nearer market. Share-of-market projections were made based upon the assumption that price being equal the shipper would serve his own economic interest by selecting the lower-cost destination. But the projections did not prove out; independent investigation revealed that while the shipper paid the transportation bill, it was, in fact, the truckers' preference that often proved the deciding factor as to where the load would be delivered. The truckers in this area almost uniformly preferred the larger market because of better access roads, more expeditious handling and greater possibilities for back-haul.

There can be little doubt that in real-life situations intangible, non-cost factors often have a determining influence upon shippers' choices among competing
services and markets. But such influences are sometimes discounted or ignored, either through ignorance of their importance, or perhaps because they are difficult to translate into figures that can be fed into the computers.

3. Essential data often are not available to researchers or are supplied in a haphazard manner.

Great reliance is placed upon electronic data processing in current research practices. Truly these computers are marvelous machines, making possible research feats which would have been out of the question only a few years ago. But our computers can only make use of what is fed to them, and they are not very discriminating in sorting the good data from the bad. The training people for one of our leading computer manufacturers have a coined word that aptly points up the problem. The word is GIGO, which stands for Garbage In -- Garbage Out.

You people in industry have available to you in the land-grant universities and colleges a research resource of great value and potential. But to make the most effective use of this resource you must concern yourselves with the research which is to be undertaken and cooperate in obtaining adequate and accurate data. Without such data acceptable and useful research results are hardly to be expected.

4. Strict commodity orientation of transportation studies may sometimes be a limiting factor in achieving acceptable results. For example, exempt agricultural and bulk commodities are widely used in the trucking industry as back-haul to help defray the cost of moving equipment back into position for head-haul loads. Under these conditions, the interplay of seasonal supply and demand for the various commodities which might be used for this purpose have an important effect upon the availability and utilization of equipment at a given location and point of time. Consequently such interplay has an effect upon the freight rates which may be secured by shippers of the various exempt commodities involved. Under such conditions, a study devoted to shipping costs for a single isolated product, without reference to the interplay of other commodities and shippers competing for available equipment, can bring about research results which are partial and misleading.

5. The tendency to look at transportation costs "in a vacuum," without reference to the other related costs of physical distribution, can be misleading.

Changes in transportation methods and services may have important effects upon inventory levels, and upon warehousing, packaging and handling costs. In a recent case the introduction of new specialized transportation equipment and services resulted in a 7 percent increase in transportation costs but greatly reduced packing and handling costs at origin and destination. The net over-all physical distribution saving to the shipper was 12 percent.
We researchers recognize that physical distribution is a single integrated and coordinated whole; that the activities of transportation, warehouse operations, inventory control, order processing, customer service, material handling and special packing are interrelated and must be considered in terms of the interaction of one function with another. This explains why we sometimes request information which does not seem closely related to the immediate problem under review.

6. Greater efforts should be made toward application and utilization of research results.

Despite any impression to the contrary which I might have given earlier, a considerable amount of useful research has been done in the field of agricultural transportation, and more is in the mill. During my years of service in the transportation industry, I had occasion to note over and over again our failures to make intelligent application of research results which were available for the asking from USDA and land-grant college sources, covering a wide range of traffic and transportation problems. My primary reason for returning to college extension work was to do what I could to help correct the deficiencies in communication which have given rise to this unhappy condition. The pilot study of extension educational needs and opportunities in the field of agricultural transportation now under way at the University of Missouri is an approach toward improving communications between the agricultural transportation sector and the researchers. We hope this will ultimately bear fruit in directing research resources more unerringly to the critical and continuing problems of transportation and in bringing about a fuller utilization of these research results. This is an objective to which we all need to apply ourselves with energy.

We have a multitude of problems involving physical distribution in the livestock and livestock products industries and a variety of research resources which may be applied to these problems, but as a team we are not too well coordinated in applying these tools to get the answers we need. Both researchers and the industry share responsibility for this condition, and I am sure there is a disposition in both groups to move toward correcting it. Here are some suggestions of how industry representatives can be especially helpful in bringing about a more effective team relationship:

1. Keep state experiment station researchers, regional committees, and USDA personnel informed as to problems on which the industry could use research help.

2. Work cooperatively with researchers in shaping the research design of studies undertaken to assure practicality in terms of data to be collected, methodology and usability of results.

I understand that North Central packers and researchers have recently moved in the direction of setting up machinery for closer coordination. At a terminal livestock market forum recently on the University of Missouri campus attended by terminal market, extension and research personnel from 22 states, consider-
able attention was given to ways of getting better communication between the markets and the colleges in the interest of more needed research and extension programs. These are certainly steps in the right direction, and it is to be hoped that we will see more of this kind of cooperative effort.

3. Assist in obtaining funds from both public and industry sources for more effective basic research.

4. Take care to assure accuracy and adequacy of data provided by industry to meet requirements of jointly-approved research objectives.

5. Work with land-grant college and USDA research and extension groups to achieve the fullest possible utilization of research results.

It would be helpful to have a similar list of suggestions from industry, spelling out what researchers could do to improve the climate for cooperative effort between the two groups.

A highly competent transportation researcher recently said to me, "Business men think we are hard to talk to. But they have much to gain from really competent research, and we must learn to communicate if we are to turn out an acceptable and useful research product. It will take repeated contact to break down the communications barriers between us and to develop the kind of team relationship that is needed."

Here is an undertaking to which we should all apply ourselves in the interest of providing the physical distribution research findings so sorely needed as an undergirding for sound management decisions in the livestock industry.
CYCLICAL AND SEASONAL SUPPLY AND PRICE PATTERNS FOR BEEF

By Wilbur R. Maki

Since 1947 our beef economy has experienced two complete cattle cycles and a series of seasonal price fluctuations. The first cattle cycle reached its post-war peak in 1951. At that time the feeder calf price at Kansas City was over 41 cents and the slaughter steer price at Chicago was over 37 cents. By October 1953, the Kansas City price had dropped to its lowest post-war level. However, the Chicago price did not reach its lowest post-war level until 1956, when it dropped below 19 cents. Then, as the cattle cycle continued its downward course, cattle prices climbed, with characteristic seasonal variations, until 1959. Thus within a period of five years cattle prices dropped more than 50 percent, and over the next three years they recovered to about 80 percent of their former peak levels.

Nature of the Problem

What supply and price repercussions are generated by the cyclical and seasonal fluctuations in the cattle market? As a result of the year-to-year and month-to-month variations, livestock producers suffer substantial losses that are not, in individual cases, offset by later market advances. From the cattle feeder's standpoint, a more rapidly rising feeder market or a more rapidly failing slaughter market results in a narrowing feeding margin that eventually reduces the demand for feeders. However, when the falling feeding margin is unexpected, the feeder incurs losses that, again, are not necessarily recovered in the typical market advances that follow the low point in the cattle cycle. From the rancher's standpoint, a rapidly declining feeder market is always a bad omen.

Excessive market fluctuations also disturb the long-run prosperity of the entire cattle industry. When beef is in short supply, the consumer generally finds some other meat items to replace temporarily the beef that he would consume but that is not available. However, as the beef output cycle climbs upward the price of beef moves downward more rapidly than the increase in consumption. Thus producers' total returns actually fall. Yet, as far as consumers and retailers are concerned, it makes no difference whether or not beef supplies are small or large, falling or rising, for the simple reason that plenty of other goods are available to buy and sell. And certainly a little less competition from beef would mean higher incomes for swine and broiler producers.

When lamenting over the problems generated by excessive fluctuations in the cattle market, it must not be forgotten that in our particular economic system we still look to our agricultural markets as the means of equating supply with demand.

1/ Dr. Maki is professor of economics, Iowa State University.
For the most part, what is produced will be bought at a price that is determined essentially by the interplay of market forces. If the pricing system is to fulfill its highest purpose in directing agricultural resources to their best and most profitable use, then the imperfections that arise because of unexpected cyclical and seasonal market fluctuations must be remedied. In this presentation, the remedies that I refer to are those forthcoming from the more intelligent use of market information.

In my discussion of beef market fluctuations I would like to do two things. First, I would like to examine with you the functioning of the pricing system as it occurs in the cattle industry. Second, I would like to test our knowledge of this system against its actual performance over the past four or five years insofar as it will help us to detect danger signals in the cattle cycle.

Logic of Cattle Market Fluctuations

Seasonal variability. As we study the cattle industry we discover that cyclical market variability is four to five times as large as seasonal or month-to-month variability. Moreover, the seasonal price variability is the consequence of two forces:

1. Consumers maintain or even step up their demand for beef during the summer and fall months.

2. Producers also step up their demand for replacements during the last six months of the year with a resulting substantial increase in feeder market activity.

Since World War II, consumer demand for the three-month period July–September has exceeded the average annual demand level for beef by an amount equivalent to one-half pound per capita. In other words, an additional 150,000 head of cattle could be slaughtered during this period, given all other factors, without any change in wholesale or retail price. This seasonal increase in demand has been attributed to the popularity of hamburgers and hot dogs during the summer months and, more recently, to the growing popularity of steaks and roasts for outdoor cookery.

The seasonality problem in cattle and beef prices is illustrated in Table 1. Though the range in average monthly prices is as much as 8.2 percentage points (Chicago slaughter price, February to September), the use of an average monthly index obscures its year-to-year variability. For example, during the first and last years of the 1950's the Chicago slaughter steer market reached its peak prices during March, April and May and its low prices during the latter part of the calendar year. The Kansas City feeder calf market behaved similarly. From January, 1955, to February, 1956, however, slaughter cattle prices dropped steadily and then shifted direction to a September peak. Thus, excess marketings in early 1956 were followed by relatively few marketings later that year, contrary to the historical pattern. During the 1955 to 1957 period, therefore, both the slaughter and feeder market behaved erratically.
Table 1. Indexes of monthly prices of beef and cattle, 1947-1961.

<table>
<thead>
<tr>
<th>Month</th>
<th>U. S. Choice grade, 700 pound beef carcass, New York</th>
<th>U. S. Choice grade slaughter steer, Chicago</th>
<th>U. S. Good and Choice feeder calves, Kansas City</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>99.6</td>
<td>98.5</td>
<td>98.8</td>
</tr>
<tr>
<td>February</td>
<td>97.3</td>
<td>95.5</td>
<td>100.5</td>
</tr>
<tr>
<td>March</td>
<td>98.0</td>
<td>97.4</td>
<td>103.4</td>
</tr>
<tr>
<td>April</td>
<td>99.2</td>
<td>98.4</td>
<td>103.7</td>
</tr>
<tr>
<td>May</td>
<td>99.3</td>
<td>98.8</td>
<td>104.0</td>
</tr>
<tr>
<td>June</td>
<td>98.9</td>
<td>99.2</td>
<td>100.1</td>
</tr>
<tr>
<td>July</td>
<td>99.6</td>
<td>101.3</td>
<td>98.1</td>
</tr>
<tr>
<td>August</td>
<td>101.2</td>
<td>102.4</td>
<td>99.2</td>
</tr>
<tr>
<td>September</td>
<td>103.7</td>
<td>103.7</td>
<td>98.6</td>
</tr>
<tr>
<td>October</td>
<td>101.9</td>
<td>102.8</td>
<td>97.2</td>
</tr>
<tr>
<td>November</td>
<td>101.1</td>
<td>101.6</td>
<td>98.9</td>
</tr>
<tr>
<td>December</td>
<td>100.3</td>
<td>100.4</td>
<td>97.5</td>
</tr>
<tr>
<td>Annual average</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The seasonal pattern of prices in Table 1 is changing gradually to one with less month-to-month variability. Larger-than-average third-quarter marketings are more than enough to balance the above average third-quarter consumer demand. Cattle feeders are changing their operations in accord with the seasonal patterns in consumer demand and in feeder cattle supplies.

**Cyclical variability.** Year-to-year variability in cattle supplies and prices is not as large now as it was five to ten years ago. It is, however, the source of much uncertainty in the cattle industry, particularly when the producer response to price changes must occur over a period of three to four years. In fact, because of this delayed production response, the danger signals in the cattle cycle are revealed several years in advance of an exceptionally low market.

Several factors are frequently cited as determinants of the cattle cycle, namely, the biological make-up of beef herds, the management practices of ranchers and feedlot operators and the method of making future market estimates. It is, however, the producer response to price fluctuations in terms of changing the number of cattle on hand, particularly breeding stock, that actually generates the cattle cycle. For example, an increase in feeder prices leads to increases in beef cattle numbers, not only in heifers and steers, but also -- a year and one-half later on the average -- in calves, as illustrated in Fig. 1. The change in steer inventories leads to an increase in commercial slaughter during the following 12-month period, while the change in heifer inventories contributes to a corresponding increase in beef cow numbers a year later. The change in commercial slaughter immediately results in a drop in slaughter steer prices. Feeder prices are directly associated with slaughter prices. Thus falling steer prices are followed by a lower feeder market.

Meanwhile, the increase in beef cow inventories generates a decline in commercial cattle slaughter two years after the initial increase in the feeder market. Because beef cows and heifers are withheld from slaughter in response to an initial increase in feeder prices, beef production must decline temporarily. Consequently, both slaughter steer and feeder calf prices must increase. Thus, the price changes in the third year tend to counterbalance the price changes in the second year. The beef cycle, however, still maintains its positive relation to the initial change in feeder price. The change in beef cow numbers results, therefore, in an increase in calf inventories. The increase in calf inventories, in turn, results in increase in steer and heifer inventories. Meanwhile, the inventory changes lead to further changes in commercial slaughter. Eventually, the production and price cycles turn around and start moving in opposite directions from whence they started. Thus, the cattle cycle of about six to eight years duration illustrated in Fig. 2 is generated by a complex of factors that influence the long-run make-up of the beef economy.

At this point, let us refer briefly to the output and price cycles illustrated in Fig. 2. Two different assumptions were made regarding the behavior of the beef economy over a 10-year period. Under the first assumption, the beef economy was
MARKET OR PRODUCTION VARIABLE

FEEDER PRICE, JAN.-DEC.

YEAR t-2 YEAR t-1 YEAR t YEAR t+1 YEAR t+2

OTHER CATTLE ON FARMS, JAN. 1:

CALVES

HEIFERS

STEERS

COWS

COMMERCIAL SLAUGHTER

SLAUGHTER PRICE

FEEDER PRICE: JULY-DEC., t-k

FEEDER PRICE: JAN.-JUNE, t-k+1

FIGURE 1. INTERNAL MECHANISM OF THE BEEF CYCLE
FIGURE 2. BEEF OUTPUT AND PRICE CYCLES IN TWO PRODUCTION SYSTEMS
examined in isolation from the rest of the economy. A 1 billion pound drop in beef production occurred in year "0". The beef economy then was allowed to run its course without interaction between it and hog production and consumer demand. As a result, a rather well-defined output cycle of seven year duration was obtained. A corresponding series of price changes also was obtained. Under the first assumption, therefore, the system fluctuated around a production level that was about one-half billion pounds below the level from which it started before the initial 1 billion pound drop in production. Meanwhile, slaughter steer prices fluctuated around a price level about 1 1/4 cents above its initial level. The feeder calf price, however, tended to fluctuate around a level about 1 cent lower than its original level.

When the beef economy is considered as a part of the entire economic system, the initial 1 billion pound drop in production is superimposed upon a long-run pattern of growth in aggregate demand. The output cycle is now stretched out along an upward sloping output trend line. The feeder calf price cycle also is superimposed upon a corresponding upward moving price trend line. The slaughter steer price, however, shows a tendency to fall gradually to its initial level. In actuality, the interdependent system roughly illustrates the operation of the beef economy since 1958. Because of the growth in aggregate demand since 1958, the full price impact of the increasing beef supplies has been lessened, as suggested by a comparison of the two production systems.

What is the meaning of the falling feeder prices in the isolated system and the falling slaughter prices in the interdependent system? First, it must be emphasized that only changes from an equilibrium level of production and prices are represented in Fig. 2. The absolute starting, or equilibrium, levels in the isolated system would be somewhat less than in the interdependent system. This is because aggregate demand is expanding in the interdependent system but not in the isolated system. Feeding margins, therefore, are not necessarily profitable in the isolated system even though slaughter steer prices are above feeder calf prices. Also, feeding margins are not necessarily unprofitable in the interdependent system even though slaughter steer prices are below feeder calf prices. The results do show, however, that the average cow-calf operation is worse off in the isolated system and better off in the interdependent system after the initial drop in production. Hence, ranchers generally will look more favorably upon a rapidly growing demand for beef while feedlot operators will face a cost-price squeeze that eventually results in unprofitable feeding margins.

Applications of Logical Analysis

How much is it worth to livestock producers and processors to have better predictions of future market prices and supplies? Can we accept the argument that more effective use of improved market predictions would reduce excessive seasonal and cyclical market fluctuations? If we use the economic relationships suggested in Fig. 1 to prepare the market predictions, much more than estimates of future beef production and prices would be available since the series of economic variables that would be estimated yield a picture of the beef economy for each year in
the forecast period. These estimates to some extent are self-checking. Altogether they provide a basis for drawing some general conclusions with reference to the beef cycle and the interrelated system of cattle inventories, commercial slaughter and primary market prices. Because of the wide variety of market forecasts that would be generated, not only producers but also processors and market agencies would find the market estimates relevant in their planning.

To illustrate the economic value of market predictions, one segment of the beef economy -- farm feeders and commercial feedlot operators -- has been selected for close examination with reference to the losses incurred as a result of unexpected and excessive market fluctuations. In addition, some rough inferences will be made regarding the economic value of improved market forecasting practices in the case of the cattle feeding sector. For this logical analysis, we explore two means of increasing the incomes of cattle feeders -- varying the number of cattle on feed and varying the length of the feeding period.

Variable number of cattle on feed. If a cattle feeder were to vary only the number of cattle on feed and if he were to quit placing additional cattle on feed when the expected feeding margin drops below a certain minimum level, then gradually the demand for feeder cattle would fall. To clear the primary markets and feeder calf producers of the supplies of feeder cattle on hand, market prices would be reduced as an incentive for additional placements in feedlots. This process, of course, does occur whenever feeding margins drop below some minimal level, as illustrated in Fig. 3. The trend in feeding margins has been downward since early 1958. Whenever the feeding margin dropped sharply, feeder prices also dropped. Whenever the feeding margin improved, feeder prices also increases.

When the feeding margin is compared with slaughter prices, as shown in Fig. 3, an obvious fact emerges: The feeder market follows the current slaughter market rather than the expected slaughter market four to 12 months in the future. From our knowledge of the slaughter market and the dressed meat market, we realize that the current wholesale demand and current beef slaughter establish the current slaughter market.

One other fact emerges from the comparison of feeding margins and feeder prices: Increasing feeding margins trigger the upward climb of feeder prices, but a sharp drop in slaughter prices triggers the downward plunge of feeder prices. When slaughter prices drop, feeding margins also drop. Thus sharp drops in feeder prices and feeding margins occur simultaneously. If cattle feeders were guided by expected feeding margins, then the ridiculous behavior that we now experience in our feeder market would cease, provided that the expected margins are based on accurate forecasts of the slaughter cattle market. Accordingly, if the expected margin dropped below a profitable level, the cattle feeder would stay out of the market until current feeder prices were in line with expected slaughter prices.
FIGURE 4. INDEXES OF SELECTED CATTLE FEEDING MARGINS SINCE JULY, 1957.
Before leaving this particular subject, I refer briefly to the derived feeder calf price based on a fixed feeding margin shown in Fig. 3. To derive this price, the month-to-month fluctuations in slaughter prices were smoothed out so that the current feeder price would have a correspondingly smooth pattern that we can refer to as a "moving average." Surprisingly, the moving average feeder price corresponds with the reported feeder price, except for its level, which can be moved up or down depending upon the level of the fixed feeding margin. If the feeder market were based on an expected feeding margin, the moving average feeder price would be lagged (shifted to the left) about seven months -- the average length of period on feed.

Variable length of period on feed. Next let us examine the potential gains for the cattle feeder in varying the length of the feeding period. As shown in Fig. 4, the shorter the feeding period, the more violent are the fluctuations in the feeding margin. The 12-month feeding period, which assumes the placement on feed of 400-pound Good to Choice feeder calves and the marketing of 1,050-pound Choice slaughter steers, results in the most stable feeding margin. The 7-month and 4-month periods, which assume the placement on feed of 700-pound and 850-pound Good and Choice feeder steers, respectively, show especially sharp changes in feeding margins when slaughter prices rise or fall sharply. This is simply because the gains or losses on the weight added by feeding are distributed over a relatively small total weight gain. In Fig. 4 is illustrated, therefore, the potential gains that could be realized by year-around placements of feeder cattle of varying weight and quality.

Accurate market forecasts are as essential in selecting the most profitable feeding program as in selecting the cut-off level on staying in or staying out of the feeder market. With accurate market forecasts and the ability to vary the intended weight gain of year-around placements on feed, the feedlot operator has an advantage that would not be enjoyed by the farm feeder with a fixed feeding program. For example, in fall 1958 and again later in spring 1960 and spring 1961, short-term feeding programs were substantially more profitable than long-term feeding programs. During much of the intervening periods, however, the longer feeding programs were more profitable. Astute market analysis, together with flexible feeding programs, would have made the difference between net loss and profit for many feeders during the last two or three years.

Benefits and Costs of Forecasting the Cattle Cycle

When we assess the net benefits and costs of forecasting the cattle cycle we must recognize that for the most part the cattle feeder operates, or would like to operate, on a fixed feeding margin. The meat packer and the meat retailer are very much alike in their tendency to prefer a fixed operating margin. As a result, when excess beef supplies depress cattle prices, the feeder calf producer is left holding the bag for what it's worth. In the economist's jargon, the demand for slaughter cattle is inelastic and the demand for feeder cattle is even more inelastic. Under
these circumstances a smaller total supply of beef yields more total income to the cattle producer than does a larger total supply of beef. This is not true, however, for the feeder, packer and retailer segments of beef economy. In the long-run setting, therefore, the feeder calf producer benefits from improved market forecasting to the extent that it encourages a more conservative attitude on the part of all producers toward expanding their cow-calf operations when the current feeder market is favorable.

In the short-run setting, the fixed margin segment of the beef economy -- and that includes at least part of the cattle feeding sector as well as most of the meat packing and meat retailing sectors -- benefits from more accurate forecasting of both seasonal and cyclical changes in beef supplies and prices. Cattle feeders can vary their feeding programs and meat packers can vary their work gangs and inventories so as to reduce economic losses associated with wrong estimates of future supply and price prospects. Indeed, it is difficult to find a problem facing the beef industry today that offers in its solution more substantial benefits to the average producer and to the entire industry than does improving our methods of forecasting beef markets.

In trying to better forecast the cattle market, however, the influence of the long-run cyclical forces are overlooked in efforts to forecast short-run market changes. Yet, the long-run forces, insofar as they establish the general price level for cattle, are far more important to the livestock producer than the short-run variations in cattle supplies of different weight and quality characteristics.
...The Impact of Plant Location, Transportation Costs and Size of the Feeding Enterprise

by Lee R. Kolmer

Background and Historical Patterns

The modern livestock marketing system as we know it today began in the 1860's with the establishment of the central market. The extension of the railroad into the western livestock producing regions and later the invention of the refrigerator car transformed livestock from a business that was a local or regional business at best, wherein slaughterers were dependent upon livestock supplies produced in adjacent areas, to a nationwide market for cattle. It removed the restraints of distance from the industry and made it feasible for large scale livestock production developments in the western regions of the country and large scale processing facility development in the more populous eastern portions of the nation.

Meanwhile development of the central market had a profound impact not only upon the agricultural economy but also upon the development of a modern industrial economy. The central markets and the processing facilities developed around such markets made it possible for industrial complexes to be developed. Such facilities made food supplies available for feeding large concentrations of population.

This condition prevailed up until the 1920's. The central markets and terminal-based processing facilities were the only feasible method of transferring meat from western production areas to eastern consumption areas. However, during the 1920's several technological developments brought about significant changes in the nature of the marketing and processing of livestock. The advent of hard surface roads and the motor truck provided a degree of flexibility in transportation that was not available prior to the 1920's. Motor trucks and hard surfaced roads made it feasible for processors to locate plants and secure livestock supplies in areas away from terminal market facilities. This movement was further enhanced by the establishment of differential freight rates for products shipped in areas west of Chicago. These differential freight rates provided another inducement to establish plants at interior points. The U. S. postal system also played a role in this change in the complexion of the livestock industry. The establishment of Rural Free Delivery made it possible for producers to remain in fairly close touch with the markets through the medium of the daily newspaper. Later the widespread use of the radio contributed to increased market knowledge on the part of producers and

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also provided additional channels of communication between processor and producer.

Establishment of interior processing plants provided additional market outlets for producers and, consequently, changed the livestock marketing pattern. As a result of these technological and administrative changes a significant shift occurred in livestock marketings. There was a decline in marketings through terminal markets and an increase in marketings directly to processors and through auctions. The marketing pattern that prevailed in the mid '50's is shown in Table 1.

Table 1. Cattle Marketing Pattern in the North Central Region, 1956

<table>
<thead>
<tr>
<th>Area</th>
<th>Terminal</th>
<th>Auction</th>
<th>Packer</th>
<th>Dealer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>West North Central</td>
<td>68%</td>
<td>14%</td>
<td>12%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>East North Central</td>
<td>43%</td>
<td>23%</td>
<td>13%</td>
<td>8%</td>
<td>13%</td>
</tr>
<tr>
<td>Total North Central Region</td>
<td>57%</td>
<td>18%</td>
<td>13%</td>
<td>6%</td>
<td>6%</td>
</tr>
</tbody>
</table>


The major change that occurred between 1940 and 1956 was a substantial shift away from local markets and dealers to auction markets.

Significant changes also occurred in the marketing of feeder cattle from 1940 to 1956. Table 2 shows the distribution of feeder cattle purchases by market outlets by farmers in 1956.

Table 2. Feeder Cattle Purchases by Market Outlet by Farmers, 1956

<table>
<thead>
<tr>
<th>Area</th>
<th>Auction</th>
<th>Terminal</th>
<th>Dealer</th>
<th>Other Farmers</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>West North Central</td>
<td>53%</td>
<td>15%</td>
<td>11%</td>
<td>17%</td>
<td>4%</td>
</tr>
<tr>
<td>East North Central</td>
<td>30%</td>
<td>8%</td>
<td>28%</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Total North Central Region</td>
<td>45%</td>
<td>12%</td>
<td>17%</td>
<td>17%</td>
<td>9%</td>
</tr>
</tbody>
</table>

For the North Central region the 45 percent of the feeder cattle purchased through auctions in 1956 compared with 24 percent in 1940; the 12 percent purchased through terminal markets compared with 32.5 percent in 1940.

This was the pattern of sales in the North Central region six years ago. Since that time many things have had significant impact upon present and future sales.

\[a/\] Ibid.
marketing patterns. In 1956 some of the trends in marketing that are coming to the fore today were just beginning. As we look into the future marketing pattern for livestock one of the major factors will be plant location.

In the late 1800's the combination of transportation and population density in the larger cities made terminal-based plants most feasible. Transportation away main line routes was poor and farm to market roads were primitive. This made direct procurement of livestock from farms impractical for large scale operations. The basic question was, "What is the most efficient way of moving western beef to eastern consumers?" Given the transportation, processing and product development technology that existed at the time, terminal base plants were the most desirable. Today the basic question is still the same, but a host of new technologies, legal considerations and competitive factors have come into the picture.

**Livestock Availability**

Livestock availability and supplies now and in the future are one important consideration. Livestock volume is greatest in areas of large feed grain production in the North Central region of the country. A preponderance of the feed grains is used within the state of origin. The bulk of the feed grain production does not move very far from the area of production to the area of use. At present the 12 North Central states provide over 95 percent of all interstate shipments of feed grains. In other words, the North Central states are the only area in the country where large supplies of feed grains are available for shipment into other regions. Under production and pricing conditions there is no reason to expect feed grain production to shift away from the North Central region in the foreseeable future.

This would indicate a continuing high level of livestock production in the traditional Corn Belt areas of the country. Maki, Liu and Motes have projected the slaughter pattern by regions up to 1965.

As Table 3 shows the total slaughter for both cattle and hogs will increase by 1965, but the predicted pattern is significantly different from the present pattern. There will be increased slaughtering in the North Central, Pacific and Mountain states and less slaughtering in the remainder of the country.

**Population Distribution**

The feed grain and livestock production pattern is only one of the relevant factors in plant location. The population distribution is also very important. The major population concentrations are still in the Northeast portion of the country. However growth of population on the West Coast has significantly increased the demand for livestock products from the Central states.
Figure 1.

ALL FEDERALLY INSPECTED AND LARGE NON-FEDERALLY INSPECTED LIVESTOCK SLAUGHTERING PLANTS

MARCH 1, 1960

- Federally inspected plants
- Large non-federally inspected plants
  (in general plants slaughtering over 2,000,000 head age weight per year)

U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL MARKETING SERVICE

MAP 75624(7)
The large population areas impose certain constraints upon processors. Processors must have continuing supplies of a product moving into the market. These supplies must be of a certain composition, a composition that changes as seasons and price relationships change. Processors must also have flexibility to change the composition of supplies on short notice. Where processing occurs in production areas, this often means that additional distribution facilities must be set up in metropolitan areas. This involves added overhead costs and increased problems of communication. These factors, plus others, provide sound reasons for operating processing facilities in the metropolitan areas. It becomes increasingly difficult to service large population areas as processing is carried out farther, in terms of geography, from the ultimate consumer.

At present the regional distribution of plants corresponds quite closely with the population distribution. In the more heavily populated regions, a higher percentage of the plants are located inside metropolitan areas. In less densely populated areas the higher percentage of processing facilities are located outside of metropolitan areas. This is understandable since output of a given plant will be utilized completely within the metropolitan area in large centers but in less densely populated areas the output of a single plant may be dispersed over several metropolitan areas.

In the past, plant size and population distribution were very closely connected. In 1954, 3.6 percent of the establishments (plants employing 500 or more workers) accounted for 56 percent of the value added by manufacturing and 73 percent of employment in the meat packing industry. Figure 1 shows the distribution of federally-inspected plants and large nonfederally-inspected plants. Population has been very important in the past but recently derived data from the Census of Manufacturers and the USDA suggest that population will be of decreasing importance in future years in explaining the number of plants of any size class in any state.²

Labor Costs

Labor costs must also be considered in any discussion of plant location. The 1954 Census of Manufacturers shows that hourly wage rates in Standard Metropolitan Areas to be approximately 50 percent higher on the average than the hourly wage rate for plants located outside of these areas. The wage rate differential between plants located in metropolitan areas and plants located outside these areas varies somewhat between regions. However, the labor cost differentials existing between regions are not as great as those existing within a region. If we examine hourly wage rates for packing plant workers in communities of equal size we find the prevailing wage rates are approximately comparable and are roughly proportional to population.

² Wilbur R. Maki, Charles Y. Liu and William C. Motes, "Inter-regional Competition and Prospective Shifts in Location of Livestock Slaughter." Iowa Agricultural Experiment Station Bulletin 511. October 1962.
Table 3. Commercial Slaughter 1955 and Projected Slaughter 1965 for Cattle and Hogs, by Regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Cattle</th>
<th>Hogs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mil lbs. live wt.</td>
<td>1955</td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New England</td>
<td>1</td>
<td>262</td>
</tr>
<tr>
<td>Mid-Atlantic</td>
<td>2</td>
<td>2190</td>
</tr>
<tr>
<td>East North Central</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td>9</td>
<td>1105</td>
</tr>
<tr>
<td>Michigan</td>
<td>10</td>
<td>795</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>11</td>
<td>870</td>
</tr>
<tr>
<td>Minnesota</td>
<td>12</td>
<td>1472</td>
</tr>
<tr>
<td>Indiana</td>
<td>13</td>
<td>653</td>
</tr>
<tr>
<td>Illinois</td>
<td>14</td>
<td>2039</td>
</tr>
<tr>
<td>West North Central</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td>15</td>
<td>1912</td>
</tr>
<tr>
<td>Missouri</td>
<td>16</td>
<td>952</td>
</tr>
<tr>
<td>North Dakota &amp; South Dakota</td>
<td>17</td>
<td>468</td>
</tr>
<tr>
<td>Nebraska</td>
<td>18</td>
<td>1880</td>
</tr>
<tr>
<td>Kansas</td>
<td>19</td>
<td>1144</td>
</tr>
<tr>
<td>Southeast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Va., W.Va., N.C.</td>
<td>3</td>
<td>347</td>
</tr>
<tr>
<td>S.C., Georgia</td>
<td>4</td>
<td>438</td>
</tr>
<tr>
<td>Florida</td>
<td>5</td>
<td>303</td>
</tr>
<tr>
<td>Ky., Tenn.</td>
<td>6</td>
<td>616</td>
</tr>
<tr>
<td>Ala., Miss.</td>
<td>7</td>
<td>297</td>
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<tr>
<td>West South Central</td>
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<td></td>
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<td>Ark., La.</td>
<td>8</td>
<td>246</td>
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<tr>
<td>Okla., Texas</td>
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<tr>
<td>Mountain</td>
<td></td>
<td></td>
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<tr>
<td>Mont., Wyo.</td>
<td>21</td>
<td>88</td>
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<tr>
<td>Colorado</td>
<td>22</td>
<td>852</td>
</tr>
<tr>
<td>N.M., Ariz.</td>
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<td>Ida., Utah, Nev.</td>
<td>24</td>
<td>318</td>
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<tr>
<td>Pacific</td>
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<tr>
<td>Wash., Ore.</td>
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<td>681</td>
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<tr>
<td>Calif.</td>
<td>26</td>
<td>2416</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>24207</td>
</tr>
</tbody>
</table>

These data suggest that there are very few general conclusions that can be made regarding the impact of wage rates upon plant location. The impact of wage rates upon a given concern is dependent upon:

1. The nature of the contract an individual company has with a union. If a company has a master contract covering all of its locations it will have a different wage structure in any given plant than might be the case if it negotiated a separate contract at each location.

2. The intensity of capital investment in any given plant will affect the impact of wage rates upon plant profitability.

3. Differences in labor productivity existing in different areas will also affect wage levels.

4. Whether the plant is located in or outside a metropolitan area. As noted earlier, wage rates are higher in metropolitan than in other areas.

**Transport Costs**

Plant location decisions cannot be made without reconciling the distribution of livestock production, population and labor costs. The "resolution factor" in this dilemma is often the transportation cost.

The problem of location boils down to the combination of slaughtering and processing facility locations that will minimize total transport costs. If the final products are less mobile than the raw materials, it is advantageous to locate plants near consumption points. If the raw material, cattle in this case is less mobile than the final products, it is advantageous to locate plants near where the raw material is produced. Some of each situation exists in the slaughtering and processing function and therefore, transportation becomes very important. As we look at the influence of transportation we have to remember that both the absolute and the relative rate is important. The level of the absolute rate determines whether a product produced in one region can compete with the same product produced in another region. If the absolute rate for the product of a particular region is too high, it acts as a tariff barrier in that the production of an advantaged region is discriminated against and the production of a disadvantaged region is protected.

The relative rates of live animals and carcass meat are important in that they determine which of several substitute products can be shipped profitably. Maki and Motes, cited previously, found that prior to 1940 the rate relationships existing between products were approximately as follows:

Livestock and product movement to the East:
Livestock = 100% rate

Fresh meat = 150% rate (150% of the livestock rate)

Meat by-products = 100% rate (same as livestock rate)

Since World War II the freight rate structure for livestock and livestock pro-
duct movements to the East has changed somewhat. On the basis that the rate
on livestock is equal to 100 percent, the freight rate for fresh meat shipment has
increased so that it is now 156 percent of the livestock rate and the by-product
rate has increased so that it is now 106 percent of the livestock rate. On a rate
basis there has been a slight shift since 1940 toward giving live animal shipment
an advantage in movement to the East.

For livestock movement to the Western portions of the country there has been
a greater change. Prior to World War II the livestock freight rate was 100%, the
meat freight rate was 241% of the livestock rate and the freight rate for by-products
was 199% of the livestock rate. Since World War II (again using the livestock
freight rate as equal to 100%) the fresh meat rate has declined to 156%. Thus it
is now the same as the rate for fresh meat moving to Eastern areas. The rate for
by-products moving West, having declined to 132%, is still higher than the rate
for by-products moving East but it is considerably reduced from the freight rates
prevailing prior to 1940. Since 1940 the shipping advantage for livestock and
livestock products moving to the West has moved from livestock toward fresh
meat.

The shift in basic rates has been important, however. Carriers have made
changes in the costs allocated to various livestock products. Live animals have
been assigned greater out-of-pocket costs by the railroads than they were assigned
prior to 1950. At the same time fresh meat shipments have been assigned a smaller
percentage of out-of-pocket costs since 1950. In most cases, livestock presently
does not cover out-of-pocket shipping costs. There are exceptions to this, es-
pecially in the Southern territory. Fresh meat, on the other hand, has covered out-
of-pocket costs of shipping more adequately than livestock. However, the ratio
of costs covered in fresh meat shipment has declined from 150 percent of out-of-
pocket costs covered in 1950 to about 100 percent at present.

Under the present system of freight rate making, product classification and
area basis, there is much discrimination. Even though the discrimination exists,
Maki, Liu and Motes\(^3\) state that, "Within the range of transportation costs used
in this study, the findings show that it would be cheaper to slaughter livestock
in supply areas and ship meat, rather than ship livestock for slaughter in areas
where the meat is consumed."

With the livestock production, population and transportation conditions as
have been outlined, the location decision likely will be resolved by placing
more plants in the heavy livestock production regions, especially in the North
Central states. However, the requirements imposed upon processors by popu-
lation distribution and livestock location will lead to a continuation of the trend
\(^3\) Ibid.
in specialization that has already started. Slaughtering plants will likely be located in production areas and meat processing facilities will likely be located in or adjacent to major metropolitan areas. We will, of course, continue to have plants where the slaughter and processing functions are carried on within the same operation. This again is most likely to occur in regions of the country that are less densely populated than, for example, the Northeastern portion of the United States. In some cases this specialization has progressed to the point where a plant slaughters only one species and then only one or two grade designations within that species.

This trend will continue. However, it would be appreciably accelerated if the basis for freight rate making would change from the present product classification or area basis to a cost of service basis. Such a shift would enhance the relative position of fresh meat shipment as compared to the shipment of livestock.

Procurement Systems

The very fact that there will be increasing numbers of slaughtering plants in the North Central states will have an impact upon marketing patterns. Farmers and feeders will have a larger number of alternative outlets to choose from and additional competition will be injected into the procurement process. The marketing pattern emerging from this plant location pattern will be influenced by the procurement systems developed by these plants. If the plants are located adjacent to or near central public markets and use the central public markets as their source of supply, the central market would benefit appreciably. Some of these plants may be so located. However, it is highly unlikely that a majority of new plants will depend exclusively upon central markets as the sole source of supply. Even though a proportion of their livestock requirements may be procured from central markets most plants will also be competing for direct purchases of cattle.

While on the surface this in itself would suggest the likelihood that a greater proportion of the cattle will move directly to slaughtering plants, the final pattern emerging will be affected by the kind of selling alternatives markets make available for cattle feeders. Carcass grade and yield selling, while not an important factor in cattle marketing at present, could become an important alternative method in the eyes of the producer in the years to come. Other procurement policies such as conditions of sale will continue to be important competitive instruments in the coming years. The market which offers the combination of services the seller feels serves him best will appreciably influence the market pattern in future years.

Feeding Enterprise Size

Another factor that will influence future marketing patterns is the size of the individual feeding enterprise. As the average size of the feeding enterprise continues to grow, I believe that it will result in changes in the cattle feeder himself.
As the feeding enterprise becomes larger it will assume greater importance in a total farm business. This will likely bring with it more managerial inputs from farmers, increased knowledge of feeding technology and increasing concern with the cattle buying and selling process. This increased concern may well manifest itself by feeders spending more time and money in an attempt to more thoroughly scrutinize the market alternatives available to them and to obtain additional market information before making selling decisions.

On the other side of this coin, as the individual feeding enterprises become larger the individual feeder becomes a more attractive account for the commission man, the packer buyer, auction or other marketing agencies. This larger, more attractive account will undoubtedly stimulate increased contact or solicitation by the different buying agencies. This greater contact by the feeder with the marketing agencies will provide further stimulus to the feeder to acquire more knowledge of the market alternatives. Also, farm publications, the Extension Service and others have continually emphasized the importance of cattle feeders having adequate market knowledge. This will have some impact upon some cattle feeders. Again as the feeding enterprise becomes larger there is more likely to be increased recognition of the need for more knowledge of market choices.

The factors having an influence on future marketing patterns, can be summarized as follows:

The economics of feed grain production indicate that the North Central states will continue to provide the bulk of feed grain supplies and subsequently a substantial proportion of the nation's livestock supplies. This livestock supply, coupled with transportation cost differentials that exist between livestock and fresh meat, indicate a continued trend to establish livestock slaughtering plants in livestock production areas. Many of these plants, however, will be strictly slaughtering operations; they will not process meat. Processing plants will tend to be established near consumption centers. The number of slaughtering plants located in the high level production areas will increase. These plants will inject increased competition in the procurement of livestock supplies. At the same time the beef cattle population is increasing and the number of farms feeding cattle declining -- fewer feeders but larger feeding enterprises. The continuing adoption of feeding technology will provide continuing impetus to expansion of the feeding enterprise. As the size of the feeding enterprise increases, the importance of cattle feeding in the farm business also tends to increase. It is very likely that feeders will expend more managerial effort in buying and selling livestock under these conditions.

**Implications**

1. The establishment of additional plants in the North Central, Southeastern and Mountain states will tend to increase slaughter in these areas at the expense of competing areas.
2. The majority of the new plants will not be located at terminal points. They will represent additional competitors for central markets and also represent additional alternative outlets for direct shipments from the feed lot.

3. As farm numbers decline and feeding enterprises become larger in size, each account becomes increasingly more valuable to the marketing agency. Also, the marketing information level of feeders is likely to increase. This means that marketing agencies will have to provide a combination of services that the feeder feels will serve his best interests if they are to obtain his business. This may mean more price bidding at the feedlot, opportunity to sell on a carcass yield and grade basis, and/or more favorable weighing and selling conditions.

4. As the feeding enterprise becomes generally larger with more outlets competing for available supplies, the opportunity is improved for contractual selling between feeder and processor. This has occurred in other areas. While it will probably never be as prevalent in the North Central states or the Southeastern states as it is in the Southwestern states or California, it will become a relevant alternative for the larger feeders in these areas.

5. The net results of these factors upon the major methods of marketing can be summed up as follows:

   a. Terminal markets face continued competitive pressure in marketing of cattle. The establishment of additional plants will increase the competitive pressure.

   b. Processors procuring livestock direct will face increased competition for supplies. The older plants with problems of obsolescence will find it increasingly difficult to maintain a competitive buying price, adequate supplies and a profitable operation at the same time.

   c. Auction markets, some of which have a substantial interest in slaughter cattle sales, will face increased competition and may well find it more difficult to become established as a slaughter cattle market than has been the case in the past.
Beef production is one of the most rapidly growing industries in the United States. It is expanding in every region of the country and every phase of the industry (Figure 1). Currently, production is 50 percent above that of a decade ago. Steak and roast beef grace the dinner table of more people than ever before. Production in the United States has increased from around 110 pounds per person in the 1930's to 130 pounds in the 1940's and to 150 pounds in the 1950's, about 20 pounds per decade.

It is only natural that farmers in every part of the country are struggling to keep up with the competition in their areas and wondering if they'll be able to keep ahead of the competition from other areas. Equally interested are the scientists who produce new crop and beef production technology on which this expansion is based and the people who process and market the beef.

The problem of which region will win the biggest share of future increases in beef production is a complicated one. Rapid shifts in land use are taking place in some parts of the country, and these shifts are affecting the acres of land used for forage. In some areas, feed grain production is expanding rapidly. Increased grain feeding is occurring in some states. In still others, there is a rapid shift from dairy to beef. In some, skyrocketing population is increasing the demand for beef. In a few, income per capita is rising rapidly and the demand for beef is consequently increasing relative to others.

**Basis for Growth of the Beef Industry**

For the country as a whole, this rapid growth in beef production and consumption is due to five major factors:

1. Rapid expansion of forage production.

2. More silage is being harvested.

3. Dairy cow numbers are declining.

4. People are demanding more beef, particularly grain-fed beef.

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1/ Dr. Dunbar is associate professor of agricultural economics at Purdue University. Currently he is on leave with the Agricultural Policy Institute, Department of Agricultural Economics, North Carolina State College.

2/ Cattle and calves live weight basis.
(5) Improved technology of beef production.

Forage production is increasing. Every farmer or rancher knows that all cow-calf and most cattle feeding programs are built around low cost forage feeds. For this reason, the nation's supply of beef comes basically from forage feeds supplemented with the necessary amount of concentrates to provide efficient production and desired flavor in our steaks, roasts, and hamburgers.

Total tons of forage produced increased sufficiently to carry about one-eighth more total roughage consuming animal units\(^3\) of livestock in 1960 than in 1950. This took place in spite of the fact that total acreage of hay and pasture declined substantially. Changes in acreage of forage and roughage from 1949 to 1959 were:

<table>
<thead>
<tr>
<th>Million Acres</th>
<th>1949</th>
<th>1959</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage, corn &amp; sorghum</td>
<td>4.9</td>
<td>8.1</td>
<td>+3.2</td>
</tr>
<tr>
<td>Hay &amp; rotation pasture</td>
<td>135</td>
<td>129</td>
<td>-6</td>
</tr>
<tr>
<td>Permanent pasture</td>
<td>416</td>
<td>466</td>
<td>+50</td>
</tr>
<tr>
<td>Woodland pastured</td>
<td>135</td>
<td>93</td>
<td>-42</td>
</tr>
<tr>
<td>Grazing land not in farms</td>
<td>402</td>
<td>328</td>
<td>-74</td>
</tr>
<tr>
<td>Total hay and pasture</td>
<td>1088</td>
<td>1016</td>
<td>-62</td>
</tr>
</tbody>
</table>

The increased carrying capacity is obviously therefore due to increased yields per acre. One source of these increased yields is the shift from lower yielding to higher yielding types of pasture. In some regions, woodland pastured is being cleared for grazing; in others, government-owned grazing land is being purchased and put into farms where it gets more care and attention. Some of the poorest pasture land is going into woodland and non-farm uses. But the biggest factor accounting for increased yields is probably the improvement in yielding ability of cropland used for hay and pasture and improved permanent pasture through more fertilization and other cultural practices.

Another factor which raises average yields and production is the shift of marginal wheat, cotton, corn, and other crop land to grass in many parts of the country.

Hay yields per acre have increased an average of about one percent per year for the past 20 years, but somewhat more than this during the past few years. It seems reasonable to assume that yields per acre of permanent pastures also have gone up about this rapidly -- in some regions much more, but in some less than this.

\(^3\) 1 animal unit = equivalent of 1 dairy cow.
Beef Cattle and Calves on Farms and Ranches
U.S., By Regions, 1920 - 1962 *

SOURCE: Estimates by Earl Miller, ERS, USDA.
* North Atlantic - less than 1 million head.
Fig. 2

Beef and Dairy Cows on Farms and Ranches,
United States, 1920 - 1962

Fig. 3

Beef and Milk Cows on Farms, U.S., By Regions, 1920 - 1960

More silage is being harvested. Improvements in harvesting, storing and feeding silage since World War II have resulted in rapid expansion of the use of this feed for cattle in most regions of the country. Practically unlimited tonnages of these forages still are available in some areas. The 60 per cent increase in acres of silage harvested has added substantially to available roughage supplies.

Dairy cow numbers are declining. Third of the major sources of increased beef production is the rapid shift from dairy cows to beef during the past two decades (Figures 2 and 3). These two kinds of livestock are the chief competitors for our increasing forage and roughage supply. This trend began at about the start of World War II and has been accelerated during the 1950's.

A combination of factors accounts for this shift from dairy to beef. First, of course, is the increased production per milk cow. Another is that in many areas, milk producers have found more profitable employment, primarily in non-farm occupations. Many farmers with small dairy enterprises, high cost production, and Grade B markets have dropped dairy cows from their farm enterprises. Also, broiler or egg production has become more profitable employment for a good many former dairy producers.

Thus, in many areas, particularly in the Corn Belt, South Central and Southeast regions more feed is being made available for beef cows. In those regions, there has been an increase of one or more beef cows for each decline of one dairy cow.

Demand is for more and higher quality beef, particularly grain-fed beef. A fourth major factor accounting for increased demand and hence expansion in the beef industry is simply the increasing population. Equally important, the per capita demand for beef is outrunning the demand for pork, chickens, eggs, and milk.

Beef is a preferred item in the diet of the American people, and when they can afford it, they buy it. Incomes of people in every part of the country are rising and with this the annual per capita consumption of beef is going up. The household USDA food consumption survey of 1955 indicated that as people's incomes go up 10 per cent they eat about 2 per cent more beef per person. This survey also indicated that practically all income groups increase their beef consumption with increased income, almost regardless of the level of income.4/

Another major factor accompanying the increased demand for total beef is the consumers' desire for mouth-watering juiciness in the beef they buy. This desire can only be fulfilled with grain-fed beef. As a result, a higher per cent of all cattle coming to market are grain fed. As a further result, cattle are being fed a gradually increasing per cent of the total concentrates which are consumed by livestock.

4/ USDA, 1955
This increasing demand for grain-fed beef plus large increases in low cost feed grains have given impetus to the rapid expansion of the cattle feeding industry in recent years.

**Increased efficiency of production.** Studies indicate that it takes about as many feed units to make a hundred pounds of beef today as it did 10 or 20 years ago.\(^5\) However, the quality of beef that comes to market today is higher than in former years. I believe that less pounds of feed would be required per 100 pounds of beef today if people were to accept the same quality they got a generation ago.

**Regional Patterns of Production**

One cannot help concluding that the forces described above will continue to operate in the period ahead and that overall beef production in the United States will continue to increase about as rapidly in the 1960's as in the 1950's. Regional shares of the production increase will be determined largely by the balance resulting from the tugging of the forces discussed above.

Of these forces, four are most important. Of principal significance is the change in supplies of forage and roughage. These bulky feeds cannot be hauled far, hence must be fed close to where they are produced. Chief determinants of forage production will be changes in land use, yields per acre, and the harvesting of corn and sorghum as silage.

The switch from dairy to beef as some dairy producers find more profitable use for their labor is another important force. Finally, the pull of increased demand in some areas and the effects of increased grain feeding also will mildly influence regional shares of production. Recent increases in feed grain production in some areas have undoubtedly had some influence on the location of beef production; however, it is very difficult to isolate this effect by regions. Reason for this is that much of the increased grain production is often shipped to other areas or exported, and grain consuming livestock may outcompete cattle for it.

**Recent trends in regional shares of beef production.** The most effective place to begin an analysis of what is likely to happen to regional shares of beef production in the future is to look at the net effect of the forces affecting beef production in the recent past. Unless there is some new factor coming in rapidly present trends are likely to continue for the foreseeable future.

In 1959-60, 49 per cent of the beef produced in the United States came from the 11 North Central states (Table 1). This was a decline in the proportionate share of less than 1 per cent from 1949-50. All of the loss was in the Eastern

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part of the region.

About equal in importance in 1959 and 1960 were the South Central and Western states, with 22.5 and 19.3 per cent of the total.

The South Atlantic States produced only 5.5 per cent of the total beef in the country but increased their share most of all during the 1950's—from 4.7 to 5.5 per cent of the total. They gained about as much as the North Atlantic states lost.

Over the past 20 years, the North Central states have dropped about 4 per cent and the North Atlantic states 2 per cent in their share of total national production. The South Central, West and South Atlantic states have gained 3, 2, and 1 per cent, respectively.

The major conclusion one can draw from this data is that even though states like California increased beef production by nearly 2/3 in each of the past two decades and Alabama more than doubled production, total beef production has not been shifting rapidly from one region to another. While the West has been increasing production rapidly, so has the North Central, the South Central and the South Atlantic states. If trends of the past decade were to continue, the change in relative share of each of the regions by 1970 would be:

Table 1. Regional Share of Beef Production, for Regions and Selected States

<table>
<thead>
<tr>
<th>Region</th>
<th>1939-1940</th>
<th>1949-1950</th>
<th>1959-1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Atlantic</td>
<td>5.5</td>
<td>4.7</td>
<td>3.5</td>
</tr>
<tr>
<td>North Central</td>
<td>52.9</td>
<td>49.9</td>
<td>49.2</td>
</tr>
<tr>
<td>ENC</td>
<td>18.3</td>
<td>15.3</td>
<td>14.2</td>
</tr>
<tr>
<td>WNC</td>
<td>34.6</td>
<td>34.6</td>
<td>35.0</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>4.5</td>
<td>4.7</td>
<td>5.5</td>
</tr>
<tr>
<td>South Central</td>
<td>20.0</td>
<td>22.2</td>
<td>22.5</td>
</tr>
<tr>
<td>Western</td>
<td>17.1</td>
<td>18.4</td>
<td>19.3</td>
</tr>
<tr>
<td><strong>U. S. Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>99.9</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>California</td>
<td>3.4</td>
<td>4.1</td>
<td>4.5</td>
</tr>
<tr>
<td>Iowa</td>
<td>9.1</td>
<td>8.1</td>
<td>8.6</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>3.5</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Alabama</td>
<td>.9</td>
<td>1.1</td>
<td>1.6</td>
</tr>
</tbody>
</table>

SOURCE: Agricultural Statistics
North Central down from 49.2 to 48.4%
South Central up from 22.5 to 22.8%
West up from 19.3 to 20.2%
South Atlantic up from 5.5 to 6.3%
North Atlantic down from 3.5 to 2.3%

Let us examine each of the regions individually to see if there are major forces on the horizon which might modify these trends.

The analysis which follows is based in large part on indicators measured in Tables 2, 3, 4, and 5 and Figure 4. It assumes that efficiencies of converting feed to beef will increase about as rapidly in one region as another. In the discussion of total cropland acres by regions, please note that all soil bank land is included in land in farms according to its present use.

Prospects for the Western Region. For the 11 Western states as a whole, beef production increased a little over 50 per cent in the 1950's. The Pacific states, with California in the lead, expanded production somewhat faster than the Mountain states.

Irrigation will continue to bring new cropland into cultivation in the Mountain states. Some marginal cropland may be shifted to grazing land. This shift plus a continued and more rapid increase in silage production than in other areas will provide the basis for continued rapid expansion of beef production. Open permanent pasture in farms will probably continue to increase through purchases by ranchers of grazing land not now in farms. However, this will change carrying capacity very little.

Table 2. Changes in Land Used For Agriculture, By Regions, 1950 to 1959. a/

<table>
<thead>
<tr>
<th>Land in Farms</th>
<th>Crop-land</th>
<th>Open Permanent Pasture</th>
<th>Woodland Pasture</th>
<th>Grazing land Not in Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>-3</td>
<td>-6</td>
<td>+12</td>
<td>-30</td>
</tr>
<tr>
<td>West</td>
<td>+5</td>
<td>+1</td>
<td>+12</td>
<td>-25</td>
</tr>
<tr>
<td>North Central</td>
<td>-3</td>
<td>-2</td>
<td>+1</td>
<td>-24</td>
</tr>
<tr>
<td>South Central</td>
<td>-3</td>
<td>-13</td>
<td>+26</td>
<td>-40</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>-19</td>
<td>-22</td>
<td>0</td>
<td>-30</td>
</tr>
<tr>
<td>North Atlantic</td>
<td>-20</td>
<td>-18</td>
<td>-30</td>
<td>-25</td>
</tr>
</tbody>
</table>

a/ Change for the total U. S. = 7 per cent. Based upon U. S. Census of Agriculture data.

<table>
<thead>
<tr>
<th>Per Cent of U. S. Total</th>
<th>U. S. Total</th>
<th>West</th>
<th>N. Central</th>
<th>S. Central</th>
<th>S. Atlantic</th>
<th>N. Atlantic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population a/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mil.</td>
<td>151</td>
<td>178</td>
<td>13</td>
<td>15</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Beef Prod. b/</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>mil. lbs.</td>
<td>19,920</td>
<td>29,126</td>
<td>18</td>
<td>19</td>
<td>50</td>
<td>49</td>
</tr>
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<td>Beef Cattle &amp; Calves c/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mil. hd.</td>
<td>42</td>
<td>63</td>
<td>24</td>
<td>21</td>
<td>41</td>
<td>44</td>
</tr>
<tr>
<td>Beef Cows d/</td>
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<td></td>
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<tr>
<td></td>
<td>16</td>
<td>25</td>
<td>28</td>
<td>23</td>
<td>30</td>
<td>32</td>
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<tr>
<td>Cattle on Feed e/</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4</td>
<td>7</td>
<td>18</td>
<td>25</td>
<td>75</td>
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\[ Less \text{ than } 5 \]

a/ 1950 & 1960 and not including Alaska & Hawaii; b/ Average 1949-50 & 1959-60; c/ Census data 1949 & 1959; d/ Earl Miller, ERS, USDA; e/ Livestock & Poultry Inventory.

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<tr>
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<th>N. Central</th>
<th></th>
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<td>416</td>
<td>466</td>
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<td>235</td>
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Average

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<th>S. Atlantic</th>
<th>N. Atlantic</th>
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<td></td>
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<td></td>
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a/ 1950 and 1960 and excludes Alaska and Hawaii
b/ Average 1949-50 and 1959-60
c/ Census data 1949 and 1959
d/ Earl Miller, ERS, USDA
Table 5. Change in Beef Production, Feed, Dairy Cows, and Population By Regions, 1948-50 to 1958-60 \(^a\)

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<th>Unit</th>
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<th>North Central</th>
<th>South Central</th>
<th>South Atlantic</th>
<th>North Atlantic</th>
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<td>Population</td>
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<td>+18</td>
<td>+35</td>
<td>+13</td>
<td>+12</td>
<td>+24</td>
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<tr>
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<td>+53</td>
<td>+44</td>
<td>+48</td>
<td>+71</td>
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<tr>
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<td>+58</td>
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<td>+80</td>
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<tr>
<td>Beef Cows</td>
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<td>+29</td>
<td>+64</td>
<td>+58</td>
<td>+106</td>
</tr>
<tr>
<td>Cattle on Feed</td>
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<td>+53</td>
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<tr>
<td>Milk Cows</td>
<td>&quot;</td>
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<td>-6</td>
<td>-17</td>
<td>-27</td>
<td>-13</td>
</tr>
<tr>
<td>All Cattle</td>
<td>&quot;</td>
<td>+21</td>
<td>+25</td>
<td>+22</td>
<td>+20</td>
<td>+31</td>
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<tr>
<td>Feed Grain Prod.</td>
<td>mil. tons</td>
<td>+26</td>
<td>+61</td>
<td>+26</td>
<td>+23</td>
<td>+14</td>
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<tr>
<td>Silage, Total</td>
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<td>+156</td>
<td>+65</td>
<td>+157</td>
<td>+178</td>
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<td>+12</td>
<td>+1</td>
<td>+26</td>
<td>0</td>
</tr>
<tr>
<td>Graz. Land not in Farms</td>
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<tr>
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<td>-24</td>
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</table>

\(^a\) Based on data in Table 4.
With population gaining faster than in the rest of the country and people hungry for beef, a market for increased numbers of fed cattle is in prospect in the West. Feed grain production, which increased 60 per cent in the region in the past decade, will continue upward but not at the same rate. The big shift from wheat to feed grains will not be repeated. Additional grain needed for cattle feeding operations will continue to be shipped from the plains states and western corn belt.

As a per cent of the U. S. total, beef cows will likely continue to decline in the West and cattle feeding increase.

In summary, there appears to be nothing characteristic of the area that will cause total cattle production in the west to increase more rapidly than during the past decade nor to increase its relative share of beef production by more than one or two per cent of total output.

Prospects for the South Central Region. Beef production in the South Central States increased a little less than 50 per cent during the 1950's. The eastern part of this area increased more than this. For example, beef production in the Delta states of Arkansas, Louisiana and Mississippi increased more than 100 per cent from 1947-49 to the mid 1950's. Since that time, however, production in the Delta states has apparently leveled out while continuing to increase in the western part of the region.

Substantial land use changes will probably continue in the South Central region. During the 1950's, farmers shifted 13 per cent of their cropland to permanent pasture and other uses. Feed grain acreage declined. In the Delta states, both acreage and production went down. Permanent pasture increased by 25 million acres. Thus the pasture base for cattle in the South Central region is increasing and will probably continue to do so in the decade ahead.

Although cattle feeding has increased 50 per cent in the past decade, the region still feeds only 7 - 8 per cent of the nation's fed cattle but has 1/3 of the beef cows in the country. Over 80 per cent of the cattle produced in the region is produced on pasture and grazing, with very little grain feeding.1/

A decrease of nearly two million dairy cows has occurred in this region in the past decade, leaving a higher percentage of the feed for beef cows.2/ As a result of these developments, this region now has more beef cows than any other region and is a growing source of feeder cattle for corn belt and western feed lots.

In summary, although beef production has leveled out recently in the Delta states, it appears that the South Central region as a whole also has a good chance of increasing beef production in the 1960's at about as rapid a rate as in the 1950's.

2/ The decrease has been fairly steady over the decade.
FARM PRODUCTION REGIONS

[Map of the United States with regions labeled: Pacific, Northern Plains, Lake States, North East, Mountain, Corn Belt, Appalachian, Southern Plains, Delta States, Southeast.]
Fig. 4
Trends in Feed Grain and Beef Production, By Regions, United States, 1940 - 1960

Per Cent of 1947-49

a. Corn Belt

b. Lake States

c. Pacific
d. Southern Plains

e. Mountain
f. Northern Plains

g. Delta
h. Southeast

i. Appalachian
j. Northeast

Key: ——— Feed Grain SOURCE: Feed Grain Index - Statistical Bulletin

——— Beef

273, USDA.
Beef Production - Ag. Stat., USDA
Prospects for the South Atlantic Region. Beef production has nearly doubled in this region in the past decade, and its share of total U. S. production has increased from 5 to 6 per cent. Most of this increase took place in the early 1950's.

Land use changes in this region during the 1950's have been more dramatic than in any other except the North Atlantic states. From 1950 to 1959, 22 per cent of its land in farms was shifted to non-farm uses.

The acreage of all types of hay and pasture declined. Therefore, the increased forage and roughage fed to beef cattle had to come from increased yields per acre, greater use of silage, and shifting from dairy to beef cows on some farms.

As incomes per capita go up in this region, an increase in demand for fed beef is occurring. Consequently a small amount of cattle feeding is beginning to appear.

In summary, it looks as if beef production will increase in this region in the 1960's. But unless present trends are changed, the rapid decline in crop and pasture land will make it very difficult to get as much increase in beef output as during the 1950's. If such an increase occurs, it will come from increased silage, improved yields, and a decline in dairy cow numbers.

Prospects for the North Atlantic Region. The North Atlantic States have less than 1 per cent of the beef cattle and calves in the United States. This percentage has remained about constant for the past decade.

The forage and roughage-consuming livestock base is declining, with 18 per cent less cropland, 30 per cent less permanent pasture and 25 per cent less woodland pasture in 1960 than in 1950. Yields are increasing, however.

With milk cow numbers holding about constant, it is doubtful if beef production can hold its own in the next decade.

Prospects for the North Central States. Beef production in the North Central States in 1959 and 1960 was about 40 per cent above the 1949 and 1950 average, a less spectacular growth rate than some regions. The Corn Belt and Northern Plains areas held their own with other areas, but the increase in the Lake States was less.

Cropland acres in this region declined only 2 per cent in the 1950's. Land was brought into production through clearing and drainage to offset most of the cropland which went into permanent pasture and non-farm uses. A great deal of the cropland lost was in the Lake states. Woodland pasture contributes a very small share of the total beef produced in the area.

This is still a forage and roughage surplus area. Its potential production of silage from corn and sorghum is practically unlimited. Shifting of land from other crops to feed grains is expected to continue, further expanding this base.
The only limiting factor to using more silage for beef production is the profitability of the operation. With modern silage harvesting, storing, and feeding methods it is anticipated that silage feeding of cattle will expand more rapidly in this region in the 1960's than in the 1950's.

Most other cattle feeding areas expanded feed grain acreage and production in the 1950's more rapidly than the North Central States. Although yields per acre are likely to continue to increase in those other areas, new corn producing technology has just entered into another rapid growth phase in the Corn Belt. These developments will likely continue to keep feed grain for cattle finishing cheaper in the North Central States than in other areas.

If dairy cow numbers fall another 2 million head in this area in the decade ahead, the way will be paved for an increase of another 2 million or more head of beef cows.

In summary, it appears that the Corn Belt will at least retain its present relative position in beef production in the decade ahead. It will probably continue to gain in beef cow numbers and in all likelihood will gain some in cattle feeding as the nation increases its demand for juicy corn-fed beef. Its main competitors in beef cow numbers will remain the South Central and South Atlantic states; in cattle feeding, the Western states.

**General Conclusions**

1. The demand for more and higher quality beef will expand about as much in the 1960's as in the 1950's. The rapidly increasing population in the West will give that area the greatest gain, but improving income levels in other regions such as the South East will create increasing demand there too.

2. Beef production will continue to be located where the forage and roughage is produced.

3. Shifts of marginal cropland to pasture will bring increased forage acreage in the Eastern, Southern, and Western areas, where most of this land exists. The decrease of total agricultural land in both the North and South Atlantic states will tend to offset this shift. In the Mountain states, irrigation will tend to add to it.

4. In the North Central states feed grain production will increase due to increased yields and more intensive use of land. Forage production will increase in response to higher yields of rotation hay and pasture, and silage production will increase due to improved technology. This region will continue to have surplus forage and roughage.

5. Declining numbers of dairy cows will continue to release substantial amounts of forage for beef production in all southern and central regions.
6. Crop yields will continue to increase in all areas.

7. Total beef production will increase by another 20 pounds liveweight per capita in the decade ahead. A higher percentage of beef production will come from grain-fed cattle and a higher percentage of the total grain produced in the country will be used for beef production.

8. Regional shares of beef production will not change much. Increasing demand in the West will cause a flow in that direction of both cattle and grain to feed them out. But the big bulk of population and demand will remain in the Eastern States. Consequently, with surplus cheap feed in the North Central States, that area will continue to feed most of the cattle and send them East. Increasing supplies of cheap forage and roughage will keep cow-calf production increasing in the South.
The four chapters in this section, "Future Direction of the Beef Business," are interrelated and interdependent. Segmenting the general topic into four rather specific topics is a necessary expedient towards division of labor. "Cow-calf production" and "feedlot operations" are, of course, two topics, although the necessary interdependence between the two is apparent.

Ranching

The economics of ranching as a field of research endeavor has only recently been renewed after a dearth of studies for 15 to 20 years. In the 1920's and 1930's classic studies on ranch economics were published by Burdick of Colorado, Saunderson of Montana, Vass of Wyoming, M. B. Johnson of North Dakota and the USDA, and Hedges of Nebraska and the USDA. In the early and mid-1950's, led by Hopkin (then at Wyoming) and Baker and Gray (then at Montana), economic studies of ranching began to reappear.

Why has the field of ranch economics been neglected, at least in a relative sense? There are three and possibly four important reasons.

1. Even though ranching uses large areas of a state's land, there are few ranch units as compared to farm units.

2. The ranching region may be located long distances from the state's principal experiment station.

3. A lack of experience, training and/or interest in ranching existed among many economists.

4. A feeling that ranches were well adjusted to their resources and hence that no economic problem existed.

To have an economic problem there must be alternate uses for resources. Do alternatives exist for resources in ranching? One apparent alternative use of land suitable for cattle is for grazing by sheep. For a variety of reasons cattle ranching has increased while sheep ranching has decreased. Another alternative use for land in some regions is wheat. But for the vast ranching region the choice is cattle and cattle only. Nonetheless, considerable alternatives still exist within this framework. Clawson

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1Dr. Finley is Associate Professor of Agricultural Economics at the University of Nebraska.

2I am indebted to my colleague Ralph D. Johnson for his helpful suggestions and review of an earlier draft of this paper.

has outlined three rather distinct cattle ranching types or alternatives:

1. Steer ranches. No breeding stock are kept; cattle are purchased and grazed for one or more seasons.

2. Cow-calf ranches. A breeding herd is kept and young stock (usually calves) are sold.

3. All-aged ranches. A breeding herd is kept and calves are raised to one or more years of age. Often stock sold is "grass fat" and can be slaughtered or finished further by another party.

Traditionally the main steer ranch areas have been in regions where an abundance of forage occurs at one season of the year: the Flint hills of Kansas, Osage hills of Oklahoma, foothill region of California, and the irrigated alfalfa pastures of California and Arizona.

Cow-calf ranches are scattered throughout the west but have been concentrated in Texas and the Southwest.

All-aged ranches, too, are found in almost every area of the West but typically have been centered in the Central and Northern Plains and Mountain areas.

Nauheim studied the organizational make-up of ranch types (Table 1). The all-aged ranches have greater flexibility than the strictly cow-calf operation. That is, in years of unfavorable range feed conditions the number of cattle can be cut back on a given range without selling part of the breeding herd. The all-aged ranch has been popular in the Central and Northern range areas since this is a region of highly variable and "bunched" rainfall, hence variable and "bunched" pasture and range conditions.

But for the gain of weather and feed flexibility there is a cost. Nauheim budgeted returns for each of the types of ranching studied and found that gross returns for the cow-calf operation were highest, returns for the cow-yearling operation were 95.5 per cent of the returns of the cow-calf operation while the most flexible type, cow-two year olds, had returns of 90.6 per cent of the first type. Which ranch type should be chosen? No single answer exists for every individual. Fundamentally the decision of substituting flexibility for income is more a psychological than economic

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4 Another type of operation, "pasture feeding," might be included. This is a hybrid operation, however, encompassing aspects of both ranching and feeding.

phenomenon. It can depend upon age, debt and family obligations, capital position, psychological make-up and numerous other factors.

Table 1. Three cowherd systems with different flexibilities (constant animal units)

<table>
<thead>
<tr>
<th>System</th>
<th>Cow-calf</th>
<th>Cow-Yrlg.</th>
<th>Cow-2 year old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>75%</td>
<td>54%</td>
<td>39%</td>
</tr>
<tr>
<td>Calves</td>
<td>19%</td>
<td>14%</td>
<td>10%</td>
</tr>
<tr>
<td>Yearlings</td>
<td>6%</td>
<td>32%</td>
<td>22%</td>
</tr>
<tr>
<td>2 yr. olds</td>
<td>--</td>
<td>--</td>
<td>29%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Adapted from: Charles W. Nauheim, "Flexible Livestock Systems" in Management Strategies in Great Plains Farming, Great Plains Council Publication No. 19, M. P. 7, Nebraska Agricultural Experiment Station, August 1961, p. 86. Animal Units per head, Cow 1.0, Calf .3, Yearling .7, and 2-year old .9.

Is the make-up of ranch organization changing? Recent surveys and observations indicate that it has and is. In the summer of 1961 the Department of Agricultural Economics at the University of Nebraska began a study of economic aspects of cattle ranching in the Sandhills. The Sandhills is a large contiguous area and traditionally has been an all-aged ranching region. Basically it remains that. However, a tendency is noted toward selling younger cattle, in a good many instances almost strictly cow-calf operations occur. Of the more than 100 ranches surveyed only two were selling three-year old cattle.

Empirical evidence fully supports the assumption that all-aged ranches are selling younger cattle than, say, 20 years ago. But this may well be the case because of (1) an improved financial situation on ranches and (2) an increased demand for young feeder stock.

Ranching is a relatively prosperous industry at present; nonetheless profit margins are narrowing and much of the return is being priced away in ranch land. For example, the price of land has risen much more rapidly in the ranching area of Nebraska as compared to the state as a whole. (see Fig. 1) The impact of bidding up prices of ranch land may not be felt by certain individuals in the short run. That is, as long as the land price
A Comparison of Indexes of Land Prices in the Sandhills Region with the State Average for Nebraska.

increases (or decreases) and the individual is not buying (or selling) land the cash returns will not be affected and the question is academic. In the long run when ranches change hands and consequently are refinanced, the impact of high land prices may place a heavy burden on that generation.

The owner of a well organized, large (about 27 sections) ranch recently budgeted out income for the coming years. By using the price originally paid for the land he calculated a rate earned on the investment approaching 12 per cent. However, land for this ranch was acquired in the 1930's and early 1940's. By calculating the rate earned on the investment at the current value of the land he figured that only about 3 per cent was earned. This ranch is one of the better adjusted and managed organizations in the area.

Another example of the financial situation of the ranching area is found in a recent study of labor returns in Nebraska.\(^6\) In the ranching region\(^7\) investment per ranch increased 166 per cent from 1949 to 1959 while average per farm investment for the state increased 101 per cent. Residual returns to labor and management per ranch unit increased less than 14 per cent (1949-1959) while similar returns per farm for the state increased over 20 per cent.

**Future Trends in Ranching**

It has been noted that many all-aged ranches may have moved closer to the calf selling organization type in recent years. In the next decade this trend may cease or be reversed. (An increase in two or three year old operations is not necessarily expected, however.) First, there is a need for flexibility in the Central and Northern Plains. Second, hay reserves provide the means for that flexibility. These are advantages other areas do not have.

Another factor influencing ranching is the growth of cattle feeding on a commercial basis. This will be an area of competition between the relatively small farm feeder and the rancher. If the growth of the commercial lots continues, demand for heavier feeder animals may increase; that is, if the commercial feeder wants to fill his lots three or four times each year, then calves at 350 to 500 pounds will not be appropriate. The question is: Who will provide the "intermediate" poundage from a weanling calf at 375 pounds to a 600 to 800 pound feeder animal the commercial feeder wants? The farmer-feeder may fill this role because of great part of any advantage he has is in the use of low

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\(^6\)Neil R. Cook, "Labor Productivity on Nebraska Farms", M. S. Thesis, Department of Agricultural Economics, University of Nebraska, 1961.

\(^7\)This region is economic area 1 in Nebraska. Most of the Sandhills ranching area is included but also some wheat and general farming are included in area 1.
opportunity cost feeds (stalks, some hays and roughages, small grain pastures, wet corn, etc.) and labor. On the other hand, the rancher may be competing for the opportunity of selling the intermediate weight. Ranches may have several advantages:

1. The all-age ranch is organized to sell heavier feeder cattle.

2. Fall calving is increasing and could be accelerated. Such calving results in heavier feeder calves.

3. Opportunities exist in many areas for pasture feeding.

Table 2. Cattle and calves: Number on feed by 12 leading states, January 1, average for 1949-58 and annual 1959 and 1960.\textsuperscript{a}

<table>
<thead>
<tr>
<th>State</th>
<th>1949-58 Rank</th>
<th>1949-58 (000)</th>
<th>1959 Rank</th>
<th>1959 (000)</th>
<th>1960 Rank</th>
<th>1960 (000)</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa</td>
<td>1</td>
<td>1,118</td>
<td>1</td>
<td>1,425</td>
<td>1</td>
<td>1,510</td>
<td>1</td>
</tr>
<tr>
<td>Illinois</td>
<td>2</td>
<td>572</td>
<td>2</td>
<td>643</td>
<td>2</td>
<td>688</td>
<td>2</td>
</tr>
<tr>
<td>Nebraska</td>
<td>3</td>
<td>545</td>
<td>3</td>
<td>637</td>
<td>3</td>
<td>665</td>
<td>3</td>
</tr>
<tr>
<td>California</td>
<td>4</td>
<td>361</td>
<td>4</td>
<td>504</td>
<td>4</td>
<td>663</td>
<td>4</td>
</tr>
<tr>
<td>Minnesota</td>
<td>5</td>
<td>323</td>
<td>5</td>
<td>400</td>
<td>5</td>
<td>416</td>
<td>5</td>
</tr>
<tr>
<td>Missouri</td>
<td>6</td>
<td>254</td>
<td>6</td>
<td>292</td>
<td>7</td>
<td>298</td>
<td>7</td>
</tr>
<tr>
<td>Colorado</td>
<td>7</td>
<td>248</td>
<td>7</td>
<td>338</td>
<td>6</td>
<td>385</td>
<td>6</td>
</tr>
<tr>
<td>Indiana</td>
<td>8</td>
<td>239</td>
<td>8</td>
<td>255</td>
<td>9</td>
<td>224</td>
<td>12</td>
</tr>
<tr>
<td>Kansas</td>
<td>9</td>
<td>228</td>
<td>9</td>
<td>229</td>
<td>10</td>
<td>293</td>
<td>8</td>
</tr>
<tr>
<td>South Dakota</td>
<td>10</td>
<td>208</td>
<td>10</td>
<td>269</td>
<td>8</td>
<td>247</td>
<td>10</td>
</tr>
<tr>
<td>Texas</td>
<td>11</td>
<td>156</td>
<td>11</td>
<td>184</td>
<td>12</td>
<td>239</td>
<td>11</td>
</tr>
<tr>
<td>Arizona</td>
<td>13\textsuperscript{b}</td>
<td>131</td>
<td>13</td>
<td>210</td>
<td>11</td>
<td>265</td>
<td>9</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Estimates include cattle being fattened for market as a more or less distinct agricultural enterprise, and exclude small operations incidental to dairy and general farming. Cattle thus fed are presumed to produce carcasses that will grade good or better.

\textsuperscript{b} For average 1949-58, Ohio ranked 12th with 152,000 head.

Cattle Feeding

Cattle feeding is in a state of evolution. Not only are the locations of cattle feeding shifting, but the size and methods of feedlot operations are changing. As indicated in Table 2, changes in rank among leading cattle feeding states have taken place and additional changes may be forthcoming. Note the small differences in number of cattle fed in 1960 among Illinois, Nebraska, and California. Over the period shown, Colorado has replaced Missouri for sixth place; South Dakota, Kansas, and Texas have changed but little in relative ranking while Indiana has declined from eighth place to twelfth, and Arizona has moved up from thirteenth to ninth place.

Changes in the Cattle Feeding Industry. During the 1930's, the increase in cattle fed in the United States was only 6.1 per cent. However, in 1949, 25 per cent more cattle were fed than in 1940, and in 1959, 50 per cent more than in 1950 (Fig. 2). However, only since 1950 has the rate of beef production exceeded to any appreciable extent the rate of population growth in the United States.

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8 This section is drawn chiefly from Robert M. Finley and Ralph D. Johnson, "Changes in the Cattle Feeding Industry of Nebraska", Bul. 476, Nebraska Agricultural Experiment Station. (In press).
9 Some authorities believe that the expansion limits of the cattle feeding industry in California have been reached. Dean & McCorkle estimate that cattle fed in California feed lots in 1975 will be equal only to the average levels of 1955-1958. See G. W. Dean and Co., O. McCorkle, Jr., Projections Related to California Agriculture in 1975, Bul. 778, California Agricultural Experiment Station, University of California, April 1961.
The rapid increase in cattle feeding which occurred in the 1940's and 1950's was undoubtedly due to improved economic and weather conditions, improved technology in feeding and feed grain production, increased population and an increase in consumer preference for beef. The per capita consumption of beef increased 49 per cent from 1940-1959, while the per capita consumption of all other red meats (pork, veal, mutton and lamb) generally declined or held constant.

Cattle Feeding Regions. Even though there is some cattle feeding in all 50 states it is important in only 26. The 26 important cattle feeding states are located in five of the six geographic regions of the United States.
Cattle feeding is important in all of the states in three of the regions—West, West North Central and East North Central. In the other three regions, only Oklahoma, Texas and Pennsylvania feed an appreciable number. In this analysis, Pennsylvania will be included in the East North Central region and Oklahoma and Texas will be included in the Western region.

A considerable increase in number of cattle fed occurred in all three of the regions from 1940 to 1959 (Fig. 3). The number of cattle fed, increased 36 per cent in the East North Central region, 81.7 per cent in the West North Central region, and 145.4 per cent in the Western region.

![Graph showing percent of cattle and calves on feed (January 1) by geographic regions, 1940-1959.](image)

**Figure 3.** Percent of cattle and calves on feed (January 1) by geographic regions, 1940-1959.

**Source:** U.S. Department of Agriculture, *Agricultural Statistics, 1940-1960:*

Substantial changes also occurred in the per cent of the nation's cattle fed by regions (Fig. 3). In 1940, 28 per cent of the cattle were fed in the East North Central Region, 51 per cent in the West North Central Region and 21 per cent in the Western region. By 1959, these
percentages had changed to 21 per cent for the East North Central, 51 per cent for the West North Central and 28 per cent for the Western region.

The long run regional trends can probably best be explained by comparing the long run national increase with that of the individual states within each region. From 1940 to 1959, cattle feeding in the United States increased 83 per cent. As previously indicated, feeding in the East North Central Region increased only 36 per cent. The largest increase in any of the states in the East North Central Region was 69 per cent in Wisconsin.

In the West North Central region feeding in three of the states increased less than the national increase of 83 per cent and four increased more than the national rate; total cattle feeding increased only slightly less than the national rate -- 82 per cent from 1940 to 1959. An important reason that cattle feeding has not increased more rapidly in this region is because the rate of increase in two of the leading states in 1940 was far less than the national rate. Minnesota and Missouri, which were second and third (in the West North Central Region) in 1940, increased only 36 and 10 per cent, respectively, and ranked third and fourth in 1959.

In Iowa, which ranked first in the region and the nation in 1940 and 1959, cattle feeding increased 85 per cent. Nebraska and South Dakota, which were fourth and sixth in the region in 1940, increased 178 and 199 per cent and ranked second and fifth in 1959. Had it not been for the rapid increase in Nebraska and South Dakota, the West North Central region would not have been able to keep pace with the national rate.

In the Western region, cattle feeding increased more than the national rate (83 per cent) in nine of the thirteen states. Feeding in four states increased more than 100 per cent; four increased at least 200 per cent; and one increased almost 500 per cent. Of the four states where cattle feeding increased less than 83 per cent, only Texas ranked in the top regional four in 1949 and in 1959. In the other three top-ranked states, feeding increased as follows: California 271 per cent, Colorado 150 per cent, and Arizona 228 per cent. In Washington, which ranked twelfth in the region in 1940, cattle feeding increased 497 per cent and was ranked sixth in 1959.

The trend toward larger and more specialized feeding operations that began during World War II continued during the 1950's. As indicated in Table 3 the small feeder (less than 50 head) still dominates in terms of numbers; however, the proportion of cattle fed by such operators has declined drastically. On the other hand, a small proportion of feeders (less than 4 per cent) now feed about two-fifths of the cattle. Although not shown in Table 3, the concentration of cattle feeding in Nebraska is even more marked; 1 per cent of operators feed 23.4 per cent of the cattle and .4 per cent feed almost 15 per cent of the cattle. While these data emphasize Nebraska, the general trends noted are applicable to other feeding
Table 3. Changes in distribution of cattle feeding by size of operation, percentage of operators, and percentage of cattle fed from 1950-1959, Nebraska.\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>Percent of Operators</th>
<th>Percent of Cattle Fed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1950</td>
<td>1959</td>
</tr>
<tr>
<td>1-49</td>
<td>87.6</td>
<td>78.0</td>
</tr>
<tr>
<td>50-199</td>
<td>10.8</td>
<td>18.4</td>
</tr>
<tr>
<td>200+</td>
<td>1.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

\(^a\) Annual State Farm Assessor's Census Records.

A factor that may have a heavy impact upon both the ranching and cattle feeding industry in the near future is the possibility that wheat may be priced as a feed grain. Numerous experiments have shown that wheat is a most satisfactory feed grain. Whereas little wheat has been fed in recent years, before and during World War II considerable wheat was used as livestock feed. In fact in the 10 year period 1935 to 1944 almost 3 1/2 times as much wheat was fed than was exported. There is considerable speculation regarding where the feed wheat be fed. Some lack of suitable roughage existing in many wheat areas may prove to be a deterrent to finishing cattle. On the other hand, a joint product of wheat and wheat pasture may encourage finishing cattle.\(^10\)

In summary, the general trends for the feeding industry depend upon:

1. Growth of commercial cattle feeding.
2. Changes in feed grain base.
3. Changes in population and location.
4. Changes in government policy, credit and tenure.

\(^10\) It should be noted that recent feeding trials have been conducted that require little or no roughage.
A new dual grading system for beef offered to the industry on a trial basis for one year went into effect July 1, 1962. But long before this occurred various segments of the industry voiced considerable concern.

Important questions need to be answered about dual grading. For instance, why was it developed? The answer: To provide a system of grading beef which will more nearly reflect the quantitative and qualitative aspects of a beef carcass. The fact is that many believe the conventional grades do not reflect the amounts of waste fat that must be trimmed before retailing the beef to the consumer.

What is the net result of dual grading of beef? If adopted on a permanent basis this system will give incentives for increasing the quantity of high quality beef. Under the system it is anticipated that the packer, feeder, producer and breeder will be able to identify and expand the production of animals that are meatier and have less waste fat.

I will not discuss in detail the validity of using rib-eye area, fat cover thickness, kidney fat and carcass weight as factors for estimating carcass yield. Carcass yield can be used in several ways. In this discussion carcass yield refers to the quantity of boneless beef for the retail market (closely trimmed fat) which is obtained from the four major wholesale cuts - round, loin, rib and chuck. There is much agreement concerning the use of these factors to measure carcass yield.

But some have argued that conformation is still an important factor concerning degree of muscling in the rounds. For example will two carcasses with the same yield score and widely different conformation of rounds have the same cut-out value? It is argued that studies should be directed towards determining what effect lack of conformation has on the quantity of muscling of rounds from carcasses getting a high score on the basis of carcass yield. This research perhaps will be done in the future. And perhaps value differences of carcasses will be determined according to cut-out percentages.

Status of Beef Grading by Industry

Firms doing a big business use private labels or brand names extensively. Similarly these same organizations make much use of federal grades for beef that will qualify as "good" and "choice" under federal standards. In large organizations advertising on a national basis is common practice. By contrast, the small processor of beef is not likely to advertise his product. His position is that the federal

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stamps of "choice" and "good" permit him to compete with national packers, who have enough volume to advertise a brand name.

In advertising beef to the consumer retailers use the terms "U. S. Choice" and "U. S. Good." With over 1500 processors producing the same product it is only logical to accept these standards, which serve to identify the product. Many processors change the fresh product into a manufactured item so that their product achieves distinctive brand identity. But if every processor of beef used his particular standards much confusion would result as retailers tried to make their purchases on the basis of these many standards.

Retailers in the past have expressed concern over having a uniform set of standards which only the government could provide without bias. This concern has diminished in recent years with the growth of large merchandizing organizations. The increased bargaining power of the larger chains has given the buyer a stronger position in the market. Previously small independent operators were limited in their choice of beef. The meat selector today, however, may fill his orders for beef in the coolers, and the price has already been established in a previous transaction between buyer and seller. Private grades or brands of beef have been increased by the retailer but not to the extent to which federal grades are used.

Status of Dual Grading

Dual graded beef carcasses represent approximately 3% of the total beef processed under federal inspection. The quantity of dual-graded beef is estimated at 18 million pounds a month. Approximately 100 packers (6%) have their entire beef kill graded on a dual basis. In brief, dual grading has not been accepted to the extent anticipated. An appropriate question to ask processors using dual grading is this: What are the price spreads between yield grades of beef of a particular quality grade, such as choice? The spread is approximately $3 under present prices.

Some packers dual grade only those carcasses which would not grade choice under conventional federal standards. These carcasses, it is reported by some packers, sell for a price lower than those that qualify for choice under the conventional standards. Ideally under the standards this should not happen. Reasons given by buyers for the lower prices of these carcasses are: (1) poor conformation of rounds, (2) fat cover insufficient to warrant protection against loss of "bloom" or excess shrinkage, and (3) poor yield.

Thus perhaps more cutability tests should be conducted to determine whether or not carcasses with poor round (conformation) but high yield scores should be equivalent in price to carcasses possessing round of good conformation. Are the ill-shaped carcasses deserving of a lower price? The suggestion has been made that if beef carcasses with poor conformation can grade choice under the dual system why not incorporate these factors in the conventional federal standards to allow these carcasses to grade choice.
The USDA's Meat Grading Service collected data on more than 15,000 carcasses in selected plants. The carcasses grading choice by conformation, rated as follows on the basis of yield grades: grade 1, 3%; grade 2, 20%; grade 3, 45%; grade 4, 25%; grade 5, 10%, and grade 6, 1%. These are from a given section of the country and do not necessarily reflect the situation for the country as a whole.

**Feasibility of Dual Grading**

Retailers and packers have practically no problem in accepting dual grading as a means of measuring differences in yields of beef carcasses. But in transactions involving the feeder and the packer there are some problems which must be solved before dual grading can be recognized as a genuine service.

Ideally dual grading will identify high yielding carcasses to the packer and the feeder. Herein lies a problem which must be solved. In general three factors determine the value of the live animal—dressing percent, carcass yield and quality grade. If the first two can be recognized then the buyers will undoubtedly have to guess on the quality, which has always been the practice.

To recognize the relationships between live weight and carcass weight in the live animal is no easy task. An additional complication is to recognize in the live animal the degree of marbling as an indication of the quality grade. Also to determine whether or not the color of the meat will be satisfactory for that particular grade. If the packer can identify these on the hoof, so must the feeder and in turn the producer or rancher. All buyers and sellers in these transactions involving sale of beef animals from producer on to feeder and packer must be able to identify these cattle. Feeder calves will certainly be a large problem in this connection.

Increased production of higher yielding beef carcasses of high quality can be achieved if the industry accepts the challenge. It must be borne in mind that the tools for carcass evaluation are available. The USDA has provided them. Every packer should be able upon request to supply carcass data to the producer. The swine industry adopted a program which has resulted in meatier trimmer hogs.

**Issue in Dual Grading**

The issue in dual grading of beef is who is to do the work. Industry says it can do it more economically than government. Government and other agencies stress the importance of an unbiased party doing the work. If in the ensuing year the industry learns that dual grading is a necessary function in its business such grading will be adopted by those who can benefit from its service. On the basis of the problems in reflecting value differences back to the producer there is some question on the merits to the producer of dual grading. Seed stock must be improved and the producer must face this challenge to improve his herd. Similarly the various other agencies of the beef industry must recognize that their part in this program of improvement is to cooperate in many ways in passing information back to the producer.
GOVERNMENT POLICY AND THE BEEF INDUSTRY IN THE WEST

by B. D. Gardner and N. K. Roberts

Livestock ranching was one of the early industries established by the white man in the West. For half a century it provided the only economic use for much of the forage resource in the area. Crop production on irrigated farms sustained range livestock during the winter months.

During these early years there were no government programs for resource protection. Usually the rancher homesteaded small parcels of land near water and used in addition, vast acreages of nearby public land for his grazing stock. The stockmen were pretty much unrestricted in their use of public forage, and they pushed their opportunities to the limit. Each rancher knew that if his stock didn't get the grass, some other rancher's would. The inevitable result was widespread depletion of range forage and destruction of land and water resources.

Near the end of the 19th century the conservation movement gathered enough momentum to produce some government action programs in the West. Forage resources were in extremely bad shape. Moreover it became apparent that our rapidly growing country was soon going to need vast quantities of timber and minerals as well as grass. The result was the creation of the Forest Service in 1897 and the Bureau of Land Management in 1936. The primary interest of both agencies has always been to develop and conserve the natural resources under their charge.

At present practically all of the public land in the 11 western states is used for multiple purposes. Most of it simultaneously produces plant cover, functions as a watershed, and supports domestic livestock and game animals. Emphasis often is placed on some particular use, however, Many areas have distinctive value as recreation sites of various kinds. Others are better adapted to the production of timber and minerals.

Different types of policies have emerged over the years in attempts to "solve" the varied problems associated with complex patterns of resource use.

The problems concerned with allocating existing public resources among uses which compete for them have received much attention in the last few years. There have not been markets to establish economic values of the various uses. Thus political factors have been more important than economic factors in settling conflicts arising in allocating resources among uses.

1 The authors are associate professors of agricultural economics at Utah State University.
Other problems concern allocating resources among individual users within a given use. For example, policies exist which attempt to ration a given amount of grazing to certain stockmen. Much of this chapter concerns these policies and their impact on the ranching firm.

Finally, other problems are encountered in developing and preserving resources. This chapter also considers policies that affect the level of investment in range management and improvement. The total quantity and quality of forage available to the livestock industries in the West are affected by improvements made.

The federal government owns about 400 million acres of land in the 11 western states, slightly more than one-half of the total land area. The Forest Service in the Department of Agriculture administers about 170 million acres; the Bureau of Land Management (BLM) in the Department of Interior manages about 180 million acres. Several other agencies are responsible for the remaining 50 million acres.

Acreages, however, may overstate the importance of these lands to the livestock industry. In 1961 forest lands supplied only about 5.5 per cent of the total feed requirements for the beef cattle and sheep industries in the 11 western states. The BLM lands supplied about 11.7 per cent, making a total of about 17.2 per cent. Approximately 3.5 per cent of the ranchers in these two industries in the West hold Forest Service permits while about 27 per cent have BLM permits or leases. Of course, some forest permittees may hold BLM permits as well. These figures suggest that a substantial number of ranchers are affected by grazing policies of these two agencies. In fact, some permittees take very sizeable proportions of their total feed supply from the public lands, although all must supply some feed from their own private land to be eligible to obtain grazing permits on the public land.

Present Grazing Policies and their Impact on the Ranching Firm

The Forest Service presently permits grazing equal to about 7 million Aum's (animal-unit-months) annually. BLM grazing amounts to about 15 million AUM's annually. Both agencies use a system of permits which authorizes a specified amount of grazing on a given land area for a fixed season of use. The forest term "allotment," will be used to designate the grazing area.

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Permits generally have duration of 10 years, but the agencies can reduce the grazing quantity in the permit whenever agency officials think it necessary.

Some assumptions will simplify the real world complexities and enable us to identify important relationships. Assume, first, that each allotment is grazed by the stock of a single permittee. Let us initially suppose, also, that the rancher is not restricted as to how he must use the allotment. He can stock it at any rate he wishes. Each stocking rate per allotment per season will have a certain value to the rancher in terms of animal production and/or maintenance. Let us call this series of values at various stocking rates the demand for grazing.

Many factors will influence this demand relationship. The important ones are the quantity of federal grazing used relative to other production inputs, the price of the livestock production which is produced, the weather and other production conditions beyond the control of the rancher, and the "state of the arts" or technology of production.

As the price of the animal production from grazing increases, the demand for grazing services will rise. If we assume perfect competition in the product market, however, the product price will be unaffected by the actions of the ranching firm and can be assumed as given. Consequently, it cannot shift demand as the rancher alters the stocking rate.

The most important weather conditions affecting forage production are rainfall and length of growing season. For the most part these are beyond the control of the stockman and cannot be altered by management decisions. We will, therefore, assume this factor to be constant in our analysis.

Improvements in technology of forage production are usually accompanied by increasing output per dollar of cost. The same can be said for developments in animal technology. Our attention, however, must be limited initially to other phenomena, so we will assume technology to be given also. This assumption will be relaxed when we look at ranching as a dynamic industry over the long pull.

Under this set of assumptions, changes in demand can be attributable only to changes in the quantity of public grazing used relative to other inputs. Taking greater quantities of public grazing on an allotment involves increasing the stocking rate. Fig. 1 shows hypothetical functional demand relationship (D) between the stocking rate and the value of livestock production and/or maintenance.

We would expect that as long as forage is abundant and livestock do not compete for it to any perceptible extent, increasing the stocking rate would increase livestock product at a constant rate. The value of grazing will be constant at a high level at low stocking rates. As the stocking
rate increases to the point where animals compete for forage, however, the value of increased stocking rates would decline. As the stocking rate is further increased, a point might be reached where forage becomes so scarce that the livestock cannot even maintain themselves and value may be negative as shown in Fig. 1.

Dollar Value of Livestock Production and/or Maintenance

Fig. 1

Stocking rate per allotment per season
Assume that the non-fee marginal costs of grazing the number of animals implied by each stocking rate are constant at MC in Fig. 1. Suppose the agencies charge a fee indicated symbolically by f. The non-fee marginal cost plus the fee equals MC' in Fig. 1. In the absence of stocking rate controls, and assuming the rancher acts in such a way as to maximize profits, he would logically choose the stocking rate qo, where marginal cost equals value of grazing.5

Of course, this stocking rate may not be maintainable over the years. If perpetuated, the rate may produce overgrazing and reduce the quality and quantity of range forage over time. If so, demand will fall until an equilibrium position is reached at some sustained yield level of forage production where MC' equals some stable demand curve.

As we indicated earlier, a primary reason for entry of the government agencies into the land management field was to protect and preserve resources. Both the Forest Service and the BLM have set the quantity of grazing to be allowed on a given allotment. A reasonable assumption is that the agencies attempt to manage the forage resources in such a way as to maximize forage production over time. The maximum sustained level of forage production can be defined as the renewable limit. Since other uses compete for forage resources, the quantity allocated to livestock grazing is most often below the renewable limit. Accordingly, suppose the quantity of forage allocated to livestock grazing is fixed at stocking rate S0 in Fig. 1, and that S0 is below the renewable limit.

The demand relationship is obviously not independent of the level of total forage use. If range condition is below maximum forage potential and forage use is below that level required to maintain present range condition, the quantity and quality of forage will increase over time and demand will rise. If range condition is at the maximum level of production, forage resources are wasted if they are under-utilized. The opposite results occur if forage use surpasses the renewable limit; i.e., the range then deteriorates in plant quantity and quality. For simplicity, we will assume that the agencies fix S0 at that level where S0 plus other forage uses equals the renewable limit. Thus, demand does not shift over time as a result of changing range condition.

If the stocking rate, and the implied AUM's of grazing are at q1, the value per unit of this forage is p1. Assuming the fee plus other costs of using the public range to be MC' or P0, it follows that the forage is being "underpriced." That is to say, at price P0 there is more demand than

5For the reader who may be acquainted with the terminology in economics, the schedule we have called a demand curve is really a value of marginal product schedule, and represents the value of incremental increases in stocking rates. The traditional concept that profits are maximized where marginal returns are equal to marginal costs is fulfilled at qo in Fig. 1.
supply and some rationing system must be used to allocate the grazing.

Both the Forest Service and the BLM have devised rationing systems to allocate supplies of livestock forage. The agencies grant permits only to ranchers who meet certain prerequisites. When permits were originally issued, ranchers had to have been "prior-users" of the range before the government began to manage it. Stockmen now must have "commensurate" base property to maintain stock during that part of the year when they are not using the public range. The ranch must be "dependent" on public land for a "well-balanced" livestock operation. These currently are the main prerequisites. When they are rigidly adhered to, a large number (perhaps a majority) of western ranchers are ineligible with their present ranching setups. Those who do qualify are forced to maintain the eligibility prerequisites, which often conflict with economic efficiency. Fulfilling the prerequisites increases the cost of production to the rancher. We will assume that these "extra" costs of maintaining eligibility will increase the marginal costs to $MC''$ in Fig. 1.

At the stocking rate $q_1$ the distance between $P_1$ and $P_2$ is "surplus value" per unit of stocking rate. To the extent that the regulations allow permits to be transferred between ranchers without private base property or other appendages, this "surplus" will be capitalized into permit values. If base properties or livestock must be transferred with the permit, some of the "surplus" will be capitalized into these assets, and they will carry higher values than their own productivity alone would warrant.

Original rancher permittees received a windfall. That is the "surplus value" represented by the area $P_1P_2$ times $q_1$ was capitalized into permit values and/or inflated base property. This doesn't mean, however, that these ranchers were necessarily better off than before the range was incorporated into a forest or grazing district. They were then grazing without fee, so a substantial windfall was wiped out when public management and charging of fees were instituted. In fact, the public range was "underpriced" when the first permits were issued largely because of resistance to competitive pricing from the ranchers who had been using the range without charge.

Consider the situation of a rancher who did not receive a permit initially but who later acquired one formerly held by another. This rancher must meet prerequisites and thus incur more cost. In addition, he must

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purchase the permit and base property if he cannot provide his own. In any case, he gets no "surplus" as the original permittee did. It is clear, therefore, that sustained "underpricing" does not involve a subsidy to succeeding generations of permittee ranchers.

Thus far we have not presented empirical support for the relationships we have postulated.

Consider the evidence that public grazing has been underpriced. It is apparent that if the cost of grazing were equal to its value a rationing system to allocate the forage among ranchers would be entirely superfluous. Those who were willing to pay the price would be able to acquire the grazing. The existence and use of a complex rationing system, therefore, is evidence that public forage is underpriced, and that demand exceeds supply.

It is similarly apparent that before grazing permits can have market value two conditions must be met. Some differential between the value and cost of grazing must be available for capitalization into permit values. Some provision must also be made in the regulations for transfer of grazing permits from one rancher to another in order for a market value to exist. The fact that one can go into any community in the West where public grazing is an integral part of ranching and find values quoted for public grazing permits demonstrates that these two conditions have been met. In a study of northwestern Colorado ranches in 1958, we found Forest Service permits being transferred at an average value of $16.45 per AUM. BLM permits had an average value of $10.95. More recent data from Utah show that forest permits are presently being transferred at a price ranging from $16 to $25 with the average being about $20 per AUM. BLM permits are moving within a range of $8 to $14 with an average of $10 per AUM. It should be made clear that these market values were appraised independently of attached base properties. That is, the transferable value of the public grazing was completely captured in the permit values.

We are not arguing that the full differential between the fee and the value of public grazing is capitalized into permit values. The fact that many ranchers cannot meet eligibility requirements undoubtedly reduces the demand price. In addition, the stringent prerequisites reduce transfer possibilities. Ranchers who get permits incur costs in maintaining eligibility. This reduces the net value of permits. Lower permit prices therefore result from eligibility requirements and transfer impediments.

These factors cause misallocation since the forage cannot be transferred to ranchers who could use it most efficiently and who would acquire it in a free market. Nevertheless, permits could not have value unless the public grazing is underpriced. It is likewise evident that the owner of the forage resources, the general public, is not realizing full value of the forage in fee receipts.

It is often tempting to compare rentals from private grazing lands to fees for public grazing of similar quality. Such a comparison is not completely valid. The private rental ordinarily includes the value of various services provided to the renter by the landlord; these are not provided to permittees by the government. Stated in another way, the rancher incurs non-fee costs in grazing the public range which are not incurred if he rents private range. Some examples are greater transportation costs, herding and fencing costs, and usually, additional death losses and lower calf crops. To be strictly comparable to private rentals these costs should be added to the fee.

Private range lands in the West are being rented at prices from $2.50 to $4.00 per AUM at the present time while the BLM fee is $0.19 and the average Forest Service fee is about $0.60. It has been estimated that "added" costs of running animals on the forest in northwestern Colorado amount to about $1.33 per AUM. Assuming this figure applies to all public lands, the sums of fee plus "added" cost are $1.52 and $1.93 per AUM for the BLM and forest lands, respectively. The marginal cost of an AUM of public grazing is less, therefore, than an AUM of private grazing. This comparison, however, does not allow for the fixed cost required to obtain the public grazing permit. It is impossible, therefore, to conclude from these figures that public grazing is necessarily the more profitable.

One minor point should be cleared up. Both the BLM and the Forest Service determine fees by formulas which require that the fee change in rough proportion to changes in livestock prices. This means that livestock prices and fees remain approximately constant over time relative to each other. This must not be confused, however, with the proposition that the fee is equal to the value of the grazing. This is false.

The impact of these pricing and allocating policies on the ranch firm that leases grazing is pronounced and sometimes critical.

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9This argument is elaborated in B. D. Gardner, "Transfer Restrictions ..." Op. Cit.
We have postulated that if ranchers were free to determine how much public grazing they would take in any given season, they would maximize profits by taking that number of AUM's where marginal cost equals marginal revenue. Marginal revenue is approximately equal to the private market value of an AUM of grazing. We have demonstrated that "underpricing" exists. In a perfectly competitive market this is equivalent to saying that marginal cost is below marginal revenue. The rancher desires more grazing than is available to him at present fees. In other words, there is an economic shortage of public grazing at prevailing fees. Rationing systems rather than price allocate grazing quantities, and these are inefficient in the sense that we can never be sure that the grazing is used by those to whom it has maximum value.

Current pricing and allocating systems also exert considerable influence on the asset structure in ranching. The sales value of a ranch depends largely on how many animal-units it can support. In areas where public grazing tenure seems reasonably secure, ranches with some public grazing often have sales values per animal-unit just as great as where all forage is supplied by private lands. For example, ranches may be selling for $500 per cow, and it doesn't matter whether the carrying capacity is produced on both private and public land or alternatively, on private land only. Where this situation prevails, the seller of a ranch might be able to capture the full value of the attached public lands.

In most areas, however, the ranch sales price per animal-unit is lower if part of the grazing is supplied from the public land. No doubt this is so because an AUM of carrying capacity can't be as valuable if its future use is uncertain. Still, private land that has a permit attached to it is always worth more than private land of similar productivity that doesn't.

As a result, ranchers who have access to public grazing have a substantial amount of wealth tied up in grazing permits and in inflated private base properties to which permits are often attached.

Peak grazing on the forests occurred in 1918, when over 20 million AUM's were grazed. By 1933 the number of AUM's had been reduced to about 13 million; by 1961, to about 7 million. AUM's on the grazing districts of the Bureau of Land Management have remained substantially constant since 1940, although it is beginning to appear that the BLM is considering grazing reductions also. Since no compensation is paid to the rancher when the

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12 This particular situation seemed to be the case in certain areas studied in Northwestern Colorado. It was especially true where the public land was BLM parcels where individual ranchers had almost exclusive use.

agencies reduce grazing, the rancher suffers a loss of wealth. The extent of the loss depends upon the value of the cancelled grazing and any reduction in the value of his own base property. If ranchers have lost 13 million AUM's of forest grazing since 1918, this amounts to a loss of 260 million dollars, assuming each AUM to be worth $20 in 1961 prices. Generally, the public range supplies grazing for certain seasons; if it is eliminated, the complete ranching program is disrupted. The loss sustained by the rancher might be substantially greater, therefore, than the sum directly attributable to the permit itself.

When part of the forage supply of the ranch is eliminated, the rancher must seek other feed sources if he is to maintain his herd and his ranching business. Other things being equal, other feed prices will rise above the levels that would persist if public grazing had not been reduced.

How much feed prices will be affected depends on the size of the public grazing cut, the importance of public grazing to the individual rancher, the possibilities of utilizing other feed substitutes, and reductions in herd size that might follow grazing cuts. Conceivably, herd size might be reduced by the same proportion as that represented by the reduction in public forage relative to the total feed supply. This would leave the demand for other feeds unchanged. Such an occurrence is extremely unlikely, however, as animal-units of grazing stock in the West have been increasing despite reductions in public grazing. Furthermore, public grazing has contributed less than one-fifth of the total feed supply. This means that an annual loss of 1 million AUM's (a comparatively large cut) would reduce public grazing by about 5 per cent and the total feed supply in the West by about 1 per cent. It seems plausible, therefore, that an annual loss of a million AUM's would not substantially alter the relative costs between feed sources and therefore would not perceptibly drive up feed prices. It must be admitted, however, that substitutes for lost forage would not be easy to find in all cases. Wealth losses always occur when permits are cut, and such cuts may cause financial hardship, especially in the short-run, for ranchers operating on narrow margins.

**Anticipated Policy Changes and their Impact**

The foregoing analysis suggests that grazing policy has misallocated resources among uses and users and has inequitably distributed the economic returns. That is, on the one hand transfer impediments, uncompensated grazing cuts, and "underpricing" have prevented optimum efficiency of resource use. On the other hand, the resource owners, the public, have been shortchanged in that they have not collected the full value of the forage. In addition, ranchers are operating under an inefficient rationing system not of their making, and they stand to lose substantial amounts of wealth as resources used for grazing are transferred to other uses.
Pressures to correct these difficulties have been growing in recent years. In general, the public seems to be increasingly aware of the potential value of its once inaccessible resources in the West. Better transportation, more leisure time, longer vacations, preferences for more outdoor recreation, and higher incomes have fostered wider and more active interest by more people. In addition, local pressures for re-examining public land policy have grown as population has shifted from rural to urban pursuits and emphasis has shifted from ranching to recreational uses of public lands.

Supplies of livestock forage on public ranges can be expected to decrease as demand for recreation, in its various extensive and intensive forms, and interest in conservation and watershed development increase. Outdoor recreation has manifold components: hunting, fishing, camping, picnicking, sightseeing, hiking, and others. All of these become competitive at some point with livestock grazing.

A changing public attitude toward natural resources will almost certainly result in eventual changes in Federal land management policies. These measures will probably take the form of increased grazing fees, a continued reduction in public forage allocated to grazing use, and perhaps a relaxation of permit transfer restrictions.

The general public impression that past grazing policies have subsidized ranchers will generate pressure for increased grazing fees. In many quarters it is argued that ranchers receive a continuing subsidy as long as under-pricing exists. This claim is largely erroneous as we demonstrated in the last section. The complete windfall from underpricing was captured by the first generation of permittees. Successive generations have paid "full" value for public grazing and have not received windfall gains except as there have been unexpected increases in the value of grazing relative to fees. Because fees change relative to livestock prices even this possibility has been largely eliminated.

Of course, the livestock industry did receive windfall gains and the public was shortchanged in the original permit issue. However, we would ask the question: Is it in the public interest to impose wealth losses on one group of citizens (present permittees) to compensate for the wealth subsidies granted to a different group (original permittees) many years ago? This would be one specific effect of an increase in grazing fees.

In the short run, ranchers will suffer a decline in annual income by the amount of additional fees paid. In terms of Fig. 1, the MC will increase by the amount of the fee change per unit. If the rancher were just covering his average variable costs before, an increase in the fee might force him out of business unless other compensating factors come to his rescue. We say it this way because data developed from a recent ranching study\(^{14}\) in Utah.

indicate that current fees compose 3 to 8 per cent of total cash costs of ranches using public lands. Generally, the fee part of ranchers' cash costs is even lower in other areas of the West. A change in price of $1 per hundredweight for livestock sold would have about twice the effect on net income as would doubling the BLM fee and increasing the Forest Service fee by $0.20 per AUM over 1960 levels. Ranch income is much more sensitive to product price changes than to substantial grazing fee increases. Still, even small fee increases might cause severe stress to ranches just breaking even.

The effect on capital asset values of fee increases is closely related to the fall in annual income. Recall our previous conclusion that the difference between the net value of forage at assigned stocking rates and the fee has been captured in higher permit and base property values. An increase in fees will reduce this difference and cause a capital loss to permittees. Permit and/or base property values will fall. Though the effect on capital value will occur soon after the announcement of fee increases, out-of-pocket losses may not be incurred until the rancher sells his ranch or attempts to borrow money with ranch assets as collateral.

Heavy grazing cuts have already been made on the forests and are expected to continue. The BLM is almost certain to make cuts in the next few years. Range appraisers in the agencies claim the stocking rate is higher than renewable limits in many areas. In some cases ranchers have taken the initiative in reducing range use even before the agencies have required it, especially on some BLM ranges. In 1960 it was estimated by BLM personnel that 10 to 15 per cent of the permitted AUM's on BLM ranges in Utah were not used by ranchers. This doesn't necessarily mean the present forage isn't worth the fee. Rather, ranchers may be able to maximize the difference between fee and forage value over time by allowing the range to recuperate to a higher level of productivity.

Though the renewable limit for a given range may become stabilized at some high level, it seems certain the allowable limit for domestic livestock will decrease over time ($S_0$ in Fig. 1). The development of watersheds, the expansion of wilderness areas and national parks, the maintenance of big game herds, and measures for conserving natural resources will shift land use away from grazing. In addition, urban transportation and industrial developments will require more public land as time passes. These factors will accelerate the existing trend toward ranch consolidation and intensification.

15 This information was given in conversation with the Utah BLM State Director at that time and supported with estimates made by BLM District managers in the state.
A loss of public range through permit cuts can have a much more telling effect on ranch income and wealth than a large per cent increase in fees. For example, a 20 per cent cut in permitted AUM's on a seasonal range for an average ranch with public grazing would require an 8.3 per cent reduction in herd size if the total rancher response was in herd reduction. Such a response would reduce ranch income on the average cattle ranch by about $1,300 and on the average sheep ranch by $3,000. Ranches just breaking even before a permit cut would be forced to reorganize immediately to compensate for income losses or to sell out. Selling out would be distasteful, however, because at least 20 per cent of rancher investment in permits plus considerable depreciation of base property values would have been lost.

As competing forage uses push stocking rates to lower levels, the value per AUM of public grazing may rise or fall. As we move back to a higher point on the demand curve in Fig. 1, each remaining AUM has a greater value providing the bundle can be economically used. If permit cuts continue, a point will ultimately be reached where it just doesn't pay to graze on the public range at all. Of course, what happens to the total permit value, that which remains after the cut in grazing will depend on the increase in value of the AUM's compared with the loss of AUM's that are cut. The crucial factor is the elasticity of the demand curve. The evidence suggests the curve is not perfectly elastic and that cuts in grazing are followed by slightly higher per AUM values, but much lower total permit values.

No concerted effort is being made at the present time to change base requirements and transfer restrictions, although we and others have suggested that this problem be examined. If no changes are made, resources will continue to be misallocated among rancher users. We think this is a rather critical problem and that policy changes that might be used to correct the situation should be discussed.

Misallocation of public forage within the livestock industry will remain as long as there are impediments to the transfer of permits and ranchers have little security of grazing tenure. Our proposal, set out in the next few paragraphs, should materially correct such misallocation.

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16 For detail see D. D. Caton et al., Economic Relationships ... op. cit.
17 Ibid.
18 For a discussion of the importance of uncertainty in establishing permit values, as well as some empirical data see J. W. Milliman, "Capitalized Values and Misallocation in Grazing Public Range," Journal of Farm Economics, Vol. 43, No. 4, November, 1962. See also the reply by B. Delworth Gardner in the same issue of Journal of Farm Economics.
Existing permits should be converted into "rights" to graze a given number of AUM's on a given allotment for a certain season of use. Ranchers should be able to regard these rights as property and be free to buy and sell them as they wish. Present prerequisites for acquiring and holding permits such as priority, commensurability, and ownership of base properties and livestock, should be eliminated. Rights would be passed on to heirs as other property rights are. The only restriction would be that livestock of a specified kind must utilize the grazing. This restriction is necessary for range protection.

It may appear that the "right" proposal propounded here might interfere with agency management of forage resources and the allocation of resources among uses. We do not think so; in fact, our proposal should produce definite improvements over present practices. If the agencies wish to transfer resources to other uses they would simply move into the market and buy up sufficient rights to accomplish their purpose. As for resource protection, the ranchers themselves would find it in their best interests to preserve the productivity of the allotment and also invest in economic range improvements. In addition, the agencies could continue to make investments that appear to be necessary in multiple-use management, as they do at present.

How could the transition to this proposed system best be made? We believe the right should be issued to those who presently hold permits. As present permits expire the rights for the same number of AUM's could be issued in exchange. As range productivity increases, conceivably more grazing could be allowed than is covered by the current permit system. If so, the additional rights could be sold at auction to the highest bidder. If grazing must be diminished the agencies could purchase rights as earlier suggested. Some kind of third-party appraisal system might be necessary if the buyer and seller can't come to an agreement on a fair price.

Since the rights are unencumbered with eligibility qualifications and involve no risk of uncompensated grazing cuts, would windfalls be created by issuing rights to present permit holders? The answer is no, providing that the fee is "properly" set. The annual fee per AUM must be set below the market value of the forage. If the fee were set at the value of grazing, the right itself would have no value and could not be bought and sold by ranchers. If the fee were set near present levels, windfall gains would be created for the initial right recipients since the right is a much more substantial asset than is the present permit. It follows that at some fee higher than present fees, rights would be worth on the average exactly what permits are now. To avoid windfall gains and losses to stockmen as much as possible, the government should ascertain what this fee level would be and charge it. Thereafter the fee should vary with general price level movements so as to be constant in "real" terms. This would prevent fee changes that produce wealth losses and would enable ranchers to estimate how much they could afford to pay for rights.

This is the general idea of the proposal. Many details have been left
out in the interest of space. Expected results are impressive. The government would not obtain as much in fee receipts as the grazing is worth, although fees would be higher than at present. The agencies would have more revenues from grazing to use in improving and managing the public resources under their care. Ranchers would be equally as well off in terms of their wealth positions, but would pay higher fees. At the same time, however, they would have guaranteed tenure and protection against wealth losses.

Society's gains would be likewise impressive. A mechanism would be provided for transferring resources out of grazing without the political and legal turmoil that now exists. Ranchers would find it in their best interest to care for and improve public ranges as they do their own. Public forage would be allocated more efficiently among ranchers, and as a result society would benefit by realizing more product from its resources.

Many forces are in motion in the West that will tend to offset the deleterious effects of increased fees and reductions in public grazing. Ranch asset values in the West are being influenced by numerous and important factors. Population in the region is growing faster than the national average. Some areas are industrializing at a rapid pace. Non-agricultural uses of land and water resources are increasing. The probable result is higher land values. In most parts of the West the value of ranch base properties will probably increase more than enough to compensate for capital losses that would result from grazing fee increases and permit cuts.

If range type operations are to expand or even maintain the present share of a growing market for livestock products, management will have to become more intensive. Private grazing lands and public lands used for grazing can be made much more productive. These possibilities are so promising that we will present some of the details. Time and space will not permit complete coverage of the research available, however,

A study concluded in 1960 on improving meadow land in Nevada, involved four sets of improvement practices. When improvements consisted of leveling, draining, reseeding, fertilization, controlled irrigation, and well development, annual forage production increased almost 3.4 tons per acre with the return on the investment amounting to 18.5 per cent (with forage priced at $16 per ton). For meadow land improved as just described, except that no wells were developed, forage production increased about 2.3 tons per acre and when priced at $16 per ton returned 26.8 per cent on the investment. When improvements consisted of controlled irrigation, limited drainage, reseeding, fertilization, and partial leveling, forage production increased about 2 tons per acre and returned 46 per cent on the investment. When the only improvement practice was to change from wild flooding to controlled irrigation, forage yields increased about 0.58 tons per acre.

and returned nearly 293 per cent on the investment.

These data from operating ranches suggest that returns to capital investment increased rapidly at first but eventually at a decreasing rate as expenditures increased on a given ranch. The return to improvement capital, however, in each alternative studied was far above the market rate of interest for money, indicating a profitable venture.

Unfortunately, many ranchers do not have meadow land of the type studied in Nevada. How can other types of privately-owned range land be adapted to more intensive management? The Utah Agricultural Experiment Station has published some information on reseeding.\(^2\) Ranges in western Utah with a carrying capacity of approximately 10 acres per AUM were reseeded with crested wheatgrass. The carrying capacity for seeded areas studied rose to an average of 3.8 acres per AUM. Yearling steer and heifer gains on unseeded ranges averaged 1.2 pounds per day, but were nearly 2 pounds per day on seeded range. Instead of 10 AUM's of forage on 100 acres a rancher could obtain slightly more than 26 AUM's of forage yielding considerably more marketable product. One hundred acres of improved private range could replace 16 AUM's formerly obtained from unimproved public range during the season. If necessary, such an adjustment could compensate for the loss of about 160 acres of public range land.

A recent study\(^2\) of northwestern Colorado ranches indicated that, on the average, reseeding returned 15 per cent on investment, sagebrush spraying 9.5 per cent, sagebrush beating 4.8 per cent. However, these rates do not reveal the profitability of these practices to the rancher. The U.S. Department of Agriculture is paying about 50 per cent of the total cost of these "conservation" practices. This means that the rates of return to the rancher's share of the cost are about twice those reported.

It must be remembered that these research results are of very recent origin, most of them in the last five years. Ranchers haven't begun to exploit potentials for profitable improvements. Because the returns are so impressive, however, and because ranchers are being squeezed by shortages of range forage, it seems certain that range improvements will increase tremendously in the next decade, especially if the government maintains its conservation program with large ACP payments. In our opinion, these sources of increased forage will more than offset losses on the public range. The cattle industry is not likely to reduce numbers of range livestock in years ahead. The sheep industry has other problems, such as foreign competition, that dwarf in importance such things as public

range policy, so its future is much more problematical.

The possibilities for internal ranch management improvements may further forestall decreases in numbers of cattle in the West. Operations may shift from the basic cow-calf type, largely dependent on range, to farm herds and feeder type activities. The rapid expansion of population in the West assures an expanding market for finished animals, and more feeders may remain in the area rather than move to the Midwest.

Of course, much depends on the general health of the cattle industry. Over the long pull most signposts seem to point to a favorable economic climate for cattle. Increased consumption of beef per capita, an expanding population, high income elasticities for beef, rising personal incomes, better transportation, etc., all substantiate an optimistic forecast. With respect to the range livestock industry in the West, our conclusion is that the relative cost of producing cattle will not rise perceptibly as a result of anticipated public range policy. Too many favorable offsetting factors exist. If other sections of the country are planning to replace western feeder cattle in the feeder markets around the country, they will have to be prepared to produce at lower cost. Western stockmen seem reasonably well equipped to maintain their present position, at the very least.
To the extent that the feed-grain program has reduced the supply of feed-grain and raised or supported the price of feed over what it would have been, it has reacted to the economic advantage of the beef cattle industry. It has increased the demand for beef and the total income to the beef industry partly at the expense of the concentrate-consuming livestock enterprises of hogs and poultry.

Feed grains make up a higher proportion of the feed inputs for hogs and poultry than for beef cattle. Therefore, when the price of feed grains rises costs of hog and poultry producers increase relatively more than those of cattle producers. Thus the feed price rise checks the expansion of these enterprises more and leaves less pounds of pork and poultry to compete with beef. Cross elasticity of demand studies indicate that a pound of other red meat and poultry has 40 to 50 per cent as much affect on the price of beef as another pound of beef. Therefore, a decrease in the supply of these competing meats increases the demand for beef.

Producers of feeder cattle have often looked with economic concern upon programs that raised the price of corn. It is true that for any one year a rise in corn prices may weaken the demand for feeders. Nevertheless, over the longer period, higher priced corn gives cattle producers an economic advantage over hog producers. For example, if the price of corn could be cut in half, hog producers would get a larger share of the total meat market than now.

The impact of a feed grain program on the beef cattle industry takes on meaning only in relation to the impact of some other course of action to meet the farm surplus problem. Therefore, let us look at the total farm problem and the impact of the feed grain program as compared to the impact of other farm program alternatives.

In this analysis I assume that there are interactions between the agricultural and non-agricultural sectors of the economy, and interactions between land and other resources, and between individual crop and livestock enterprises. I recognize that a dynamic situation is involved, that there are further interactions arising from increasing capital and technology in production and marking, and from changes in total demand and in consumer preferences.

The Nature of the Surplus Problem

During the past decade, agricultural output has increased at the rate of

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1 Mr. Bottum is professor and assistant head of agricultural economics. Purdue University.
approximately 2.6 per cent per year. Because of our growing population and improved diets, the domestic demand has increased slightly less than 2 per cent per year. Neither increased foreign exports nor new industrial uses of farm products have closed this gap. This leaves us at the beginning of the decade of the 1960's with an agricultural plant geared to produce from 5 to 6 per cent more products than the present market will take at acceptable prices as expressed by Congress on numerous occasions.

The real problem of agriculture is not the 7 to 8 billion dollars worth of agricultural products in storage, although this aggravates the situation and increases the cost of farm programs. Rather it is that we have an agricultural plant geared to produce each year 5 to 6 per cent too much.

Two events in recent years have been largely responsible for bringing about this problem.

Near the close of World War I the rate of gain in agricultural output per farm worker began to exceed the rate of gain in population. This made possible for the first time an absolute decline in the number of farm workers. The rate of gain in agricultural output per worker relative to the growth in the population has continued since that time. It increased at an accelerated rate during the 1950's and continues to result in surplus human resources in agriculture despite the rapid flow of human resources out of agriculture.

At the beginning of the 1950's the rate of increase in yields of crops per acre began to exceed the rate of increase in the population. During the decade of the 1950's yields of crops per acre increased on average by one-third; demand for food to feed our growing population increased about one-fifth. It takes fewer acres to feed the population today than in 1950; therefore, we now have a surplus of a second resource, crop-land.

This surplus resource situation holds true for each of these resources. Unless new outlets are found for farm products, the optimum combination of resources at any acceptable level of prices involves both less human resources and less cultivated land than are now committed to agricultural production.

Because these resources have not moved out of production in sufficient degree, the output of agriculture has tended to outrun demand for farm products at prices socially acceptable. The demand for total agricultural production is very inelastic. Thus farmers are penalized severely when supplies exceed a level which reasonably meets requirements. This tendency for agriculture to overproduce since the 1920's except for the war and postwar periods is the heart of the agricultural price and income problem.

With present expected trends in the adoption of new technology, this
situation appears likely to extend through the 1960's unless through our education or action programs we modify this situation.

The substitutability of resources in agriculture is sufficiently great that a reduction of output of one commodity or even several commodities results in the resources being transferred to the production of the non-limited commodities. Thus, the farm income and price problem is an aggregate problem. Attempting to solve it on a partial basis simply results in its being transferred from one group to another group of commodities.

Possible Approaches

There are three possible approaches that might be taken to aid in solving the farm problem: (1) expand outlets for farm products, (2) store food and make payments to farmers to relieve the income situation, and (3) adjust the output.

Nearly everyone would like to solve the farm problem by expanding foreign outlets, by using more farm products in industry and by expanding the food consumption at home. If this could be done, then agriculture would not have to adjust its output, and we could continue full production with reasonable prices. Nearly all analysts of the farm problem believe we should continue to work vigorously for the expansion of the market for farm products both at home and abroad. But they see expansion of the market as only a partial solution of the farm problem in the immediate period ahead. In the longer run, these possibilities may become more important.

By putting commodities into storage and by making payments to farmers for shifting production or for other purposes associated with production, we may ease the current income situation for farmers. However, unless the payments are made in a manner which brings about adjustments in supply, they simply relieve the income situation for the moment and continue the maladjustment problem. In fact, if too large operations are undertaken, they tend to increase the imbalance problem. This is what we have been doing. Thus the imbalance in agriculture has continued to increase even though many necessary adjustments have taken place.

The third possibility is to try to adjust the supply or the resources in agriculture while maintaining farm income. This is the area where legislation will continue to be considered.

Here four approaches may be taken or some combination of them:

(1) The use of quotas or supply management control on all commodities.

(2) Allowing free prices to operate.

(3) compulsory or mandatory land retirement.
(4) Voluntary land shifts or land retirement.

The limitation on capital inputs has been also proposed, but no serious program has been developed along these lines because of the difficulty and implications of limiting the various capital input items. Proposals for reducing the human factor have taken the form of providing better facilities for making the transfer out of agriculture rather than directly limiting this factor.

If any of the above four approaches is used for adjusting supply, it results in reducing both the manpower and the cultivated land used in agricultural production.

If quotas are imposed on part of the commodities, then the surplus resources are transferred to other commodities and necessitate quotas on these commodities. If commodity quotas are imposed on all commodities and production is reduced, this means less human resources and less land used in crop production. If free prices are allowed to operate, then agricultural prices will fall to the point where the marginal crop land and the marginal producer will shift out of agriculture, thereby reducing the use of these resources. If compulsory or mandatory cropland controls are used, it means less land will be under cultivation and less human resources will be needed. Even if the land is taken out of each farm, it will speed up the recombination of farms and the reduction of both of these resources. If voluntary land retirement is used either on a partial or whole farm basis, it, too, will reduce the land under cultivation and the amount of human resources needed in agriculture. It should be recognized that all of the supply adjustment programs seriously proposed to reduce the use of crop land and human resources. Therefore, let us look at the feed-grain program, which is a voluntary land retirement program and what it has done. Then let us compare its impact on the cattle industry with the other approaches.

The 1961 and 1962 Feed-Grain Program

As a result of the feed-grain program and the conservation reserve program, farmers reduced feed-grain output in 1961 and 1962 below annual utilization. In addition to the acreage reduction represented by acres put into the conservation reserve they reduced the acreage in feed-grains by 19 million acres in 1961 and by 24 million acres in 1962. Thus, the total of 105 million acres of feed-grain harvested this year was 24 million acres below the 1959 and 1960 average, the base period for the feed-grain program.

This reduced total feed-grain supplies on October 1, 1961 approximately 5 million tons below the previous year. Supplies were reduced another 13 million tons on October 1, 1962. Corn production was 3.6 billion bushels in 1961 and 3.5 billion bushels in 1962 while utilization for the average of the two market years approximated about 4 billion bushels.
With loans for those complying with the program set at $1.20 per bushel for corn and with the corn released operation financing the program, the free market price at the farm was held at around $1.00 per bushel. Other feeds have been held in line with corn.

**The Feed-Grain Program Compared to Other Alternatives**

In appraising the impact of the feed-grain program on the beef cattle industry in relation to other programs, one must make certain assumptions relative to the price and income goal for agriculture. In this comparison I am assuming programs which would hold livestock prices near the averages of 1961 and 1962 and at the same time move modest quantities of grain out of storage annually. I further assume that the land retired from production would not be pastured. Allotments would continue on cotton, tobacco, rice and wheat. Livestock prices would be expected to continue at such levels as to provide the normal livestock feeding ratios and to fluctuate at competitive relationships with each other. I would further assume that we would continue our programs to maintain and expand markets at home and abroad.

Such a goal could provide agriculture with a net income in the immediate period ahead of around $13 billion compared with 12.7 billion in 1961. This is approximately in line with the goal set forth by the Secretary of Agriculture. A goal much higher than this would probably result in part of the gains being capitalized into land. Under free prices during the adjustment period it is assumed the income would be considerably less than this.

If instead of the feed-grain program, we had continued a purely price support program which had held corn prices near the same level, as with the feed-grain program, the impact on the beef cattle industry would have been the same as with the feed-grain program. However, stocks of corn held by commodity credit would have been much larger. Such a program would not have been continued indefinitely because of the increase in feed stocks. If it is assumed that at some later date the stored feed would be fed to livestock, then the beef industry would be in a less favorable situation than with the feed-grain program, under which land retirement kept the feed from being produced.

If we had gone to a compulsory feed-grain program without payments, then feed-grain prices would have had to be held 5 to 10 per cent higher than with a voluntary feed program in order to give feed producers the same income. This would have been because the producers' volume of production would be decreased without any offsetting payment for retiring the land. This greater restriction of production and higher price of feed grain would have given the beef industry more advantage than the present voluntary feed program and more than under the free prices.

If presently held government stocks had been held off the market and free prices had been allowed to operate, there would have been a substantial drop in farm prices according to three different studies. Feed prices would
have been lower, resulting in an increase in competing meats and a lower demand for beef. Beef production and feeding would also likely increase in the feed-grain areas. After the longer run adjustments were made under free prices, the price of corn would probably be lower relative to cattle than under a feed-grain program and other meats would continue more competitive than under a feed-grain program.

No analysis is being made of a quota control program for all livestock because, (1) such a program in the period immediately ahead does not seem likely, and (2) such an analysis would require many assumptions as to how such a program might be administered.

**Longer Run Considerations**

We have now an agricultural plant of 450 million acres of crop land in the United States. Numerous analyses show that we can meet our needs with 50 to 80 million less acres of land in crops. Every realistic proposal to bring agricultural production into better balance with demand results in less acres in harvested crops, including the proposal of free prices and no program.

Studies show that an acre of cropland shifted to grass and used by beef cattle produce about one-third as many calories of food as when it is in a grain crop and fed to concentrate-consuming livestock. Thus production can be reduced two-thirds as much by shifting cropland to grass and using the grass as by idling the land.

The demand for beef in the United States has been increasing at from 3 to 3.5 per cent annually.

While for a time we may leave the land retired from crops idle, I would hazard a guess that eventually some of this cropland will find its way into pasture, timber and recreational uses. This is likely to happen either with or without a farm program or under any of the proposals.

If this shift should occur, the beef industry does not need to fear it. Every acre shifted from grain production to pasture will decrease the supply of competing meats sufficiently to more than offset the increased beef supply. Roughly every time cropland is shifted to grass and is used by beef cattle, the supply of competing meats is reduced by three pounds for every one pound increase in beef. In terms of the cross elasticity of demand and the effect of the total smaller supply of meat, this means a higher price for beef. For example an acre of good corn belt land which will produce 80 bushels of corn per acre, will supply the feed for 900 pounds of live hog production. Figuring 75 per cent dressing percentage this will make 675 pounds of pork and lard. If this same acre is placed in pasture with equally good management it will produce 300 pounds of live cattle. Figuring a 60 per cent dressing percentage this will make
180 pounds of beef. Thus, the food product per acre with beef is less than one-third as much as with hogs. For the United States the production of calories with grass and beef is about one-third as much as with grain and hogs or poultry, the grain consuming livestock.

SUMMARY

1. Government programs will likely result in a reduction in the amount of land in harvested crops.

2. If none of this land is used for grazing, the beef industry will benefit at the expense of hogs and poultry when compared to no program.

3. If the land shifted out of crops is allowed to be grazed, the beef industry will be better off than if the land remained in crops.

4. It would appear that the present feed-grain or cropland adjustment program has economically benefited the beef cattle industry.