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# Economic Considerations of the Effects of Sire and Length of Feeding on Beef Steers and Carcasses

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## SUMMARY

This project was a continuation of previous work in beef preference by the Missouri Agricultural Experiment Station. Consumer and laboratory preference panels were used to determine whether sire and feeding period differences could be detected in sampled steaks. Twelve sires and five lengths of feeding period were represented.

Results in general coincided with previous studies that used such panels for preference testing. Members of the laboratory panel were able to discriminate between sires and lots but members of the consumer panel were not.

The six-member laboratory panel and the 200 household, 400 member, consumer panel were required to rank the steaks, or samples of steaks, on the basis of flavor, tenderness and over-all desirability. If lots 2 and 4 are excluded because of their different handling, both panels agree in preferring the lots in reverse order from their length of feeding. The consumer panel scores by lot were not significant but they agreed with those of the laboratory panel in showing a slight preference for the lighter, shorter fed animals having a minimum of external fat. Weight and fat were far more important than quality grade in determining the consumer ratings.

The data revealed a significant lot effect for lifetime average daily gain, indicating that gain declined with additional feeding. The sire effect, however, was not significant, even when length of feeding was held constant.

To determine which of the sires were most effective in transmitting superior gaining rates to their progeny, Duncans NMR test was employed. The results showed a superiority of AN048 over HP015 and Hh096. The net revenue functions derived by lot and by sire were biased by inclement weather which affected these three lots. The system net revenue (farm-retail spread) by lot showed a tendency for the shortfed lots to have the highest spread, which would have been more pronounced had the total cost for the longfed lots resembled data reported previously.

The system net revenue, on a sire basis, was highest from progeny of sire AN048 which averaged $30 higher per animal than the lowest sire Hh096. Had separate feed records been collected by sire the difference might have been smaller; however, the spread gives breeders encouragement for further research effort.

The producer selling on a quality grade basis would logically choose to produce lot 1 weight steers and use sires AN048 and AN044 which returned the largest producer net return by lot and by sire. There was a tendency for the steers with highest value (at least on a sire average basis) when placed on feed to also return the highest net returns when slaughtered.

The packer-retail spread was highest with the younger, lighter weight lots. The packer would have preferred to have handled lot 1 steers because they returned a larger profit, whether he sold on quality or quality and yield grade basis. The packers' potential profit was highest from sire HP019 and lowest from AN048, the sire which maximized producer net returns.

The addition of yield grades to the net revenue functions resulted in larger producer net revenues (or smaller losses) on both sire and lot basis and reduced packer-retail spreads.

The retailer would maximize net returns by purchasing lot 1 and 3 steers within the quality grades Good and Choice. Retailer return maximizing sires were HP019 (Good), Hh096 (Good-Choice), and AN046 (Choice).

## Implications

The data revealed a slight consumer preference for lighter, shorter fed beef. The industry has responded by feeding to lighter weights but the data indicate a further drop in weight is desirable. Producer payment on the basis of retail yield would further spur a reduction in selling weight.

The sizeable breed differences in total returns found in the study may indicate a need for further research to improve gain rates and to improve beef edibility characteristics by hereditary methods. Of course an improvement in reducing the heterogeneity (variation) within existing breeds would be a worthy starting place. Even though the short run answer to overfinished beef is reduced feeding period, the long run answer may be the development of new strains or breeds of cattle which maintain higher yield through a broader range of weights.

Perhaps widespread adoption of yield grading, subject to unbiased industry, state, or federal supervision may be the answer. This would encourage shorter feeding and use of steers which are more efficient converters of resources into lean meat. This, supposedly, is what the game is all about.

This study suggested several areas which invite continued research:

- A more thorough study of the breed effect (including more breeds) under similar conditions to those encountered in this study.
- Extend the feeding period to encompass younger, lighter weight steers to determine the weight actually preferred by consumers.
- More extended research on feed costs in the 500 to 1,000 pound live weight range is needed to determine effect of feeding on total costs of production.

## CONTENTS

# Economic Considerations of the Effects of Sire and Length of Feeding on Beef Steers and Carcasses

## INTRODUCTION

Numerous research studies have been made concentrating on various levels of the beef marketing system beginning with the producer and ending with the consumer. These efforts have gathered much data covering resource allocation, pricing, production and processing costs, market structure, retail concentration, and consumer preferences. In many cases the role of government in the industry in grading, standardization, and regulation has been included as it pertains to the individual levels of the system.

As a result of the separate studies the system has become more efficient and flexible. The studies have made it better able to meet the changing requirements placed upon it by a rapidly developing technology, the shifting export demands, and an increasing domestic demand. Extension of these separate studies beyond their natural boundaries (sources of data) or combining them requires the assumption of homogeneity of data.

Such a procedure is often entirely justified and permits a much broader interpretation of the individual studies. A more satisfactory method of studying the beef marketing process, however, would be to follow a beef sample from production through the various levels of the system, ending with an analysis of consumer evaluation of the product itself. This publication reports on an attempt at a modified form of such a study. Not all of the requirements were met. But enough were to permit this study to be termed a simulated industry marketing concept study.

What were the distinguishing characteristics of this "system" study? Two hundred feeder steers were selected from known ancestry (known sire at the minimum) and full fed in five periods, ranging in length from 139 to 251 days. The steers were slaughtered and loin steaks from each steer were subjected to laboratory panel, consumer panel, shear, and chemical tests for ratings of edibility characteristics. Records on costs, gains, returns, and acceptability ratings were kept by feeding period length and by sire.

What answers were expected from this study? The time series data permitted evaluation of the steer from the time of weaning until the meat reached the con-

sumers' table, culminating in net revenues per animal for the various stages of the marketing process. A more accurate appraisal of the causes of high or low returns (or rate of gain or consumer acceptance) was made possible and the method increased the degree of confidence in the results.

Problems uncovered by other studies were analyzed in this one, such as overfinishing, variable consumer acceptability standards, and non use of the retail yield factor in pricing. Much progress has been made by the industry in reducing slaughter weights and over-all finish. Advances also have been made in meeting the weight, grade and finish most acceptable to the consumer. Much less progress has evolved in gaining use of retail yield as a factor in pricing of beef.

## The Problem

Various means have been used to increase the consumer acceptability of beef. Many of these involved specific treatments of the beef after, or just prior to, slaughter. Others involved specific feeding or care of the feeders themselves. The influence of heritability on gain rates and conformation has been studied widely. Much less attention has been paid to its effect on meat characteristics. If desirable edibility characteristics could be attained through selective breeding, the need for supplementary means of improving beef edibility would be reduced.

The extent of variation in length of feeding on acceptability (and carcass returns) of beef has been studied previously. However, the combination of selected breeding (sires) and controlled feeding (lengths) has not been reported. Consumers, in general, reject beef with high external fat and are conscious of the role of fat consumption in their diets. The result has been industry pressure for lighter weight slaughter animals.

## Objectives

The objectives of the study reported here are:

(1) To determine the effect of extended feeding on retail yield and market value of cattle and their carcasses.
(2) To evaluate the feedlot performance and quantitative carcass characteristics of progeny by sire groups.
(3) To ascertain the influence of sire and feeding length variation in slaughter steers on consumer and laboratory panel acceptance of beef loin steaks.

## Review of Previous Research

Numerous studies have been made of the effect of feeding period length on preferences. Tuma (28), Dunsing (10) and Ramsey (22) found that tenderness and over-all rating dropped as animals matured beyond 11 months of age. Others have reported little or only a small positive relation between age and tenderness [Palmer (21), Alsmeyer (1) and Field (13)].

The effect of feeding period length on rate of gain and carcass composition has been reported by several. Hendrickson and Monroe (15) indicated a five-fold increase in weight of fat as animals matured from 9-24 months. Little (19),

studying Angus steers, reported that the percentage of retail cuts decreased significantly ($P<.05$) when feeding period increased from 28 to 112 days. It is generally accepted that rate of gain declines with increased feeding, especially if fat increases are not included as gain. A dissenting opinion has been reported by Dinkel (9), who reported no change in percentages of lean and fat as weight was increased from 750-1,250 lbs.

Suess (26 and 27) reported that sire explained little of the variation in tenderness, juiciness, or palatability of beef tested by preference panels and by shear. Differences due to breed in tenderness were reported by Cartwright (4), Klosterman (17), Hedrick (16), and Ramsey (23). Cartwright reported statistically significant ($P<.05$) differences between Hereford, Brahman, and their crosses. Klosterman's and Hedrick's findings concerned Charolais, Hereford, and Angus. Ramsey studied only the latter two breeds.

Sire differences in progeny attributable to breed have been reported. Results conflict. Ramsey (22), De Rouen (8), Butler (3), Cole (6), and Hedrick (14) reported Angus progeny quality graded significantly higher ($P<.05$). In studies involving Angus and Hereford-sired progeny, Cole (6) and Butler (3) found Hereford progeny faster gainers with better feed efficiency. In general, Hereford-sired progeny showed larger loins, legs, and rounds [Butler (3), Cole (5, 6)] than Angus, whereas Angus-sired steers have larger chucks and a greater fat content [Cole (5) and Butler (2)]. Hedrick (14) reported Angus progeny higher yielding than Hereford; Butler (2) disagreed.

## PROCEDURE

### Selection and Treatment of Steers and Their Carcasses

A non-random sample was selected. Included were 200 progeny (steers) of 12 purebred sires (four Angus, six Polled Hereford and two Horned Hereford) and purebred or crossbred Hereford and Angus dams. These steers were randomly placed into five uniformly aged lots such that each sire had the same number of offspring in each lot (Table 1). The different lots were to receive different lengths of feeding.

The steers were weaned in the summer of 1965 and placed on full feed. When the average slaughter grade of all lots was estimated to be at least high Good, lot 1 was removed from feed and slaughtered. This lot was on full feed for 139 days. Lot 2 through 5 were taken off feed in order after 167, 195, 223, and 251 days on feed (or every 28 days) and slaughtered. The ration fed (Table 2) was changed as feeding progressed to increase the energy content. Feed consumption data and weights were recorded at selected intervals. From the weights, average daily gains were calculated by lot and by sire.

After slaughter the carcasses were given a 48-hour chill and then were ribbed and graded (for both quality and yield). The right sides were quartered and cut into boneless retail cuts, with the exception of the short loins which were left intact. The loins from lots 1, 3, and 5, were wrapped, blast frozen and stored from

Table 1

DISTRIBUTION OF STEERS BY SIRE AND LOT

| Sire[a] | Lot 1 | Lot 2 | Lot 3 | Lot 4 | Lot 5 | Total |
|---|---|---|---|---|---|---|
| AN044 | 2 | 2 | 2 | 2 | 2 | 10 |
| AN045 | 5 | 5 | 5 | 5 | 5 | 25 |
| AN046 | 5 | 5 | 5 | 5 | 5 | 25 |
| AN048 | 3 | 3 | 3 | 3 | 3 | 15 |
| HP014 | 5 | 5 | 5 | 5 | 5 | 25 |
| HP015 | 3 | 3 | 3 | 3 | 3 | 15 |
| HP016 | 4 | 4 | 4 | 4 | 4 | 20 |
| HP017 | 3 | 3 | 3 | 3 | 3 | 15 |
| HP018 | 3 | 3 | 3 | 3 | 3 | 15 |
| HP019 | 3 | 3 | 3 | 3 | 3 | 15 |
| Hh005 | 2 | 2 | 2 | 2 | 2 | 10 |
| Hh096 | 2 | 2 | 2 | 2 | 2 | 10 |
| Total | 40 | 40 | 40 | 40 | 40 | 200 |

[a]Note: AN = Angus, HP = Polled Hereford and Hh = Horned Hereford

Table 2

RATION COMPOSITION (POUNDS)

| Component | Ration "8C" | "BCI 8" | "Steer 7" | "9" |
|---|---|---|---|---|
| Alfalfa Meal | 500 | 375 | 350 | 300 |
| Cracked Corn | 2250 | 2250 | 2410 | 2800 |
| 50% Supp. w/stil. | 200 | 150 | 120 | 125 |
| 50% Supp. wo/stil. | 100 | 75 | 0 | 0 |
| Salt | 30 | 30 | 30 | 30 |
| Molasses | 150 | 150 | 150 | 150 |
| Total | 3230 | 3030 | 3060 | 3405 |

5 days (lot 5) to 124 days (lot 1) at 0°F. Loins from these lots were removed later. Steaks were cut from them, 1½ inch thick for shear tests and ¾ inch for laboratory and consumer panel sampling. All steaks were wrapped individually and returned to a 0°F. freezer. Laboratory panel steaks were stored from 10 to 32 days (the period used by the laboratory panel). The consumer steaks were stored from 1 to 15 days before being removed for testing.

The loins from lots 2 and 4 were handled different from lot 1, 3, and 5 loins. They were evaluated only by the laboratory panel. Instead of being frozen as whole loins first, they were cut into steaks after the initial chill period. The steaks were wrapped and stored in a 0°F. freezer for a minimum of 52 days and a maximum of 139 days.

## Selection Procedures for Laboratory Panel

The laboratory panel members were selected from University personnel and graduate students. They were screened by a process consisting of rating known

meats on a flavor intensity scale (see Appendix A, Figure 1). The panel held two sessions per day, sampling six steaks per session. The steaks had been randomly assigned to sessions with the sole provision that each lot be represented at each session.

After an initial controlled thaw, each steak was broiled to an internal temperature of 155°F. and then held for 5 minutes in a 150°F. oven. The portions of steak tasted were cut from the *longissimus dorsi* of each steak. The portions were randomly assigned to the panel members. The testing environment was carefully controlled to remove or mask the influence of most variables exogenous to the steaks. The evaluation schedule used by the laboratory panel called for ratings on flavor, tenderness, and over-all desirability (See Appendix A Figure 1).

## Selection and Procedures for Household Consumer Panel

The 200 household consumer panel was selected from random block cluster samples of residents of Jefferson City, Mo. They evaluated loin steaks from lots 1, 3, and 5. Restrictions on selection of households were those given in Appendix A, Figure 2. Households were required to include a man and a woman.

Housewives from the households chosen were interviewed to determine eligibility and to record the information requested on the Household Data Sheet (Appendix A, Figure 3). The housewives were told when to expect delivery of the steaks and requested to serve them intact within a week.

The loins were assigned randomly to households. Ten households were serviced by each pair of loins, such that a given household held a particular steak position on the loin. Each household received two steaks per delivery (week) for three deliveries (weeks). Each loin was therefore evaluated by 10 individual members of the consumer panel, five men and five women (with men and women alternating on the loin). The consumer panel evaluated the steaks for flavor, tenderness, and over-all desirability (Appendix A, Figure 4).

## Determination of Net Revenue by Sire and Lot

Data on feed consumption was recorded by lot but not by sire. Unfortunately, unusually bad weather during the latter part of the feeding periods for lots 4 and 5 upset normal rates of gain and invalidated cost data for these lots.

Live animal weights were recorded at regular intervals, including the weights when animals were placed on feed and when they were ready for slaughter. The feeder steers were valued at the beginning of the test using current feeder steer prices adjusted for feeder grade. Non-feed costs were assumed to be $0.12 per head per day. Value of the carcass at retail was computed from the USDA composite carcass price for the period of slaughter. Live animal (producer) values were determined from prices actually existing at the time of slaughter for steers of similar grades and weights. The value of fat was assumed to be 3¢ per pound to a packer and of no value at retail.

The net revenue functions (profit or loss) on lot and sire basis were derived from the following formulas:

Farm-Retail Spread = Retail composite carcass price + Value of packer fat trim - (Value when placed on feed + feed cost + non-feed cost)

Producer Net Revenue = Live animal value on a quality grade basis (or live animal value on quality and yield grade basis) - (Value when placed on feed + feed cost + non-feed cost)

Packer-Retail Spread = Retail composite carcass price - live animal value on quality grade basis (or live animal value on quality and yield grade basis).

## ANALYSIS OF RATE OF GAIN BY LOT AND SIRE

Live steer weights were taken at the beginning of the feeding period, at selected intervals during the feeding period, and when the animals were removed from feeding for slaughter. From these measurements, two types of average daily gains (ADG) were obtained: ADG for lifetime of the animal and ADG for the period under feed. Feed period ADG was expected to decline with feeding while the ADG relationship by sire and breed was an unknown factor. Differences in ADG would be a valuable factor in sire or breed selection. But the harsh weather that affected the later lots resulted in some actual weight losses for the affected periods, invalidating comparisons.

Table 3 gives the average daily gain (along with other live animal and carcass characteristics) for the 200 steers by lot and sire. As expected, ADG declined with additional feeding when only the feeding period was considered. For the lifetime period, lots 2 and 4 interchanged positions.

For the lifetime period, Stringer (25, p. 1548) reported (from analysis of variance tests) that the mean square for lot was significant ($P<.05$) for rate of gain. The mean square for sire was not significant at the same level. The data, therefore, did not show a significant difference between sires.

Individual differences in rates of gain were rather large, but these differences were not generally associated with any particular sire. Only one sire (AN048) produced noticeably higher total gains. Eleven of this sire's 15 offspring exceeded a 1,000 pound slaughter weight. This sire produced the heaviest (1385#) and the second heaviest (1280#) test progeny as well.

Duncans New Multiple Range Test is useful in detecting superior performance of one sire in relation to another. Duncan's test, as extended by Kramer (18) for uneven treatment sizes, was used to test rate of gain by sire. It was applied first by holding feeding period length (lot) constant and then for all lots together. The results are in Table 4. In general, Duncan's test revealed a superiority of sire AN048 progeny in rate of gain over those of sires HP015 and HhO96.

Table 3

LIVE ANIMAL AND CARCASS CHARACTERISTICS BY LOT AND SIRE

| Grouping | Age at Slaughter Days | Live Slaughter Weight Lbs. | Lifetime ADG Lbs. | Days on Feed | Weight Gained on Feed Lbs. | Feed Period ADG Lbs. | Hot Carcass Weight Lbs. | Carcass Quality Grade | Carcass Yield Grade |
|---|---|---|---|---|---|---|---|---|---|
| Lot 1 | 413 | 918 | 2.05 | 139 | 408 | 2.94 | 541 | 17.1 | 2.82 |
| 2 | 447 | 948 | 1.90 | 167 | 461 | 2.76 | 551 | 18.5 | 3.36 |
| 3 | 464 | 971 | 1.94 | 195 | 476 | 2.44 | 585 | 19.2 | 3.55 |
| 4 | 493 | 1047 | 2.00 | 223 | 537 | 2.41 | 645 | 19.3 | 3.70 |
| 5 | 529 | 1074 | 1.88 | 251 | 582 | 2.32 | 659 | 18.9 | 3.84 |
| Sire 05 | 489 | 1023 | 1.89 | 195 | 514 | 2.42 | 617 | 18.7 | 3.61 |
| 14 | 472 | 986 | 1.97 | 195 | 482 | 2.50 | 586 | 18.2 | 3.59 |
| 15 | 477 | 958 | 1.87 | 195 | 452 | 2.21 | 572 | 17.6 | 3.32 |
| 16 | 461 | 962 | 1.92 | 195 | 489 | 2.41 | 577 | 18.5 | 3.06 |
| 17 | 456 | 984 | 2.00 | 195 | 512 | 2.51 | 591 | 17.8 | 3.53 |
| 18 | 466 | 949 | 1.88 | 195 | 476 | 2.27 | 560 | 18.3 | 3.35 |
| 19 | 468 | 1018 | 1.89 | 195 | 494 | 2.39 | 612 | 17.9 | 3.68 |
| 44 | 467 | 1006 | 2.00 | 195 | 502 | 2.55 | 605 | 19.8 | 3.24 |
| 45 | 466 | 977 | 1.95 | 195 | 489 | 2.42 | 591 | 19.4 | 3.42 |
| 46 | 470 | 1022 | 2.03 | 195 | 497 | 2.41 | 620 | 19.0 | 3.44 |
| 48 | 471 | 1075 | 2.12 | 195 | 545 | 2.63 | 664 | 19.2 | 4.17 |
| 96 | 477 | 939 | 1.80 | 195 | 450 | 2.11 | 558 | 18.6 | 2.89 |

Table 4

ANALYSIS OF VARIANCE BY LOT OF RATES OF GAIN FOR LIFETIME AND FOR FEED PERIOD ONLY

| Item | Source of Variance MS Sire | MS Error | "F" |
|---|---|---|---|
| Lot 1 (Feed Period) | 3878 | 3604 | 1.07 |
| Lot 2 (Feed Period) | 3608 | 1054 | 3.42 * |
| Lot 3 (Feed Period) | 3743 | 2907 | 1.28 |
| Lot 4 (Feed Period) | 3669 | 3152 | 1.16 |
| Lot 5 (Feed Period) | 7128 | 3671 | 1.94 |
| Lot 1 (Lifetime) | 4838 | 7855 | .61 |
| Lot 2 (Lifetime) | 5317 | 6256 | .85 |
| Lot 3 (Lifetime) | 8525 | 4385 | 1.94 |
| Lot 4 (Lifetime) | 11058 | 5514 | 2.00 |
| Lot 5 (Lifetime) | 10906 | 7478 | 1.45 |
| All Lots (Feed Period) | 8885 | 6802 | 1.30 |
| All Lots (Lifetime) | 22537 | 9886 | 2.28 * |

*P < .05

## DEVELOPMENT AND ANALYSIS OF NET REVENUE FUNCTIONS

As indicated earlier, one objective of the study was to determine net revenue functions to denote returns and profitability for the various levels of the beef marketing system. Each of the segments of the system (producer, packer, wholesaler, retailer, etc.) is striving, generally, to maximize net returns within their individual constraints. As will be shown, the goals in one segment are often difficult to obtain within the restraints imposed by other segments of the system. In this analysis net revenue accruing to the entire market system was calculated, then net revenues for the individual segments were figured.

### Computations of Costs and Returns

The rations used (Table 2) averaged approximately 2¢ per pound. Non-feed costs of 12¢ per head per day were obtained from a study conducted by McCoy and Hansman (20) of a 2,500 head capacity feed lot at 75 percent utilization rate. The remaining producer cost (assuming producers total cost = feed cost + non feed cost + initial cost of feeders) involved valuing the steers when placed on feed (8/24/65).

The feeders were graded prior to going on feed using the scale: 17 (Fancy plus), 16 (Fancy), . . ., 14 (Choice plus), . . ., 9 (Good minus). Prices for these grades were obtained from published sources (11) for the August-September, 1965, period for Good and Choice 500-800 pound feeder steers. A linear interpolation between the two prices (Good $22.58 cwt. and Choice $25.74 cwt.) was made to satisfy the grade scaling above.

Total revenue was assumed to consist of the composite carcass price plus the value of packer trimmed fat. Net revenue would therefore consist of total revenue minus producer's cost. The composite prices for Choice carcasses were obtained from the LMS (12). Adjustment of this price for Good carcasses was made as suggested by Cramer (7). Linear interpolations between the Choice and Good grade prices were made to correspond with the carcass quality grades used: 17 (Good), 18 (Good plus), . . . , 21 (Choice plus). The value of fat at the packer level was assumed to be 3¢ per pound.

### Farm-Retail Spread by Lot

Since carcass composition changes with feeding length, the net revenue from the five lots will differ. Table 5 gives the data leading to farm-retail spread (system net revenue) by feeding period length. The composite carcass price used was the average for the period in which the steers were slaughtered.

Note that the largest farm-retail spread is not associated with the longest feeding period but with the shortest. The high retail yield coupled with lowest feed costs easily overcame the lowest quality grade and weight. The spread was expected to be in almost reverse order of length of feeding. The fact that total cost declined for the last feeding period and failed to increase much for the fourth (due chiefly to the inclement weather noted earlier) explains partially why this expectation was not fulfilled.

### Farm-Retail Spread By Sire

Unfortunately separate records were not kept for feed consumed by progeny of each sire; therefore, feed cost per animal has been assumed as a constant. For the analysis by sire all steers were considered to be on feed for 195 days (actual lot 3 length) even though actual days on feed varied from 139 to 251 days. The net revenues (farm-retail spread) by sire are recorded in Table 6.

The most readily apparent observation from Table 6 is the large spread attained by progeny of AN048. Progeny of Hh096 had the lowest spread ($30 less than AN048). This large a difference between sires was not expected due to the assumed homogeneity of sires as each sire was performance proven or under evaluation for the rating. Possibly this spread would have been smaller had feed records been kept by sire as well as by feeding period.

### Producer Net Revenue (Quality Grade Basis) By Lot

Up to this point producer and packer net revenue maximization has been ignored. Table 7 lists the return to the producer when prices recognize weight and quality grade differences. The live animal prices are from the LMS (12) for the slaughter period. Again a linear interpolation was made to relate prices to the quality grade scale using the differential recorded earlier for Good grade.

The profit maximizing producer who had perfect knowledge definitely would not have slaughtered these steers at the end of feeding period 1 but would have held them until the end of feeding period 2. Table 7 indicates lot 5 was the most

Table 5

CALCULATED FARM TO RETAIL SPREAD BY LOT (MEAN COMPOSITE CARCASS PRICE)

| Lot # | Days on Feed * | Wt. When Placed on Feed Lbs.* | Total Gain Lbs.* | Total Feed Consumed Lbs.* | Feed Per Cwt. Gain $* | Cost Feed Per Cwt. Gain $* | Total Feed Cost $* | Total Non-Feed $* | Feeder Grade * | Value When Placed on Feed $* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 139 | 510 | 408 | 129,254 | 792 | 15.84 | 64.63 | 16.68 | 12.40 | 128.77 |
| 2 | 167 | 487 | 461 | 156,371 | 848 | 16.96 | 78.19 | 20.04 | 12.00 | 120.19 |
| 3 | 195 | 495 | 476 | 173,264 | 910 | 18.20 | 86.63 | 23.40 | 12.23 | 123.75 |
| 4 | 223 | 510 | 537 | 192,461 | 896 | 17.92 | 96.23 | 26.76 | 12.38 | 128.75 |
| 5 | 251 | 492 | 582 | 193,690 | 832 | 16.64 | 96.84 | 30.12 | 12.03 | 121.43 |

* Average Per Animal
** Average Per Carcass

| Lot # | Total Feed, Non-Feed and Beginning Cost $* | Average Composite Carcass Price $/cwt. | Retail Cuts Lbs.* | Value of Retail Cuts $* | Fat Lbs.* | Value of Total Fat $* | Total Value $** | Farm Retail Spread $* |
|---|---|---|---|---|---|---|---|---|
| 1 | 210.08 | 84.40 | 373.7 | 315.40 | 84.6 | 2.54 | 317.94 | 107.86 |
| 2 | 218.42 | 84.71 | 258.2 | 303.43 | 102.4 | 3.07 | 306.50 | 88.08 |
| 3 | 233.78 | 85.02 | 377.9 | 321.29 | 118.2 | 3.55 | 324.84 | 91.06 |
| 4 | 251.74 | 85.02 | 410.0 | 348.58 | 139.9 | 4.20 | 352.78 | 101.04 |
| 5 | 248.39 | 85.02 | 407.8 | 346.71 | 152.9 | 4.59 | 351.30 | 102.91 |

Table 6

CALCULATED FARM TO RETAIL SPREAD BY SIRE

| Sire # | Days on Feed * | Wt. When Placed on Feed Lbs.* | Wt. Gained Lbs.* | Feeder Grade * | Value of Animal When Placed on Feed $* | Total Feed, Non-Feed and Beginning Cost $* | Average Composite Carcass Price $/cwt.** | Retail Cuts Lbs.** | Value of Retail Cuts $** | Fat Lbs.** | Value of Total Fat $** | Total Value $** | Farm-Retail Spread $* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 195 | 509 | 514 | 12.10 | 125.62 | 233.52 | 84.86 | 393.7 | 334.09 | 125.32 | 3.76 | 337.85 | 104.33 |
| 14 | 195 | 504 | 482 | 11.88 | 121.97 | 229.87 | 84.71 | 380.7 | 322.49 | 118.28 | 3.54 | 326.03 | 96.16 |
| 15 | 195 | 506 | 452 | 12.07 | 124.88 | 232.78 | 84.40 | 372.5 | 314.39 | 111.26 | 3.34 | 317.73 | 84.95 |
| 16 | 195 | 473 | 489 | 12.15 | 116.74 | 224.64 | 84.86 | 381.6 | 323.83 | 107.06 | 3.22 | 327.05 | 102.41 |
| 17 | 195 | 472 | 512 | 12.53 | 119.18 | 227.08 | 84.40 | 380.8 | 321.40 | 116.86 | 3.50 | 324.90 | 97.82 |
| 18 | 195 | 473 | 476 | 11.80 | 114.47 | 222.37 | 84.71 | 366.6 | 310.55 | 107.58 | 3.22 | 313.77 | 91.40 |
| 19 | 195 | 524 | 494 | 12.33 | 132.31 | 240.21 | 84.40 | 400.8 | 338.28 | 116.38 | 3.50 | 341.78 | 101.57 |
| 44 | 195 | 504 | 502 | 12.30 | 127.26 | 235.16 | 85.64 | 394.7 | 338.02 | 119.34 | 3.58 | 341.60 | 105.44 |
| 45 | 195 | 488 | 489 | 12.44 | 123.22 | 231.12 | 85.32 | 379.7 | 322.87 | 122.16 | 3.66 | 326.53 | 95.41 |
| 46 | 195 | 525 | 497 | 11.96 | 129.57 | 237.47 | 85.02 | 396.6 | 337.15 | 129.16 | 3.88 | 341.03 | 103.56 |
| 48 | 195 | 530 | 545 | 12.53 | 133.83 | 241.73 | 85.32 | 411.5 | 351.09 | 157.96 | 4.74 | 355.83 | 114.10 |
| 96 | 195 | 489 | 450 | 12.50 | 123.47 | 231.37 | 84.86 | 368.1 | 312.37 | 94.44 | 2.84 | 315.21 | 83.84 |

Note: Feed Cost Per Animal was assumed to be $84.50 and Non-Feed Cost Per Animal was assumed to be $23.40. Therefore feed and non-feed costs were $107.90 per animal.

*Average per animal
**Average per carcass

Table 7

CALCULATED PRODUCER NET REVENUE AND PACKER-RETAIL SPREAD BY LOT

| Lot | Slaughter Weight Lbs.* | Slaughter Quality Grade** | Av. Price $/Cwt. | Total Producer Revenue $* | Total Cost of Production $* | Producer Net Revenue $* | Retail Yield %** | Total Retail Value $** | Packer-Retail Spread $** | Total Retail Cuts Lbs.** | Packer-Retail Spread Per/Cwt. Retail Cuts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 918 | 17.1 | 22.84 | 209.67 | 210.08 | .41 | 70.97 | 317.94 | 108.27 | 373.7 | 28.97 |
| 2 | 948 | 18.5 | 23.32 | 221.07 | 218.42 | 2.65 | 67.62 | 306.50 | 85.43 | 358.2 | 23.85 |
| 3 | 971 | 19.2 | 24.27 | 235.66 | 233.78 | 1.88 | 66.48 | 324.84 | 89.18 | 377.9 | 23.60 |
| 4 | 1047 | 19.3 | 24.27 | 254.11 | 251.74 | 2.37 | 65.50 | 352.78 | 98.67 | 410.0 | 24.07 |
| 5 | 1074 | 19.0 | 24.27 | 260.66 | 248.39 | 12.27 | 63.97 | 351.30 | 90.64 | 407.8 | 22.23 |

*Average per animal.
**Average per carcass.

profitable for the producer. The indicated drop in cost of production between feeding periods 4 and 5 is inconsistent with previously published data concerning the effect of length of feeding on cost of gain (19). A calculated guess would place lots 4 and 5 at near the same producer net revenue level per animal.

### Producer Net Revenue (Quality Grade Basis) by Sire

A similar analysis by sire is recorded in Table 8. The most profitable progeny for the producer were those from sires AN048 and AN044 while the least profitable (largest losses) were from sires HP015 and Hh096. Among sires, offspring from sire AN048 were the most expensive (highest feeder grade) when placed on feed yet returned the largest net revenue to the producer. The least expensive offspring (those of sire HP018) when placed on feed did not return a profit but did not bring the greatest loss. Sire HP015 showed the greatest loss. Higher initial quality tended to be most profitable on a sire basis whereas it was not so on a lot basis.

### Packer-Retail Spread (Quality Grade Purchase) by Lot and Sire

Tables 7 and 8 also list other pertinent data including the packer-retail spread. This spread tended to decline with feeding, especially when placed on a per 100 pound retail cwt. basis. The spread on a sire basis was less meaningful except (on a 100# retail cwt. basis) for sire AN048 which had maximized producer returns. However, the $15 difference in spread between the low and high sire is justification for packers to consider the breeding when purchasing inputs (steers).

### Addition of Yield Grade to Net Revenue Computation

The analysis of the producers' position has, thus far, been predicated on the assumption that the steers were valued at the producer level on only weight and quality grade standards. Fortunately the USDA yield grade is available to improve the accuracy of producer prices. The carcasses were each given a USDA yield grade (1-5) based upon their yield of boneless, closely trimmed cuts from the round, loin, rib, and chuck. An average yield grade was calculated for each lot and sire and recorded in Tables 9 and 10.

The price differentials used for this analysis are *estimates* of the average differentials existing between yield grades during the July, 1967 to June, 1968, period reported by the USDA (Tyler 29). The differentials used per hundred-weight are: Yield Grade 1 (+$1.50), 2 (+$1.00), 3 (+0.50), 4 (0), and 5 (-$0.50). Tables 9 and 10 give the net revenue to producers and the packer-retail spread by lot and sire using quality and yield grade pricing.

The most noticeable effect of the addition of yield grade to the producer price was to reduce producer's losses and packer-retail spreads (both on lot and on sire basis). Lot 1 became profitable, indicating that carcass value determination on quality and yield grade basis aids the producer of lighter weight steers. The average progeny of all sires became more profitable (or suffered smaller losses) for the producer but progeny of Angus sires were most profitable, due principally

Table 8

CALCULATED PRODUCER NET REVENUE AND PACKER-RETAIL SPREAD BY SIRE

| Sire | Slaughter Weight Lbs.* | Slaughter Quality Grade** | Av. Price $/Cwt. | Total Producer Revenue $* | Total Cost of Production $* | Producer Net Revenue $* | Retail Yield %** | Total Retail Cuts Lbs.** | Total Retail Value $** | Packer-Retail Spread $** | Packer-Retail Spread Per Cwt. Retail Cuts $** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 1023 | 18.7 | 23.80 | 243.47 | 233.52 | 9.95 | 66.14 | 393.7 | 337.85 | 94.38 | 23.97 |
| 14 | 986 | 18.2 | 23.32 | 230.17 | 229.87 | .30 | 67.13 | 380.7 | 326.03 | 95.86 | 25.18 |
| 15 | 958 | 17.6 | 22.82 | 218.62 | 232.78 | -14.16 | 67.28 | 372.5 | 317.73 | 99.11 | 26.61 |
| 16 | 962 | 18.5 | 23.80 | 228.96 | 224.64 | 4.32 | 68.45 | 381.6 | 327.05 | 98.09 | 25.70 |
| 17 | 984 | 17.9 | 22.82 | 224.55 | 227.08 | - 2.53 | 66.53 | 380.8 | 324.90 | 100.35 | 26.35 |
| 18 | 949 | 18.3 | 23.32 | 221.31 | 222.37 | - 1.06 | 67.53 | 366.6 | 313.77 | 92.46 | 25.22 |
| 19 | 1018 | 17.9 | 22.82 | 232.31 | 240.21 | - 7.90 | 67.68 | 400.8 | 341.78 | 109.47 | 27.31 |
| 44 | 1006 | 19.8 | 25.23 | 253.81 | 235.16 | 18.65 | 67.34 | 394.7 | 341.60 | 87.79 | 22.24 |
| 45 | 977 | 19.4 | 24.75 | 241.81 | 231.12 | 10.69 | 66.23 | 379.7 | 326.53 | 84.72 | 22.31 |
| 46 | 1022 | 19.1 | 24.27 | 248.04 | 237.47 | 10.57 | 66.23 | 396.6 | 341.03 | 92.99 | 23.45 |
| 48 | 1075 | 19.3 | 24.75 | 266.06 | 241.73 | 24.33 | 64.33 | 411.5 | 355.83 | 89.77 | 21.82 |
| 96 | 939 | 18.6 | 23.80 | 223.48 | 231.37 | - 7.89 | 68.83 | 368.1 | 315.21 | 91.73 | 24.92 |

*Average per animal.
**Average per carcass.

Table 9

CALCULATED PRODUCER NET REVENUE AND PACKER-RETAIL SPREAD BY LOT
(YIELD GRADE ADJUSTED)

| Lot | Slaughter Weight Lbs.* | Slaughter Quality Grade** | Slaughter Yield Grade** | Av. Qual. Gd. Price $/Cwt. | Average Qual. and Yield Gd. Price $/Cwt. | Total Producer Revenue $* | Total Cost of Production $* | Producer Net Revenue $* | Total Retail Value $** | Packer-Retail Spread $** |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 918 | 17.1 | 2.8 | 22.84 | 23.69 | 217.47 | 210.08 | 7.39 | 317.94 | 100.47 |
| 2 | 948 | 18.5 | 3.4 | 23.32 | 23.87 | 226.29 | 218.42 | 7.87 | 306.50 | 80.21 |
| 3 | 971 | 19.2 | 3.5 | 24.27 | 24.77 | 240.52 | 233.78 | 6.74 | 324.84 | 84.32 |
| 4 | 1047 | 19.3 | 3.7 | 24.27 | 24.67 | 258.29 | 251.74 | 6.55 | 352.78 | 94.49 |
| 5 | 1074 | 19.0 | 3.8 | 24.27 | 24.62 | 264.41 | 248.39 | 16.02 | 351.30 | 86.89 |

*Average per animal.
**Average per carcass.

Table 10

CALCULATED PRODUCER NET REVENUE AND PACKER-RETAIL SPREAD BY SIRE
(YIELD GRADE ADJUSTED)

| Sire # | Slaughter Weight* Lbs. | Slaughter Quality Grade** | Slaughter Yield Grade** | Av. Qual. Gd. Price. $/Cwt. | Average Qual. and Yield Gd. Price $/Cwt. | Total Producer Revenue* $ | Total Cost of Production $* | Producer Net Revenue* $ | Total Retail Value of Carcass $** | Packer-Retail Spread $** |
|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 1023 | 18.7 | 3.5 | 23.80 | 24.30 | 248.59 | 233.52 | 15.07 | 337.85 | 89.26 |
| 14 | 986 | 18.2 | 3.4 | 23.32 | 23.87 | 235.36 | 229.87 | 5.49 | 326.03 | 90.67 |
| 15 | 958 | 17.6 | 3.5 | 22.82 | 23.32 | 229.47 | 232.78 | - 3.31 | 317.73 | 88.26 |
| 16 | 962 | 18.5 | 2.9 | 23.80 | 24.60 | 236.65 | 224.64 | 12.01 | 327.05 | 90.40 |
| 17 | 984 | 17.9 | 3.5 | 22.82 | 23.32 | 229.47 | 227.08 | 2.39 | 324.90 | 96.43 |
| 18 | 949 | 18.3 | 3.1 | 23.32 | 24.02 | 227.95 | 222.37 | 4.58 | 313.77 | 85.82 |
| 19 | 1018 | 17.9 | 3.5 | 22.82 | 23.32 | 237.40 | 240.21 | - 2.19 | 341.78 | 104.38 |
| 44 | 1006 | 19.8 | 3.0 | 25.23 | 25.93 | 260.86 | 235.16 | 25.70 | 341.60 | 80.74 |
| 45 | 977 | 19.4 | 3.3 | 24.75 | 25.35 | 247.67 | 231.12 | 16.55 | 326.53 | 78.86 |
| 46 | 1022 | 19.1 | 3.4 | 24.27 | 24.82 | 253.66 | 237.47 | 16.19 | 341.03 | 87.37 |
| 48 | 1075 | 19.3 | 4.1 | 24.75 | 24.75 | 268.21 | 241.73 | 26.48 | 355.83 | 87.62 |
| 96 | 939 | 18.6 | 2.9 | 23.80 | 24.60 | 230.99 | 231.37 | - 0.38 | 315.21 | 84.22 |

*Average per animal.
**Average per carcass.

to their higher quality grade. An analysis of variance of producers' net revenues by breed, where Angus and Hereford were the two breeds, was significant ($P < .01$). (Table 11). The progeny of the Angus sires were significantly more profitable than those of the Hereford sires.

Table 11

ANALYSES OF VARIANCE OF PRODUCERS NET REVENUE BY BREED OF THE 200 STEERS

| Item | Breed MS | Error MS | d.f. | "F" |
|---|---|---|---|---|
| Prod. Net. Rev. (Qual. + Yield Gd.) | 772.71 | 36.12 | 1,11 | 21.39** |
| Prod. Net Rev. (Qual. Gd.) | 905.90 | 49.05 | 1,11 | 18.46** |

**P < .01

## Profit Maximizing Lots and Sires

Taking the marketing system in its entirety, which are the profit maximizing lot and sire for each segment of the system (i.e., producer, packer and retailer)?

The profit maximizing criteria have already been established for the producer (sell at lot 2 feeding length and/or use progeny from sire AN048) when selling at either quality or quality plus yield grade prices.

The packer, regardless of his buying or selling basis, would prefer to purchase at lot 1 weight. His profits are potentially highest with this lot and also from progeny of sire HP019. Whether or not the packer will get his first choice depends upon his willingness to give price differentials to entice the producer to provide them.

The choice for the retailer is not as clear as for the others. The retailer, of course, is interested in receiving the largest possible amount of salable product within the quality grade and weight. This he does by choosing highest yield grades within the quality grade he purchases. Under these circumstances he would choose lots 1 and 3. These offer the largest percentages of salable product within quality grades Good and Choice, respectively. Under the assumption the retailer buys on the basis of quality grade he will choose sire HP019 (Good), sire Hh096(Good-Choice) and sire AN046 (Choice) thus maximizing receipt of salable product. If the retailer must pay a yield grade price differential, maximization becomes a bargaining process. Indeterminate solutions such as these abound under the imperfect markets encountered beyond the producer level.

## ANALYSIS OF LABORATORY AND CONSUMER PANEL FINDINGS

### Laboratory Panel Analysis

The laboratory panel members were able to detect flavor, tenderness, and over-all desirability differences in steaks, attributable to lot and sire (Tables 12 and 13). The panel gave highest scores for the three characteristics to lot 4, next highest to lot 2 and then rated lots 1, 3, and 5 in that order. Since lots 2 and 4 were frozen as steaks, rather than as loins like the others, and were not tested by the consumer panel they should be considered separately. After omitting lots 2 and 4, the remaining sample gives evidence that younger, shorter fed beef receives the highest scores.

Table 12

MEAN FLAVOR, TENDERNESS AND OVERALL DESIRABILITY SCORES OF LABORATORY TASTE PANEL STEAKS BY LOT

| Item | Lot[a] 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Mean Flavor Desirability Score[b] | 6.07 | 6.23 | 6.10 | 6.41 | 6.04 |
| Mean Tenderness Desirability Score[c] | 5.92 | 6.05 | 5.70 | 6.22 | 5.51 |
| Mean Overall Desirability Score[d] | 5.88 | 6.06 | 5.80 | 6.23 | 5.70 |

[a]Number of observations per lot were 240

[b]LSD ($P < .05$) : 4 > 2, 3, 1, 5; 2 > 5

[c]LSD ($P < .05$) : 4 > 1, 3, 5; 2, 1 > 3, 5; 3 > 5

[d]LSD ($P < .05$) : 4 > 2, 1, 3, 5; 2 > 1, 3, 5; 1 > 5

Progeny from sire AN044 were most preferred for the three characteristics. Progeny from Hh096 were ranked next. The remainder of the progeny were scored less consistently, except for Hh005 which was least preferred for flavor, tenderness, and over-all desirability. The analysis by sire, therefore, displays no particular relationship by breed or sire.

To check the validity of the assumptions required by the parametric analysis of variance, the non-parametric Chi Square test was employed. Table 14 gives the contingency table coefficients by lot and sire for the three characteristics. The hypothesis of independence was rejected in all tests, indicating that the results were statistically significant for lot and sire. Significant variation in flavor, tenderness, and over-all desirability due to lot was found at the .05 level, whereas significant variation attributable to sire was found in flavor ($P<.05$), tenderness ($P<.01$), and over-all desirability ($P<.05$).

Since the nonparametric test results indicated significant differences due to sire and lot, the more discriminatory parametric analysis of variance test was also

Table 13

MEAN FLAVOR, TENDERNESS AND OVERALL DESIRABILITY SCORES OF LABORATORY TASTE PANEL STEAKS BY SIRE

| Sire | Number of Observations | Mean Score Flavor[a] | Mean Score Tenderness[b] | Mean Score Overall[c] |
|---|---|---|---|---|
| 44 | 60 | 6.50 | 6.42 | 6.37 |
| 96 | 60 | 6.37 | 6.05 | 6.15 |
| 19 | 90 | 6.31 | 5.92 | 6.06 |
| 48 | 90 | 6.28 | 5.98 | 6.10 |
| 16 | 120 | 6.28 | 5.98 | 6.07 |
| 46 | 150 | 6.18 | 5.99 | 5.97 |
| 14 | 150 | 6.17 | 5.82 | 5.88 |
| 18 | 90 | 6.13 | 5.70 | 5.81 |
| 45 | 150 | 6.11 | 5.84 | 5.91 |
| 17 | 90 | 6.01 | 5.81 | 5.79 |
| 15 | 90 | 5.91 | 5.68 | 5.66 |
| 05 | 60 | 5.85 | 5.38 | 5.48 |

[a]LSD $P < .05$ : 44 > 46, 14, 18, 45, 17, 15, 5
96, 19 > 17, 15, 5
48 > 15, 5
16 > 17, 15, 5
46 > 15, 5
14 > 5

[b]LSD $P < .05$ : 44 > 46, 48, 16, 19, 45, 14, 17, 18, 15, 5
96, 46 > 18, 15, 5
48 > 5
16 > 15, 5
19, 45, 14, 17 > 5

[c]LSD $P < .05$ : 44 > 16, 46, 45, 14, 18, 17, 15, 5
96, 48, 16 > 18, 17, 15, 5
19, 46 > 15, 5
45, 14, 18 > 5

Table 14

CONTINGENCY TABLE (CHI SQUARE) COEFFICIENTS BY LOT AND SIRE FOR FLAVOR, TENDERNESS AND OVERALL DESIRABILITY (LABORATORY TASTE PANEL)

| Item | Lot d.f. | Lot $X^2$ | Sire d.f. | Sire $X^2$ |
|---|---|---|---|---|
| Flavor Desirability | 16 | 45.26 ** | 44 | 61.98 * |
| Tenderness Desirability | 16 | 69.10 ** | 44 | 73.27 ** |
| Overall Desirability | 16 | 63.59 ** | 44 | 64.84 * |

*$P < .05$
**$P < .01$

employed using loin mean scores. The results are in Appendix B Tables 1, 2, and 3 for flavor, tenderness, and over-all desirability by sire, lot and sire x lot. Significant differences were found by sire ($P<.05$) and lot ($P<.01$) in flavor, by lot ($P<.01$) in tenderness, and by sire and lot ($P<.01$) in over-all desirability.

## Analysis of Consumer Panel

The consumer panel results also indicated slight differences in scores which could be attribued to lot and sire. Tables 15 and 16 give the mean scores by lot

Table 15

MEAN CONSUMER PANEL SCORES, BY LOT

| Item | Lot[a] 1 | 3 | 5 |
|---|---|---|---|
| Flavor Desirability | 2.57 | 2.64 | 2.68 |
| Tenderness Desirability | 1.79 | 1.86 | 1.89 |
| Overall Desirability | 2.43 | 2.48 | 2.56 |

[a]Number of samples per lot was 40

Table 16

MEAN CONSUMER PANEL SCORES BY SIRE

| Sire | Number of Observations Per Sire | Mean Flavor Desirability | Mean Tenderness Desirability | Mean Overall Desirability |
|---|---|---|---|---|
| 45 | 150 | 2.59 | 1.83 | 2.47 |
| 46 | 150 | 2.54 | 1.71 | 2.29 |
| 48 | 90 | 2.47 | 1.70 | 2.20 |
| 44 | 60 | 2.68 | 1.93 | 2.42 |
| 14 | 150 | 2.83 | 1.88 | 2.67 |
| 16 | 120 | 2.55 | 1.77 | 2.40 |
| 15 | 90 | 2.68 | 1.87 | 2.59 |
| 17 | 90 | 2.53 | 1.92 | 2.56 |
| 18 | 90 | 2.59 | 2.01 | 2.48 |
| 19 | 90 | 2.67 | 1.91 | 2.63 |
| 05 | 60 | 2.85 | 2.07 | 2.68 |
| 96 | 60 | 2.63 | 1.75 | 2.62 |

and by sire. The scores given for all three characteristics decline with length of feeding, indicating the consumer panel also rated highest the younger, shorter fed steers. The analysis by sire shows sire AN048 most preferred for the three characteristics, AN046 as next preferred (with exception of being third in flavor) and the remainder being inconsistent in standing with the exception of HP005 which was least preferred (as it was also in the laboratory panel). The ratings by sire and breed are, therefore, inconsistent.

As with the laboratory results the Chi Square test was used to check the statistical significance of the differences in scores by lot and by sire. Table 17 lists the Chi Square coefficients; none were significant at the .05 level.

Table 17

CONTINGENCY TABLE (CHI SQUARE) COEFFICIENTS BY LOT AND SIRE FOR FLAVOR DESIRABILITY, TENDERNESS DESIRABILITY AND OVERALL DESIRABILITY (CONSUMER PANEL)

| Item | Lot | | Sire | |
|---|---|---|---|---|
| | d.f. | $X^2$ | d.f. | $X^2$ |
| Flavor Desirability | 10 | 9.18 | 44 | 37.89 |
| Tenderness Desirability | 6 | 7.96 | 33 | 37.65 |
| Overall Desirability | 12 | 5.87 | 44 | 53.92 |

Significant ($P < .05$) : None

The analysis of variance was also conducted on flavor, tenderness, and over-all desirability loin mean scores of the consumer panel (Appendix B Tables IV, V and VI). As with the Chi Square test no significant differences were found. This was not unexpected as the exogenous variables controlled in the laboratory panel were free to mask or eliminate the variation in scores attributable to sire and/or lot.

The Household Data Sheet requested information on age of housewife, education of housewife, and family income. Table 18 shows the distribution of these for the 200-household sample. It is often hypothesized that education, age, and

Table 18

DISTRIBUTION OF CONSUMER PANEL HOUSEHOLDS BY AGE OF HOUSEWIFE, EDUCATION OF HOUSEWIFE AND BY FAMILY INCOME

| Age (Years) | No. | % | Income ($) | No. | % | Education (Last Attended) | No. | % |
|---|---|---|---|---|---|---|---|---|
| 20-29 | 54 | 27.0 | 200-299 | 3 | 1.5 | Grade | 17 | 8.5 |
| 30-39 | 55 | 27.5 | 300-399 | 14 | 7.0 | High School | 103 | 51.5 |
| 40-49 | 55 | 27.5 | 400-499 | 28 | 14.0 | College | 55 | 27.5 |
| 50-59 | 36 | 18.0 | 500-599 | 31 | 15.5 | Business School | 25 | 12.5 |
| Total | 200 | 100.0 | 600-699 | 32 | 16.0 | Total | 200 | 100.0 |
| | | | 700-799 | 29 | 14.5 | | | |
| | | | 800 899 | 23 | 11.5 | | | |
| | | | 900 + | 38 | 19.0 | | | |
| | | | Blank | 2 | 1.0 | | | |
| | | | Total | 200 | 100.0 | | | |

income have an explanatory effect on the consumers' choice of beef, how the housewife prepares it, and the degree of doneness the consumers desire. The Chi Square test was used to check various relationships between these factors for the consumer panel data. Results are in Table 19. The scores given for over-all desirability did not vary significantly ($P < .05$) by education and income. Age had a significant effect on cooking method. The younger housewives preferred charcoal broiling while medium aged and older housewives preferred dry heat. The family income level was correlated significantly with doneness. Lower income families preferred well done steaks, whereas the medium and higher income families preferred rare to medium doneness.

Table 19

CHI SQUARE COEFFICIENTS BETWEEN EDUCATION OF HOUSEWIFE, AGE OF HOUSEWIFE AND FAMILY INCOME AND OVERALL RATING, COOKING METHOD, AND DONENESS

| Item | Consumer Panel Overall Desirability | | Cooking Method | | Doneness | |
|---|---|---|---|---|---|---|
| | d.f. | $X^2$ | d.f. | $X^2$ | d.f.. | $X^2$ |
| Education of Housewife | 16 | 9.95 | -- | -- | -- | -- |
| Age of Housewife | -- | -- | 6 | 45.47* | -- | -- |
| Family Income | 32 | 31.58 | -- | -- | 6 | 42.83* |

*P < .05

## Relationship Between Ratings and Rate of Gain

The question arises as to the relationship between rate of gain by sire and over-all desirability by the consumer. A positive relationship would have great economic importance even in this limited context. Spearman's Rank Correlation coefficient (Siegel 24) was used to determine if rate of gain and over-all desirability were correlated or, as hypothesized by the test, independent. Spearman's $r_s$ for the consumer panel was 0.21; for the laboratory panel it was 0.08. Neither hypothesis was rejected at the .05 level. Therefore, this study did not find a positive relationship between rate of gain and over-all desirability by sire.

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# APPENDIX A

Fig. 1

LABORATORY EVALUATION SHEET

BCI TASTE PANEL

Name _____

Date _____

| Flavor Intensity Scale | | Desirability Scale | |
|---|---|---|---|
| Strong Beef Flavor | 6 | Very Desirable | 8 |
| Slightly Stng Beef Flavor | 5 | Desirable | 7 |
| Typical Beef Flavor | 4 | Moderately Desirable | 6 |
| Slightly Weak Beef Flavor | 3 | Slightly Desirable | 5 |
| Weak Beef Flavor | 2 | Slightly Undesirable | 4 |
| Flat or No Beef Flavor | 1 | Moderately Undesirable | 3 |
| | | Undesirable | 2 |
| | | Very Undesirable | 1 |

| Sample Number | Flavor Intensity | Desirability | | | Comments |
|---|---|---|---|---|---|
| | | Flavor | Tenderness | Overall | |
| | | | | | |

Fig. 2

ELIGIBILITY REQUIREMENTS

Eligibility Requirements for Consumer Panel:

1. Housewife must be under 60 years of age.
2. Housewife must have at least an eighth grade education.
3. Husband and wife must eat beef fairly regularly.
4. Family income must usually be $250 per month or more.
5. None of the immediate family are working or have worked as meat cutters or meat salesmen.

Fig. 3

HOUSEHOLD DATA SHEET

1. Full Name _____

2. Mailing Address _____
(street) (city)

3. Phone Number _____

4. Is beef regularly eaten by both husband and wife? _____

5. Number in family regularly eating meat at home: _____
Note: Must be at least two adults at home most of time and preparation of the steaks for the two adults must not present a problem for meal preparation for entire family.

6. Will the steaks be delivered at the above address? _____
If not, where? _____
If delivered at home, any regular time at home? _____

7. Age of housewife? _____ (Must be under 60)

8. Are there meat cutters or meat salesmen in the family? _____
(If so, disqualified)

9. Are the respondents available for panel purposes from 18 May to 13 June 1966? _____

10. Who works for pay? _____

11. Total family income per month, all sources before income taxes:
_____ 200-299 (Under $250 disqualified)
_____ 300-399
_____ 400-499
_____ 500-599
_____ 600-699
_____ 700-799
_____ 800-899
_____ 900 and over

12. What was the last school attended by the housewife?
_____ Grade School (Disqualified if under 8th grade completion)
_____ High School
_____ College or Graduate School
_____ Business College, Beauty School, etc.

Fig. 4

CONSUMER PANEL PREFERENCE SCHEDULE

How well did you like it?

| | |
|---|---|
| 1 Like Extremely | 6 Dislike Slightly |
| 2 Like Very Much | 7 Dislike Moderately |
| 3 Like Moderately | 8 Dislike Very Much |
| 4 Like Slightly | 9 Dislike Extremely |
| 5 Neither Like nor Dislike | |

Please rate this steak on tenderness: (check rating scale once)

Entirely Satisfactory 1 2 3 4 5 Not Acceptable

Please rate this steak on its flavor:

| | |
|---|---|
| 7 Extremely Poor Flavor | 3 Good Flavor |
| 6 Very Poor Flavor | 2 Very Good Flavor |
| 5 Poor Flavor | 1 Excellent Flavor |
| 4 Fair Flavor | |

Any flavoring added (catsup, steak sauce, barbecue sauce, etc.)?

_____ Yes _____ No If yes, what?_____

How cooked: (Please check one)

1 Moist Heat (Liquid added or lid on)
2 Dry Heat (No liquid added and no lid)
3 Charcoal Broiled
4 Broiled

Doneness?

1 Well (No pink meat)
2 Rare (Some pink meat)

## APPENDIX B

### Table I

ANALYSIS OF VARIANCE OF FLAVOR DESIRABILITY OF LABORATORY TASTE PANEL STEAKS

| Source | df | MS | "F" |
|---|---|---|---|
| Sire | 11 | .4173 | 1.93* |
| Lot | 4 | .7592 | 3.52** |
| Sire X Lot | 44 | .2571 | 1.19 |
| Error | 140 | .2160 | |
| Total | 199 | | |

### Table II

ANALYSIS OF VARIANCE OF TENDERNESS DESIRABILITY LABORATORY TASTE PANEL STEAKS

| Source | df | MS | "F" |
|---|---|---|---|
| Sire | 11 | .7058 | 1.42 |
| Lot | 4 | 3.1562 | 6.36** |
| Sire X Lot | 44 | .4878 | .98 |
| Error | 140 | .4960 | |
| Total | 199 | | |

### Table III

ANALYSIS OF VARIANCE OF OVERALL DESIRABILITY OF LABORATORY TASTE PANEL STEAKS

| Source | df | MS | "F" |
|---|---|---|---|
| Sire | 11 | .6760 | 2.90** |
| Lot | 4 | 1.4478 | 6.21** |
| Sire X Lot | 44 | .3359 | 1.44 |
| Error | 140 | .2332 | |
| Total | 199 | | |

* $P < .05$ ** $P < .10$

### Table IV

ANALYSIS OF VARIANCE OF FLAVOR DESIRABILITY OF CONSUMER PANEL STEAKS

| Source | d.f. | MS | "F" |
|---|---|---|---|
| Sire | 11 | .1225 | .82 |
| Lot | 2 | .1626 | 1.08 |
| S X L | 22 | .1087 | .72 |
| Error | 84 | .1401 | |
| Total | 119 | | |

Table V

ANALYSIS OF VARIANCE OF TENDERNESS DESIRABILITY OF CONSUMER PANEL STEAKS

| Source | d.f. | MS | "F" |
|---|---|---|---|
| Sire | 11 | .1167 | 1.06 |
| Lot | 2 | .1111 | 1.01 |
| S X L | 22 | .0850 | .77 |
| Error | 84 | .1103 | |
| Total | 119 | | |

Table VI

ANALYSIS OF VARIANCE OF OVERALL DESIRABILITY OF CONSUMER PANEL STEAKS

| Source | d.f. | MS | "F" |
|---|---|---|---|
| Sire | 11 | .2035 | 1.35 |
| Lot | 2 | .1583 | 1.06 |
| S X L | 22 | .1365 | .91 |
| Error | 84 | .1501 | |
| Total | 119 | | |