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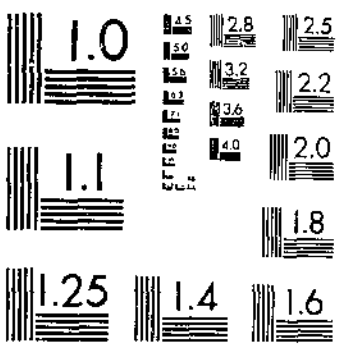

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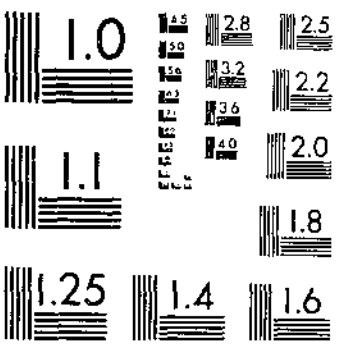

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NATIONAL BUREAU OF STANDARDS-1963-A

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BEEF PRODUCTION AND QUALITY AS AFFECTED BY GRADE OF STEER AND FEEDING GRAIN SUPPLEMENT ON GRASS

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CONTENTS

SCOPE OF WORK

In many of the beef-production areas, grass is considered the feed that produces the most profitable gains, and a maximum use is made of it. It is not uncommon to have cattle make remarkable gains on grass alone and dress out well-finished carcasses. Ordinarily, however, cattle that are fed grain while on pasture will make larger gains than those fed grass alone, and the beef from them usually brings a higher price.

It was with a view of obtaining some definite information on the production costs and comparative quality and palatability of the meat resulting from these two feeding methods that these experiments were planned. The feeding was conducted in the bluegrass section of West Virginia, and the results are applicable to similar grazing areas.

The comparison of the meat produced by the experimental cattle was a part of the national cooperative project, "A Study of the Fac-

[1] Prepared in consultation with the other members of the project publications committee, O. G. Hankins, (chairman), L. M. Alexander, L. B. Burk, P. E. Howe, and H. C. McPhee.

tors that Influence the Quality and Palatability of Meat." The methods of sampling and studying the meat conformed to those prescribed in that project.

PLAN OF THE EXPERIMENTS

In the three 1-year experiments (1925 to 1927, inclusive), 40 steers, consisting of equal numbers of Good and Medium grade, were selected each fall with the exception of the first year, when 39 steers were used. Each group was wintered separately but on the same type of ration, and was fed so as to enter the grazing season in approximately the same condition. The winter feeding period began in the first part of December and extended about 140 days. The summer grazing period following averaged 125 days.

FIGURE 1.—Type of cattle and grazing land used in the experimental work. The cattle illustrated, lots 1B and 2B of the 1927-28 experiment, used the same pasture

When pasture conditions became favorable in the spring, each winter group of steers was divided into two lots of Good steers and two lots of Medium for the summer feeding. One lot of each grade received a supplement of corn and cottonseed meal throughout the grazing period; a similar lot was carried on grass alone. (Fig 1.)

Committee gradings were made of each steer as a feeder, as a fat steer, and in the carcass. Each steer was photographed at the beginning and end of each experiment. Individual weights of steers were taken on three consecutive days at the beginning and end of the winter feeding period.

Occasional individual weights only were taken during the first two grazing experiments, as it was believed that the gains of the cattle would be influenced considerably by a comparatively long

drive to the scales; but during the last year's grazing, with scales placed more conveniently, individual weights were taken at 28-day intervals.

The cattle were marketed early in the fall each year, at a time which seemed most favorable, taking into consideration the condition of the cattle and of the market.

CATTLE AND FEEDS USED

Grade steers of approximately 2½ years of age and raised locally were used in these experiments. They were beef-bred steers representing the predominating beef breeds, and were purchased with a view of having about equal numbers of two distinct market grades. A grading committee consisting of three men familiar with the standard market grades of steers, as adopted by the United States Department of Agriculture, classified the two groups as representative of the Good and Medium grades of feeder steers.

FIGURE 2.—A portion of the pasture used by the experimental cattle. Note the abundant growth of grasses June 20, 1928

The steers were wintered each year on corn silage, wheat straw, and cottonseed meal. The supplemental summer feed consisted of coarsely ground shelled corn (No. 2 grade) and cottonseed meal. The pastures used were above the average in quality (fig. 2), the grasses consisting largely of Kentucky bluegrass with some white clover, red clover, and timothy. Approximately 4 acres of pasture were allowed each steer.

PRODUCTION STUDIES

THE 1925-26 EXPERIMENT

WINTER RATIONS AND GAINS

The 19 Good steers (lot 1) and the 20 Medium steers (lot 2) were fed separately on the same type of ration, consisting of corn silage, wheat straw, and cottonseed meal. There was but little variation

in the ration throughout the winter feeding period. As shown in Table 1 the average ration for lot 1 was 25.03 pounds of corn silage, 5.78 pounds of wheat straw, and 1.09 pounds of cottonseed meal per head per day; lot 2 received 22.56 pounds of corn silage per head per day, and practically the same quantity of wheat straw and cottonseed meal as lot 1. Lot 1 was fed slightly more silage because of the greater initial weight of the steers as compared to those in lot 2, there being an average difference of 77 pounds in weight. In view of the limited number of available steers it was not possible to reduce this variation; however, such a difference is not unusual between Medium and Good steers at 2½ years of age.

TABLE 1.—*Winter gains and rations of steers, December 7, 1925 to April 25, 1926, 140 days*

Item		Lot 1, Good steers	Lot 2, Medium steers
Number of steers		19	20
Initial cost per 100 pounds	dollars	6.80	6.55
Average initial weight	pounds	953	876
Average final weight	do	1,054	962
Average winter gain per steer	do	101	86
Average daily gain per steer	do	.72	.61
Average daily feed per steer:			
Corn silage	do	25.03	22.56
Wheat straw	do	5.78	5.63
Cottonseed meal	do	1.09	1.06
Value of winter feed per steer:			
Corn silage—			
3,504 pounds at $6 a ton	dollars	10.51	
3,158 pounds at $6 a ton	do		9.47
Wheat straw—			
809 pounds at $7 a ton	do	2.83	
788 pounds at $7 a ton	do		2.76
Cottonseed meal—			
153 pounds at $40 a ton	do	3.06	
148 pounds at $40 a ton	do		2.96
Total value of winter feed	do	16.40	15.19
Average cost per steer, Dec. 7	do	64.80	48.62
Average cost per steer, Apr. 25 [1]	do	81.20	63.81

[1] Does not include labor and other miscellaneous charges.

The gains during the winter by periods are shown graphically in Figure 3. The Good steers gained 101 pounds per head during the 140-day wintering period, as compared to 86 pounds per head for the Medium steers. While the Good steers consumed more feed, their gains were enough larger to make the cost of gains more economical than for the Medium steers.

The results of the first winter's feeding are shown in Table 1. In this and subsequent tables the average of the lot is used as the basis for the individual data.

SUMMER RATIONS AND GAINS

At the end of 140 days' wintering period lot 1 (Good steers) was divided into lots 1A and 1B, and lot 2 (Medium steers) into lots 2A and 2B, and turned on pasture for 124 days. The A lots were fed a supplement of coarsely ground shelled corn and cottonseed meal (fig. 4), while the B lots had grass alone. The summer gains per steer are shown graphically in Figure 3.

A study of the summer gains in Table 2 shows that a small ration of corn and cottonseed meal increased the gains over 50 per cent with each grade of cattle.

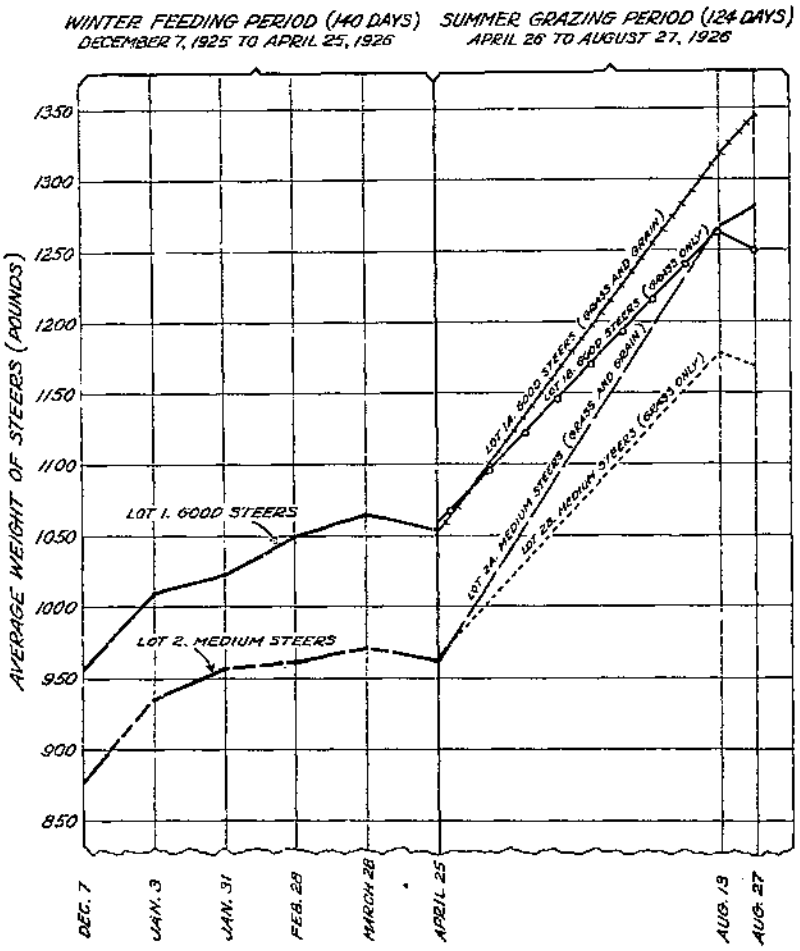

FIGURE 3.—Average winter and summer gains of Good and Medium steers, 1925–26

TABLE 2.—*Summer gains of steers, rations, and marketing data, grazing period, April 26 to August 27, 1926*

Item	Lot 1A, Good steers on grass and grain	Lot 1B, Good steers on grass alone	Lot 2A, Medium steers on grass and grain	Lot 2B, Medium steers on grass alone
Number of steers	9	10	10	10
Average initial weight.....pounds	1,051	1,057	901	903
Average final weight.....do	1,346	1,251	1,281	1,168
Average summer gain per steer.....do	295	194	320	205
Average daily gain per steer.....do	2.38	1.56	2.58	1.65
Average daily feed per steer:				
Coarsely ground shelled corn.....do	5.93	.....	5.34	.....
Cottonseed meal.....do	1.88	.....	1.69	.....

TABLE 2.—*Summer gains of steers, rations, and marketing data, grazing period, April 26 to August 27, 1926*—Continued

Item	Lot 1A, Good steers on grass and grain	Lot 1B, Good steers on grass alone	Lot 2A, Medium steers on grass and grain	Lot 2B, Medium steers on grass alone
Value of supplemental feed per steer:				
Corn—				
735 pounds at 84 cents a bushel.....dollars..	11.02			
662 pounds at 84 cents a bushel.....do....			9.93	
Cottonseed meal—				
233 pounds at $40 a ton.....do....	4.66			
210 pounds at $40 a ton.....do....			4.20	
Total value of supplemental feed.....do....	15.68		14.13	
Average cost per steer, Apr. 26.....do....	80.97	81.43	63.84	63.98
Average cost per steer, Aug. 27 [1].....do....	96.65	81.43	77.97	63.98
Average sales weight per steer at market.....pounds..	1,286	1,201	1,229	1,115
Sale price per 100 pounds at market.....dollars..	10.10	9.10	9.50	8.50
Gross returns per steer.....do....	129.89	109.29	116.75	94.77
Average marketing expense per steer.....do....	8.33	7.90	8.02	7.54
Average profit per steer [2].....do....	24.91	19.96	30.76	23.25
Average shrinkage per steer in transit.....pounds..	60	50	52	53
Do.....per cent..	4.45	4.00	4.06	4.53
Average hot carcass weight.....pounds..	759	698	722	620
Average dressing percentage (hot weight and sales weight).....per cent..	59.07	58.12	58.74	55.61
Average dressing percentage (hot weight and experimental weight).....per cent..	56.39	55.80	56.36	53.08

[1] Does not include pasture and labor charges.
[2] Miscellaneous expenses other than feed and steer costs have not been deducted from the gross returns.

FIGURE 4.—Group of Medium steers after being on grass 60 days with supplemental feeding

The Medium steers (lots 2A and 2B) made greater gains than the Good steers in lots 1A and 1B. This may be attributed partially at least to the greater winter gains made by the Good steers. It has been fairly definitely proved that steers making the greater winter gains do not make as large subsequent summer gains as steers making smaller winter gains. The grain supplement increased the selling price of both grades of steers (lots 1A and 2A) $1 per 100 pounds, which resulted in increased profits over the returns for the cattle on grass alone.

The Good steers (lots 1A and 1B) sold for 60 cents per 100 pounds more than the corresponding groups of Medium steers (lots 2A and 2B). The Medium steers fed grain (lot 2A) made a margin of $3.95 and those on grass alone $2.95. The Good steers fed grain (lot 1A) made a margin of $3.30 as compared to $2.30 for the same grade steers on grass alone (lot 1B).

THE 1926–27 EXPERIMENT

WINTER RATIONS AND GAINS

One lot each of Good and Medium steers were handled in the same manner as in the preceding experiment. The quantities of feed allowed the cattle were such as to produce somewhat lower winter gains, however, as it was believed that the gains the previous year were somewhat excessive, if the maximum use of grass was to be obtained during the following grazing season.

Gains during the winter by periods are shown graphically in Figure 5.

Both lots of steers were fed essentially the same quantities of feed, but considerably more feed was required by the Medium steers in this instance to make the same amount of gain, as the total winter gain per head for the Medium steers was 24 pounds as compared to 60 pounds for the Good grade. (Table 3.) The more economical use of feed by the Good steers coincided with that of the first experiment.

TABLE 3.—*Winter gains and rations of steers, December 15, 1926, to May 3, 1927*

Item		Lot 1, Good steers	Lot 2, Medium steers
Number of steers		20	20
Initial cost per 100 pounds	dollars	7.40	6.15
Average initial weight	pounds	1,035	1,025
Average final weight	do	1,095	1,049
Average winter gain per steer	do	60	24
Average daily gain per steer	do	.43	.17
Average daily feed per steer:			
Corn silage	do	24.43	26.23
Wheat straw	do	5.83	5.83
Cottonseed meal	do	.94	.94
Value of winter feed per steer:			
Corn silage—			
3,420 pounds, at $6 a ton	dollars	10.26	
3,672 pounds, at $6 a ton	do		11.02
Wheat straw, 816 pounds at $7 a ton	do	2.86	2.86
Cottonseed meal, 132 pounds, at $40 a ton	do	2.64	2.64
Total value of winter feed	do	15.76	16.52
Average cost per steer, December 15	do	76.59	63.04
Average cost per steer, May 3 [1]	do	92.35	79.56

[1] Does not include labor and other miscellaneous charges.

SUMMER RATIONS AND GAINS

Lots 1 and 2, Good and Medium steers, respectively, were divided into lots 1A and 1B and 2A and 2B at the end of 140 days' wintering, as was done at the end of the first year's wintering experiment. The summer gains per steer are shown in Table 4 and graphically in Figure 5.

The feeding of a grain supplement increased the gains of each grade of steers approximately 22 per cent. The Medium steers under each system of handling gained about 15 per cent more than the Good grade. The quantities of grain supplement fed each of the groups

were the same. The Medium steers evidently used greater quantities of grass than the Good steers. Each lot of steers gained more than the corresponding lots in the preceding year. This was at least partially attributable to the somewhat lower winter gains during the winter feeding.

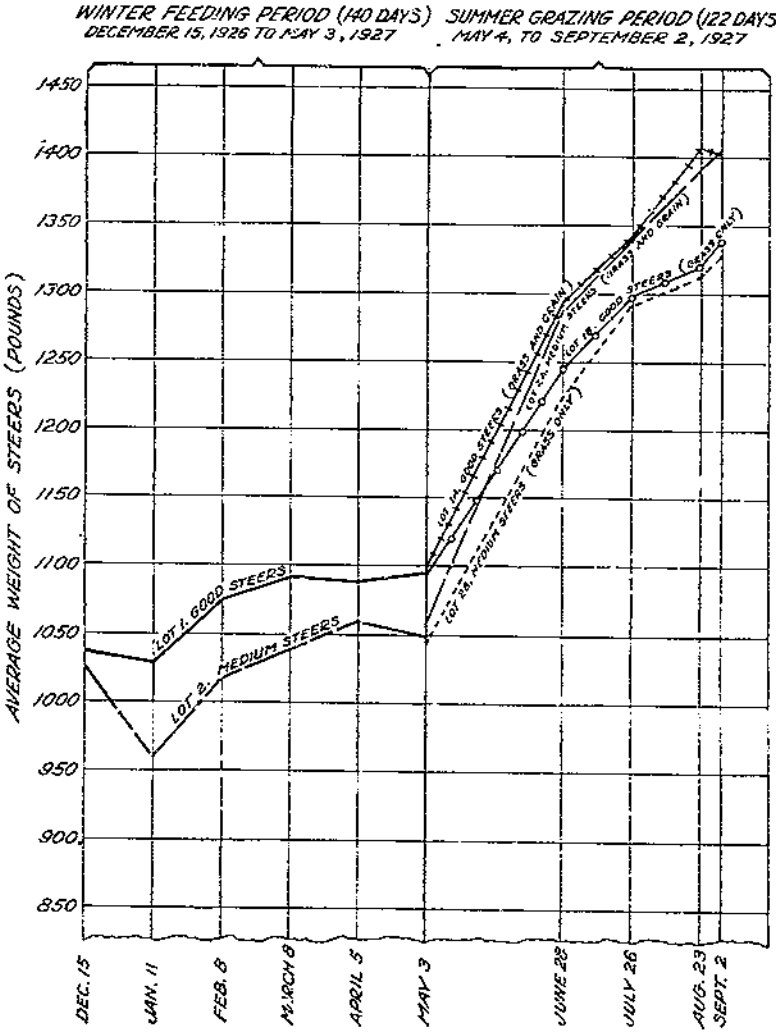

FIGURE 5.—Average winter and summer gains of Good and Medium steers, 1926–27

The grain supplement increased the sales price of the Good steers $1.20 per 100 pounds, and $1.41 for the Medium steers. With feed costs and market prices of cattle such as prevailed in this test, both grades of steers fed the supplement made essentially the same returns. The Medium steers on grass alone made slightly greater returns than the Good steers handled similarly; however, this difference was not of great significance. At the end of the summer grazing period, the

Medium steers fed grain had made a margin of $6.36 per 100 pounds, as compared to $5.80 for the Good steers fed grain. (Tables 3 and 4.)

TABLE 4.—*Summer gains of steers, rations, and marketing data, grazing period, May 4 to September 2, 1927, 122 days*

Item	Lot 1A, Good steers on grass and grain	Lot 1B, Good steers on grass alone	Lot 2A, Medium steers on grass and grain	Lot 2B, Medium steers on grass alone
Number of steers	10	10	10	10
Average initial weight, May 4.....pounds	1,098	1,092	1,056	1,042
Average final weight, September 2.....do	1,403	1,340	1,405	1,329
Average summer gain per steer.....do	305	248	349	287
Average daily gain per steer.....do	2.50	2.03	2.86	2.35
Average daily feed per steer:				
Coarsely ground shelled corn.....do	6.64	.....	6.64	.....
Cottonseed meal.....do	1.82	.....	1.82	.....
Value of supplemental feed per steer:				
Corn, 810 pounds, at 98 cents a bushel.....dollars	14.17	.....	14.17	.....
Cottonseed meal, 222 pounds, at $40 a ton.....do	4.44	.....	4.44	.....
Total value of supplemental feed.....do	18.61	.....	18.61	.....
Average cost per steer, May 4.....do	92.60	92.10	80.09	79.03
Average cost per steer, September 2 [1].....do	111.21	92.10	98.70	79.03
Average sales weight per steer, at market.....pounds	1,333	1,228	1,319	1,234
Sales price per 100 pounds at market.....dollars	13.20	12.00	12.41	11.00
Gross returns per steer.....do	175.96	147.36	163.69	135.74
Average marketing expense per steer.....do	8.41	8.14	8.42	8.10
Average profit per steer [2].....do	56.34	47.12	56.57	48.61
Average shrinkage per steer in transit.....pounds	70	112	86	95
Do.....per cent	4.99	8.35	6.12	7.14
Average hot carcass weight.....pounds	824	739	786	724
Average dressing percentage (hot weight and sales weight).....per cent	61.81	60.18	59.59	58.67
Average dressing percentage (hot weight and experimental weight).....per cent	58.73	55.14	55.94	54.48

[1] Does not include pasture and labor charges.
[2] Miscellaneous expenses other than feed and steer costs have not been deducted from the gross returns.

THE 1927-28 EXPERIMENT

WINTER RATIONS AND GAINS

The steers were wintered on the same ration as during the two preceding winters. They were lighter in weight, but were fed essentially the same quantities of feed as during the second year (1926–27). It was desired to have the total winter gains per steer approximately midway between the comparatively high gains of the winter of 1925–26, and the lower gains of 1926–27.

Gains of the steers for the third experiment are shown graphically in Figure 6.

Both lots were fed the same quantities of straw and cottonseed meal, but the steers in lot 1 received 2.52 pounds more silage per head daily because of their somewhat greater initial weight. (Table 5.) The gains of both groups were very nearly the same, and, as there was only a slight difference in quantities of feed consumed, there was no marked difference in the cost of wintering the two grades of cattle.

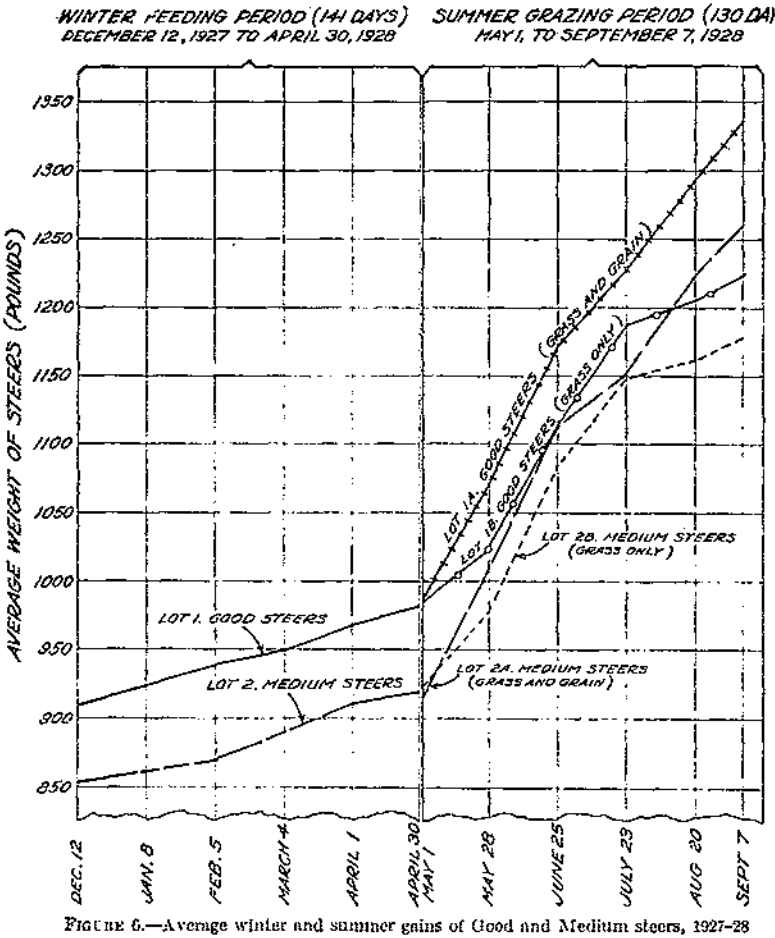

FIGURE 6.—Average winter and summer gains of Good and Medium steers, 1927–28

TABLE 5.—*Winter gains and rations of steers, December 12, 1927 to April 30, 1928, (141 days)*

Item		Lot 1, Good steers	Lot 2, Medium steers
Number of steers		20	20
Initial cost per 100 pounds	dollars	8.75	7.50
Average initial weight	pounds	909	853
Average final weight	do	983	910
Average winter gain per steer	do	74	60
Average daily gain per steer	do	.52	.47
Average daily feed per steer:			
Corn silage	do	20.02	23.50
Wheat straw	do	5.75	5.75
Cottonseed meal	do	.96	.90
Value of winter feed per steer:			
Corn silage—			
3,609 pounds at $6 a ton	dollars	11.01	
3,314 pounds at $6 a ton	do		9.94
Wheat straw, 810 pounds at $7 a ton	do	2.83	2.83
Cottonseed meal, 135 pounds at $40 a ton	do	2.70	2.70
Total value of winter feed	do	16.54	15.47
Average cost per steer, Dec. 12	do	79.54	63.97
Average cost per steer, Apr. 30[1]	do	96.08	79.44

[1] Does not include labor and other miscellaneous charges.

SUMMER RATIONS AND GAINS

Lots 1 and 2 were divided into lots 1A and 1B and 2A and 2B, respectively, as was done in previous years, and grazed for 130 days. The gains per steer by periods are shown graphically in Figure 6.

The feeding of the grain supplement increased the summer gains of the Good steers 46 per cent and the Medium steers 34 per cent. This was the only instance in which the better-grade steers (lot 1A) fed a grain supplement, surpassed the Medium steers (lot 2A) in total summer gains. The difference, however, was only 9 pounds a steer. The Medium steers on grass alone (lot 2B) gained about 6 per cent more than the Good steers (lot 1B). This result was similar to those of the two previous years.

Both lots of cattle receiving a supplement (1A and 2A) were fed the same quantities of shelled corn and cottonseed meal. Both lots received practically all they would eat. In this experiment the Medium steers (lot 2A) were not so economical in their use of supplemental feed as the Good steers (lot 1A). The Good steers fed grain sold for $1.50 more per 100 pounds than those of the same grade receiving grass alone. They sold for $1 per 100 pounds more than the Medium grade of grain-finished cattle, and $2.25 more than the Medium grade on grass alone.

The Medium grade of grain-finished steers made a margin of $8 per 100 pounds as compared to $7.75 for the corresponding lot of Good steers getting grass and grain. The Medium grade of steers on grass alone made a margin of $6.75 per 100 pounds and the Good grade $6.25. (Tables 5 and 6.)

TABLE 6.—*Summer gains of steers, rations, and marketing data, grazing period, May 1 to September 7, 1928 (130 days)*

Item	Lot 1A, Good steers on grass and grain	Lot 1B, Good steers on grass alone	Lot 2A, Medium steers on grass and grain	Lot 2B, Medium steers on grass alone
Number of steers	10	10	10	10
Average initial weight, May 1.....pounds	984	982	915	923
Average final weight, Sept. 7.....do	1,336	1,223	1,258	1,179
Average summer gain per steer.....do	352	241	343	256
Average daily gain per steer.....do	2.71	1.85	2.64	1.97
Average daily feed per steer:				
Coarsely ground shelled corn.....do	5.30	.....	5.30	.....
Cottonseed meal.....do	1.20	.....	1.20	.....
Value of supplemental feed per steer:				
Corn, 689 pounds at $1.12 a bushel.....dollars	13.76	.....	13.76	.....
Cottonseed meal, 156 pounds at $40 a ton.....do	3.12	.....	3.12	.....
Total value of supplemental feed.....do	16.90	.....	16.90	.....
Average cost per steer, May 1.....do	96.18	95.98	79.09	79.79
Average cost per steer, Sept. 7 [1].....do	113.08	95.98	95.99	79.79
Average sales weight per steer at market.....pounds	1,279	1,174	1,202	1,119
Sales price per 100 pounds at market.....dollars	16.50	15.00	15.50	14.25
Gross returns per steer.....do	211.03	176.10	186.31	159.46
Average marketing expense per steer.....do	8.05	7.66	7.72	7.47
Average profit per steer [2].....do	89.90	72.46	82.60	72.20
Average shrinkage per steer in transit.....pounds	57	49	56	60
Do.....per cent	4.27	4.00	4.45	5.09
Average hot carcass weight.....pounds	773	674	702	642
Average dressing percentage (hot weight and sales weight).....per cent	60.44	57.41	58.40	57.37
Average dressing percentage (hot weight and experimental weight).....per cent	57.86	55.11	55.80	54.45

[1] Does not include pasture and labor charges.

[2] Miscellaneous expenses other than feed and steer costs have not been deducted from the gross returns.

The additional weight of the Good steers fed grain, with an increased selling price, was sufficient to overcome the $0.25 difference in margin, resulting in a greater profit of $7.30 a head. Both lots of steers on grass alone netted essentially the same profit, exclusive of pasture and other miscellaneous charges. Detailed results of the summer feeding are given in Table 6.

SUMMARY OF PRODUCTION STUDIES

The Good steers made greater winter gains in proportion to feed consumed than the Medium steers. In an average winter feeding period of 140 days for the three years, the Good steers (lot 1) gained 78 pounds a head, as compared to 59 pounds for the Medium grade (lot 2). Average results of the three years' feeding experments are given in Table 7.

TABLE 7.—*Average winter and summer weights and gains of steers, daily feed, and profits per steer, and initial and sales prices per 100 pounds, for the 3-year period*

Item	Lot 1			Lot 2		
	Entire lot	A, Good steers on grass and grain	B, Good steers on grass alone	Entire lot	A, Medium steers on grass and grain	B, Medium steers on grass alone
Initial winter weight.....pounds	960			918		
Final winter weight.....do	1,044			977		
Total winter gain (140 days).....do	78			59		
Daily winter gain.....do	.56			.42		
Daily winter feed:						
Corn silage.....do	25.50			24.10		
Wheat straw.....do	5.79			5.73		
Cottonseed meal.....do	1.00			1.00		
Initial summer weight.....do		1,045	1,043		977	976
Final summer weight.....do		1,362	1,271		1,314	1,225
Total summer gain (average 125 days)...do		317	228		337	249
Daily summer gain.....do		2.53	1.81		2.69	1.99
Daily supplement:						
Corn.....do		5.96			5.76	
Cottonseed meal.....do		1.63			1.57	
Initial cost per 100 pounds.....dollars	7.65			6.40		
Sales price per 100 pounds.....do		13.27	12.03		12.47	11.25
Profits per steer (exclusive of pasture charge).....dollars		57.04	46.51		56.64	48.02

An average of the summer gains for the three years shows that the Good steers fed grain (lot 1A) gained 317 pounds as compared to 337 pounds for the Medium grade (lot 2A) handled in like manner. The increased gain of the Medium steers over the Good grade amounted to 6.3 per cent.

The Good steers on grass alone (lot 1B) made an average summer gain of 228 pounds, as compared to 249 pounds for the Medium steers (lot 2B) on grass alone. The average increased gain of the Medium steers on grass alone for the three years was 9 per cent. Figure 7 shows graphically the average winter and summer gains for the three years.

A supplement of corn and cottonseed meal increased the summer gains 37 per cent as an average for the three years' experiments.

The feeding of grain increased the selling price of both grades of steers more than 10 per cent, the Medium grade having a slight advantage. The Medium steers fed grain made a margin of $6.07 a

100 pounds as compared to $5.62 for the corresponding lot of Good grade. The Medium and Good steers on grass alone made a margin of $4.85 and $4.38 a 100 pounds, respectively.

The three years' experiments reported in this bulletin indicate that the gains and finish of 3-year-old steers on good pasture can be increased sufficiently by the feeding of a grain supplement to more than offset the additional expense. Although the feeding of a grain supplement increases the gains of steers on grass, the increased gain may not necessarily be put on at a profit, as the buying and selling prices of the cattle may have a more direct bearing on the profits than the feed costs.

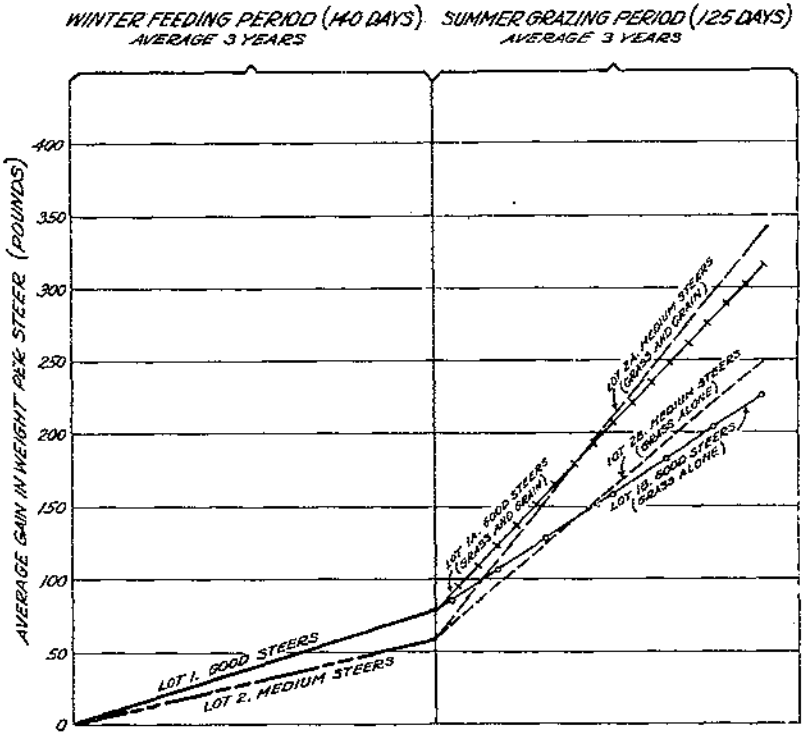

FIGURE 7.—Average winter and summer gains of Good and Medium steers for the three years' experiments

Good and Medium steers handled similarly during the winter feeding period and through the summer grazing period following may be expected to make similar total gains. The relative returns of each grade will therefore depend primarily on the margins obtained.

MEAT STUDIES

Formerly, reports of the effectiveness and desirability of various livestock-production practices were made on the basis of gain, cost of gain, and comparative selling price. The first two recorded the economic efficiency of the methods used. Selling price was frequently used by animal-husbandry investigators as the measure of the amount and character of the product. Although it was the best yardstick

available, its use is open to serious criticism. In the first place, it was the opinion of a man or a small group of men. Moreover, the personnel of these appraisers varied from year to year and from experiment to experiment, introducing the added variables of personal ability and the influence of current market demands.

From the research standpoint, however, the most serious fault of this widely used system lies in the fact that the quality measure used is a single statement, incapable of disclosing the various factors that created it. Any selling price is a compromise, in which dressing percentage, weight, fatness, conformation, appearance, palatability, and current market demand alternately raise and lower the value in the appraiser's mind. Selling price, even if accurate, is but a general statement from the viewpoint of the market and the consumer. It affords no detailed information as to the strengths or weaknesses of the rations used.

The meat investigations reported here are part of a series that has been designed to separate and compare the various characteristics of amount and quality that the market considers under the one term, "selling price." An effort is made to break up this single, all-inclusive statement into cause and effect.

Detailed information as to the influence of such factors as age, weight, type, breed, sex, and ration on the tenderness and flavor, the yield, and the nutritive value of the meat permits the adaptation of production practices to the ever-changing desires of the consumer. It also prepares for the producers the information needed to develop the greatest market value from the stock, feed, and conditions available in his locality.

In this particular experiment, grade of steer and a supplemental feed of grain on grass were the production factors studied. In the following pages a comparison is made of their effect on the appearance, composition, structure, cooking losses, and palatability of the beef.

METHOD OF SAMPLING

The first year samples were taken from only one animal in each lot. This inadequate representation combined with a subsequent change in some of the laboratory technic made it seem fairer to exclude the record of the 1925–26 steers from the final averages. In 1926–27, three steers from each lot were used; in 1927–28, five steers. This larger representation proved to be much more satisfactory.

It will be recalled that the feeding trials of this experiment extended over three years and included 119 steers. The meat studies reported here include observations on the meat from 32 head selected from the experiments of 1926–27 and 1927–28. This selection was made by the committee who graded the carcasses. They chose a representative cross section from each lot, in preference to a sample of similar carcasses all composing the middle or average of the group. This method of selection will explain some of the individual variations noted in the following tables. It will also give more significance to averages and to individual uniformity where it appears.

The laboratory comparisons of the meat from these four lots of steers were made by the use of a standard rib sample. The data would be more nearly complete if the entire carcass had been in-

cluded, but financial and laboratory limitations confined the comparisons to a single wholesale cut. The rib was selected because of the accuracy with which it could be removed and sampled. Tests conducted in other experiments,[2] show that its composition correlates closely with that of the entire beef side.

The sample was cut according to the standard procedure adopted by the cooperators for the national project. By the use of definite measurements developed by Loeffel and Trowbridge,[3] a proportionate part of each front quarter was taken out as the rib. The cut, as made, was almost identical with the commercial prime rib cut, Chicago style. It contained the twelfth to sixth ribs, inclusive. The twelfth rib was removed from both the right and left sides for the tenderness tests, by cutting close to the posterior or loin side of the eleventh rib. The standard middle sample was removed by cutting close to the posterior side of the eighth rib. The cut comprising the ninth, tenth, and eleventh ribs from the right side was used for the physical and chemical analyses. The same cut from the left side was used for color comparisons and cooking tests. The eye muscle from the left eighth rib was reserved for histological examination.

PRESENTATION OF THE DATA

In the presentation of data, the average of the two 1-year experiments conducted in 1926–27 and 1927–28 is given as the final figure. The variation or consistency obtaining between the two years' work is noted in the discussion but the yearly summaries are not included in the tables. Lots have usually been ranked in accordance with their yield or rating. For the reader's convenience the difference between lots is also shown. Individual ranges are supplied in place of the standard deviation.

To obviate the necessity for constant reference to the ration and grade of each lot of steers, a brief terminology has been suffixed to each lot number. Lots 1A and 2A, the Good and Medium grade steers that received a supplement of grain on grass, are termed "Good grade, grain on grass," and "Medium grade, grain on grass." Lots 1B and 2B, the Good and Medium steers fed on pasture alone, are termed "Good grade, grass alone," and "Medium grade, grass alone." The grain-fed lots received an average supplemental grain ration of only 6½ to 8½ pounds a head daily and should not be compared with strictly grain-fed cattle.

GRADING OF THE ANIMALS AND CARCASSES

The steers were graded individually as feeders, as slaughter animals, and in the carcass, in order to record the visible evidence of variation in conformation, finish, and quality. Detailed descriptive charts were used for this purpose that resembled, in principle, the familiar stock-judging score card of the classroom.[4]

In accordance with the classification developed by the Bureau of Agricultural Economics the feeder chart included six grades ranging from "Fancy" to "Inferior." The slaughter cattle and the carcass

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[2] CHATFIELD, C. PROXIMATE COMPOSITION OF BEEF. U. S. Dept. Agr. Circ. 389, 10 p., illus. 1926.

[3] UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY. A STUDY OF THE FACTORS WHICH INFLUENCE THE QUALITY AND PALATABILITY OF MEAT. 76 p. Revised, 1927. [Mimeographed

[4] SLATER, D. J. MARKET CLASSES AND GRADES OF CATTLE. U. S. Dept. Agr. Bul. 1464, 68 p., illus. 1927.

charts included seven grades, "Prime" to "Low Cutter." For each of the characteristics or elements of conformation, finish, and quality, a comparative word series was provided that varied from the description of the most desirable development for the highest grade to that of the least desirable for the lowest.

For example, the description of general width of body in the slaughter animal varied through seven grades from "Very wide" through "Wide," "Moderately wide," "Slightly narrow," "Narrow," "Very narrow," to "Extremely narrow." The degree of marbling in the carcass chart ranged from "Abundant and extensive" in the Prime grade to "Slightly deficient and limited distribution" in the Good grade, and to "None visible" in the lowest or Low Cutter grade. Grade descriptions of the feeder cattle were designed to note differences that are usually associated with the feeding capacity or outcome of the steer. For instance, the most desirable conformation of middle or belly was listed as "Very large," the medium grade as "Slightly restricted," and the inferior grade as "Restricted."

With this system the work of the grader was done without immediate reference to the actual grade, his only function being to check the adjectives that most nearly described each part.

In developing these charts and making them suitable for summarization, it was found necessary to assign a numerical value to each element or characteristic. Any such value is necessarily arbitrary. Those used, however, were determined by comparing the proportionate weight and selling price of the wholesale cuts with those of the entire carcass. Wholesale Chicago quotations for Good beef from 1921 to 1924, inclusive, were used for this computation. The Chicago style of cutting beef was used in figuring the cutting yields.

The maximum value assigned to each item was credited to the description appearing under the highest grade. The value or score for the lower grades was proportionately less, down to a minimum of 40 per cent of the maximum for the lowest grade of feeder cattle, and to 30 per cent for slaughter cattle and beef carcasses.

The grading was done by a committee of three members working independently. Using the assigned values, the average opinion of the committee was determined for both the individual items and for the final grade of each animal and carcass.

In 1925–26 and 1926–27 arrangements were made to sell one-half of each lot of steers in Jersey City to obtain a commercial appraisal. In 1927–28 the remodeling of the Government meat laboratory at Beltsville necessitated slaughtering all the cattle at Jersey City. In two of these cases the experiment fell victim to the well-known urgencies of business. Although arrangements had been made for grading the chilled carcasses after ribbing, the local packers shipped the entire lot before the appointed time.

As a result some of the carcass grades are incomplete and lack the description of eye, marbling, color, and similar items. The carcass grades appearing in Tables 8 and 9 are based on the record of only those carcasses for which a complete grading could be made.

TABLE 8.—*Average feeder cattle, slaughter cattle and beef carcass grades and average summer gains*

[Lots averaged and ranked according to lot number]

Year	Steers	Lot designation	Feeder grades		Slaughter grades			Carcass grades [1]	
			Numerical grade	Corresponding approximate market grade	Average summer gains per steer	Numerical grade	Corresponding approximate market grade	Numerical grade	Corresponding approximate market grade
	Number				*Pounds*				
Average of 3 years	20	1A, Good grade, grain on grass	74.8	Good	317	75.8	Good		
	30	1B, Good grade, grass alone	74.2	do	228	70.5	Low Good		
	30	2A, Medium grade, grain on grass	66.6	Medium	337	69.4	High Medium		
	30	2B, Medium grade, grass alone	66.4	do	249	64.7	Medium		
1925–26	9	1A, Good grade, grain on grass	74.5	Good		75.8	Good		
	10	1B, Good grade, grass alone	73.9	do		69.6	High Medium		
	10	2A, Medium grade, grain on grass	66.0	Medium		71.7	Low Good		
	10	2B, Medium grade, grass alone	65.4	do		64.5	Medium		
1926–27	10	1A, Good grade, grain on grass	75.6	Good		76.2	Good	75.4	Good.
	10	1B, Good grade, grass alone	74.4	do		70.8	Low Good	70.0	High Medium.
	10	2A, Medium grade, grain on grass	64.7	Medium		68.3	High Medium	67.3	Do.
	10	2B, Medium grade, grass alone	64.6	do		63.1	Low Medium	65.4	Medium.
1927–28	10	1A, Good grade, grain on grass	74.4	Good		75.6	Good		
	10	1B, Good grade, grass alone	74.5	do		71.1	Low Good		
	10	2A, Medium grade, grain on grass	69.0	High Medium		68.1	High Medium		
	10	2B, Medium grade, grass alone	69.2	do		66.5	Medium		

[1] Carcasses of half of the 1925–26 and all the 1927–28 steers had to be graded without ribbing; observations of grain, marbling, and similar items were not obtainable and the carcass grades have therefore been omitted.

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Table 8 compares the average grade of these four lots of steers as feeders, slaughter cattle, and in the carcass. Figures 8 to 19 show representative animals from each lot as a feeder, at slaughter, and the rib samples from their carcasses.

Lot 1A, the Good grade cattle fed grain on pasture, graded consistently higher as slaughter cattle than the others. Lot 2B, the Medium grade grass-alone lot was persistently last. Lot 1B, the Good, grass-alone steers, and lot 2A, the Medium, grain-on-grass steers were graded close together at slaughter without either showing a definite superiority.

Comparison of feeder and slaughter grades for the respective lots reveals a very definite and consistent trend throughout the three experiments. The Good grade feeders receiving a supplement maintained a corresponding grade of Good as slaughter animals, while those on grass alone lost one-third to one-half a grade during the feeding period. Of the Medium feeders those fed grain had improved about one-third of a grade when the experiment closed while those on grass alone graded slightly lower as slaughter cattle than they had graded as feeders.

The average summer gains per steer are given in Table 8 for comparison with these grade changes. It will be noted that the supplement-fed lots made very similar gains, 317 pounds for the Good grade and 337 for the Medium. In spite of this similarity, however, the Medium lot improved their grade during the feeding period more than the Good grade.

Both grass-alone lots graded lower as slaughter cattle than as feeders but the Good grade dropped 3.7 points while the Medium steers lost but 1.7 points. Yet both lots made comparable gains, 228 pounds and 249 pounds, respectively.

It appears from these results that it takes a greater actual gain to maintain or improve the grade of Good cattle than it does that of feeders of a Medium grade. Of special interest is the fact that these results with mature steers correspond to those from other experiments in which cattle of various ages and degrees of finish have been compared.[5]

In general, the carcass and slaughter grades conformed to the comparative dressing percentage and fat content of the four lots as noted in the following pages. The chief exception is the slightly higher grade of the Good cattle fed grass alone as compared with the Medium grade receiving grain.

Eight subdivisions of the carcass-grading chart describing such points as color, texture, and marbling have been selected for special analysis in Table 9. The ones chosen are those considered, in market channels, as being most indicative of the quality of the meat. Because of the unfortunate combination of circumstances under which some of these cattle were killed and graded, this summary includes only 59 head, or half those handled in 1925–26 and all the 1926–27 steers. This selection includes only 12 of the 32 cattle used in the detailed meat studies.

[5] Unpublished data.

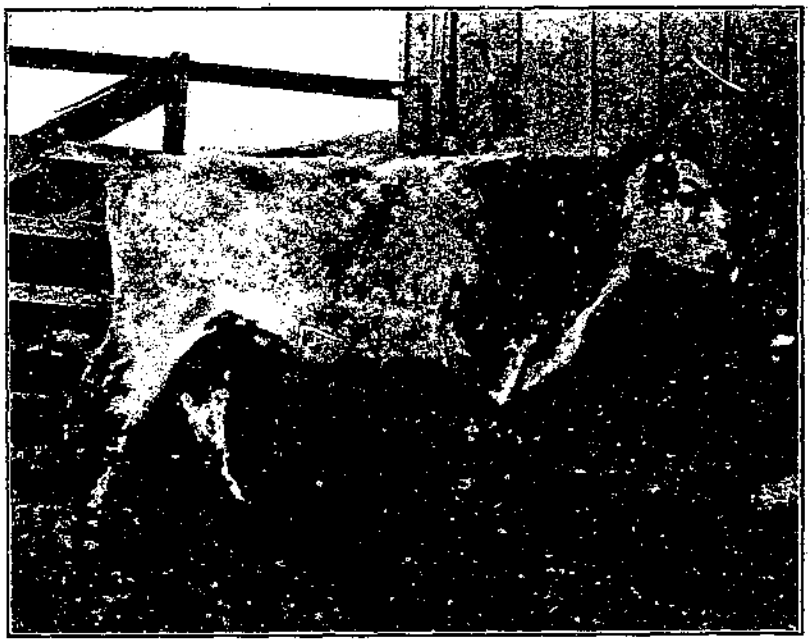


FIGURE 8.—Steer No. 6, Good grade, grain on grass, as a feeder

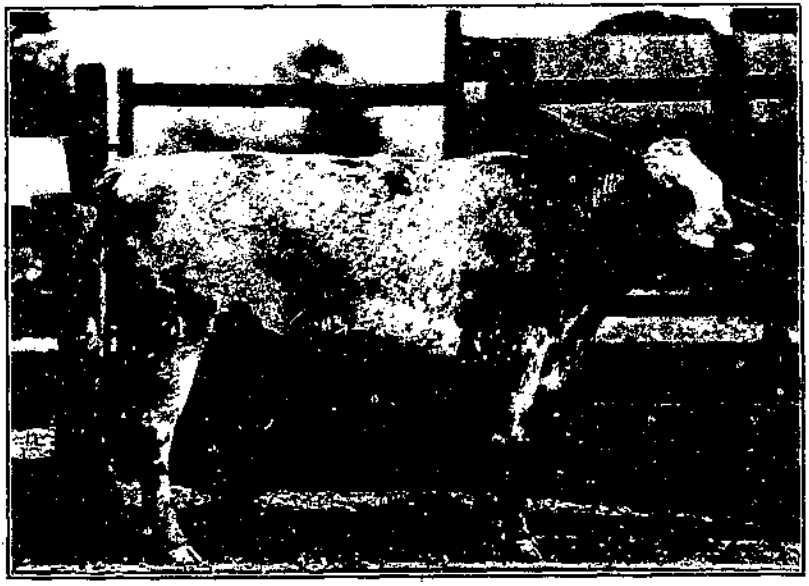


FIGURE 9.—Steer No. 6, Good grade, grain on grass, at slaughter

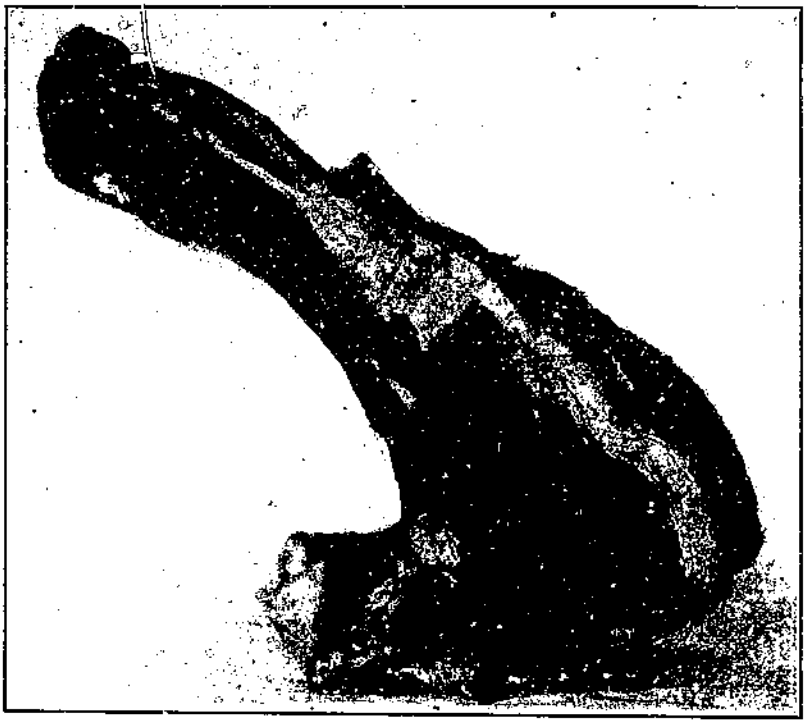


FIGURE 10.—Rib sample from steer No. 6, Good grade, grain on grass

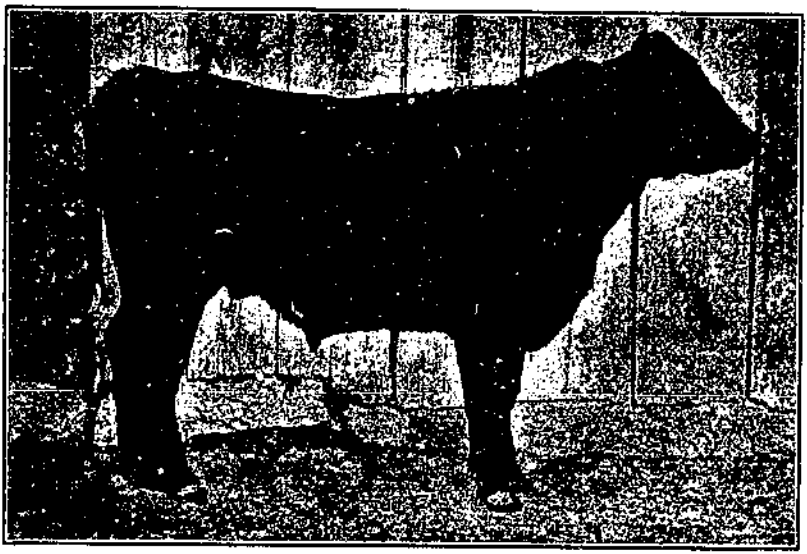


FIGURE 11.—Steer No. 17, Good grade, grass alone, as a feeder

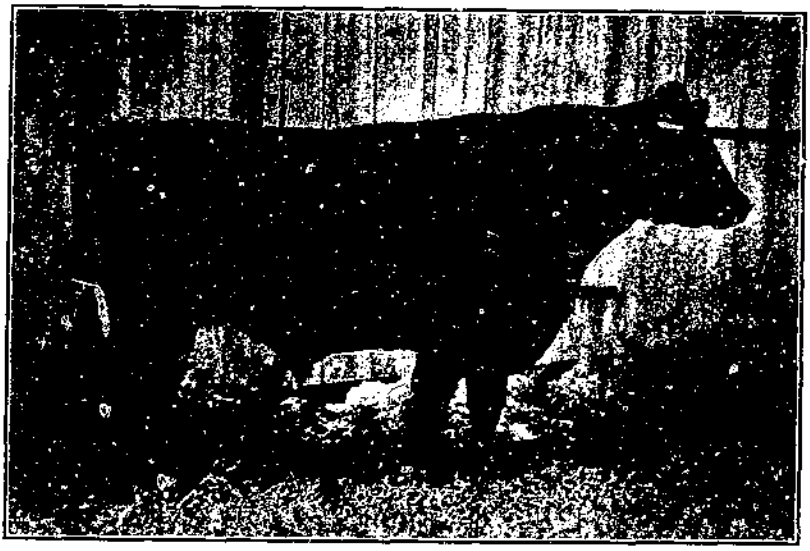


FIGURE 12.—Steer No. 17, Good grade, grass alone, at slaughter

FIGURE 13.—Rib sample from steer No. 17, Good grade, grass alone

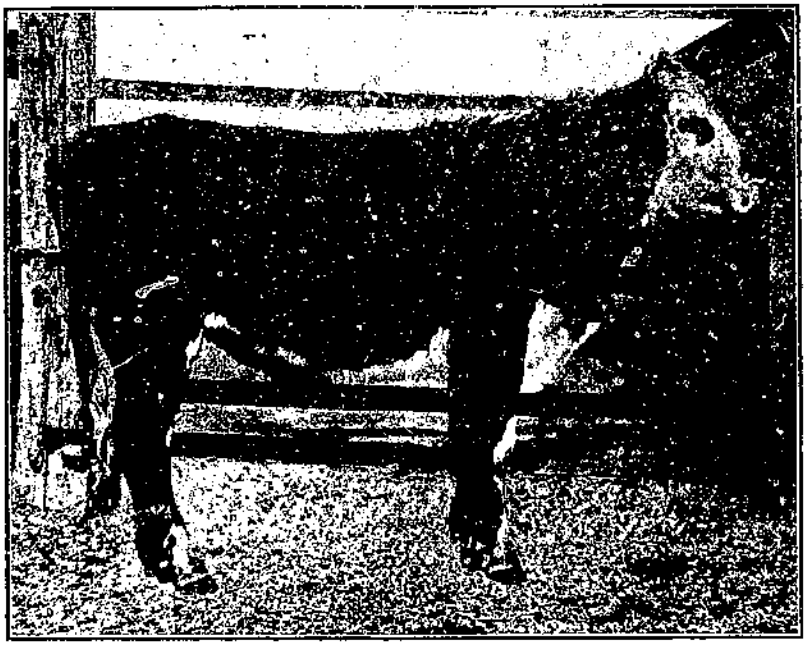


FIGURE 14.—Steer No. 28, Medium grade, grain on grass, as a feeder

FIGURE 15.—Steer No. 28, Medium grade, grain on grass, at slaughter

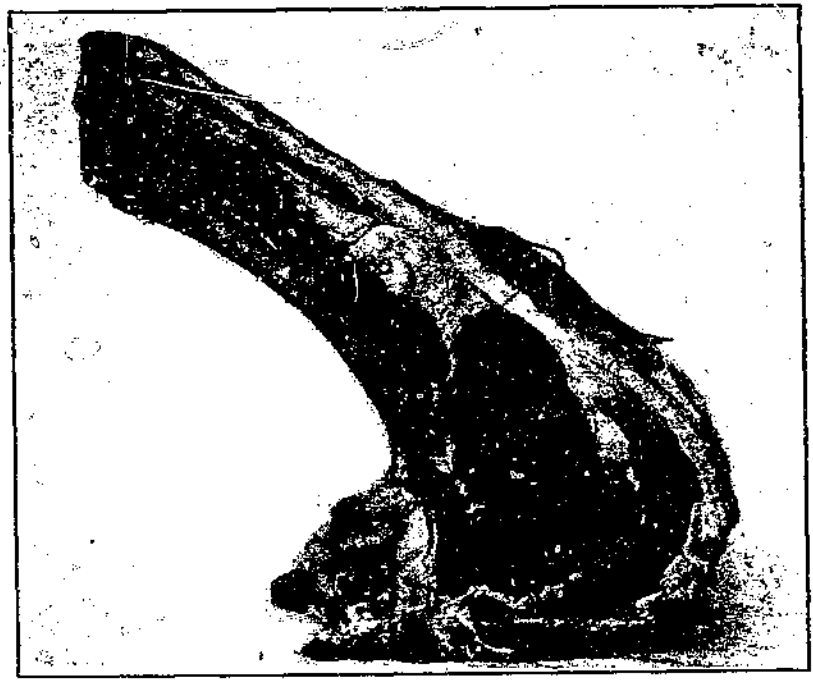


FIGURE 16.—Rib sample of steer No. 28, Medium grade, grain on grass

FIGURE 17.—Steer No. 36, Medium grade, grass alone, as a feeder

FIGURE 18.—Steer No. 36, Medium grade, grass alone, at slaughter

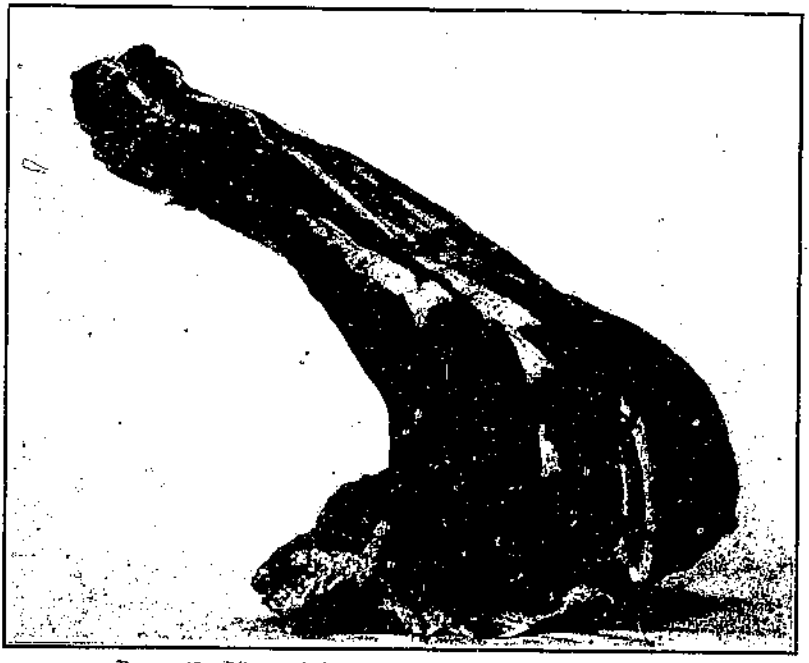


FIGURE 19.—Rib sample from steer No. 36, Medium grade, grass alone

TABLE 9.—*Appearance and numerical scores of carcasses, the descriptions being based on averaged judgment of the grading committee*

[Lots averaged and ranked according to lot number]

Item	Lot 1A, Good grade, grain on grass. (14 steers)		Lot 1B, Good grade, grass alone. (15 steers)		Lot 2A, Medium grade, grain on grass. (15 steers)		Lot 2B, Medium grade, grass alone. (15 steers)	
	Average numerical score	Corresponding description	Average numerical score	Corresponding description	Average numerical score	Corresponding description	Average numerical score	Corresponding description
Thickness of flesh (maximum score, 4)	3.0	Moderately thick	2.8	Moderately thick	2.7	Slightly thin	2.6	Slightly thin.
Thickness of fat (maximum score, 8)	6.0	do	5.6	do	5.6	Moderately thick	5.3	Do.
Marbling (maximum score, 5)	3.7	Slightly deficient; limited distribution.	3.4	Deficient	3.5	Slightly deficient; limited distribution.	3.2	Deficient.
Texture of lean (maximum score, 4)	2.8	Moderately fine	2.8	Moderately fine	2.7	Slightly coarse	2.6	Slightly coarse.
Firmness of lean (maximum score, 2)	1.5	Moderately firm	1.4	Moderately firm	1.4	Moderately firm	1.3	Slightly soft.
Color of lean (maximum score, 3)	2.3	Moderately dark cherry red.	2.1	Moderately dark cherry red.	2.2	Moderately dark cherry red.	2.1	Moderately dark cherry red.
Color of fat (maximum score, 2)	1.4	Creamy white	1.3	Pale yellowish white	1.3	Pale yellowish white	1.3	Pale yellowish white.
Size of eye (maximum score, 4)	3.0	Moderately large	2.9	Moderately large	2.7	Slightly small	2.5	Slightly small.

The maximum score listed under each item is the part of the 100 points of the complete carcass-grading chart that was allotted to that particular characteristic. It will be recalled that provision was made on the grading chart for the recognition of seven grades or degrees of desirability with a verbal description for each of the grades. Thus, thickness of flesh varied from "very thick" with a perfect score of 4, through "thick," "moderately thick," "slightly thin," "thin," "very thin," and "extremely thin." Color of lean began with "light cherry red," "slightly dark red" being the middle of the seven grades, and ended with "extremely dark red" as the color description of the lowest or Low Cutter grade.

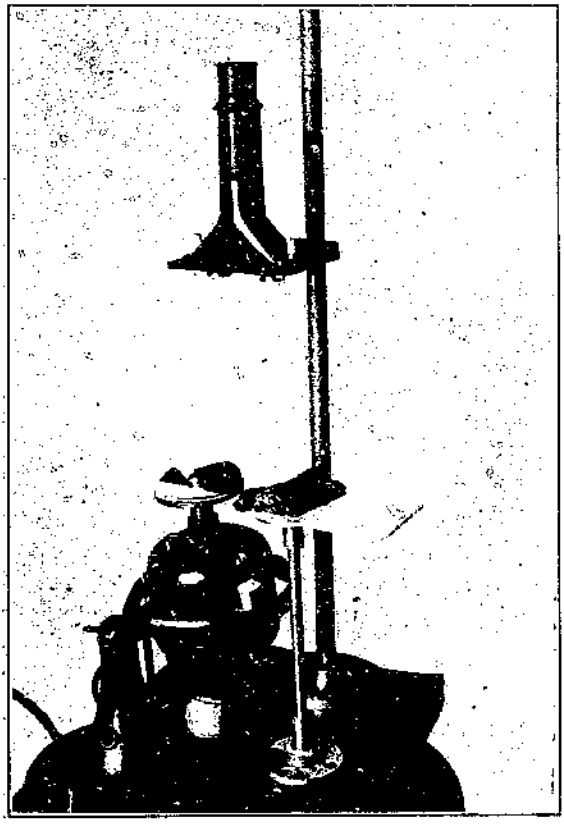


FIGURE 20.—Color comparator. One-half the field seen through eyepiece contains the color of the spinning disk, the other half the color of the samples. Adjustment is made to keep both objects slightly out of focus

The comparisons in Table 9 show a slight trend toward accepted market standards in the description of the meat from the Good and supplement-fed lots. There was also a fairly consistent decrease in the numerical grades from lot 1A through to lot 2B, as recorded by the graders.

COLOR COMPARISONS

Dark-red lean beef is believed, in commercial channels, to be tougher and less palatable than that of a bright cherry-red color. Many market men also think that grass-fed beef has a darker color than the meat from steers that have been fed grain. With these facts in mind, special effort was made to compare the color of the meat from these grass and supplement-fed steers. To do this it was first necessary to establish a color standard. A color comparator, or spinning disk, was finally devised in which varying amounts of red, yellow, white, and black could be combined until the color of the meat was matched. (Fig. 20.) When observed by means of this instrument, the field holding the meat sample crosses that holding the color cards.

By altering the proportionate exposed area of the various colors on the spinning disk, its color can be changed until the two fields

match. The exposed area of each color on the disk is then measured and recorded. In collaboration with the national cooperative committee, there was also developed a color series corresponding to the colors of the lean of beef from animals over 18 months of age. Each color was given a number. The lightest one is called A1 and the darkest A10. This standard series was available before the spinning disks and is the basis for the color readings given in Table 10. This table includes only the rib samples on which comparable color studies could be made.

TABLE 10.—*Color of uncooked eleventh rib eye, 80 minutes after cutting when matched with standard series*

[Lots averaged and ranked according to lightest color]

Year	Steers	Lot designation	Average color readings [1]	Range within lot
	Number			
Average of two years	6	1A, Good grade, grain on grass	A 4.7	A2–A10
	6	2A, Medium grade, grain on grass	A 4.8	A3–A10
	7	2B, Medium grade, grass alone	A 6.3	A4–A10
	7	1B, Good grade, grass alone	A 7.6	A5–A10

[1] Lightest shade of red was called A1, the darkest A10.

The figures in Table 10 show a slightly lighter-colored lean in the beef from the steers that had received a supplement of grain on grass. However, there was too wide an individual variation in each lot to warrant conclusions on this point.

DRESSING PERCENTAGES

In presenting these figures it should be emphasized that the relation between the carcass and live weight of an animal is not always an accurate criterion of its conformation and fatness. Individual variations in live weight, owing to fill, may cause extreme differences in yield. Comparisons of dressing percentages are chiefly significant when the contrast is fairly large and when the ranking of respective lots shows a definite consistency through several experiments. There is also much to be said in favor of the use of final feed-lot and hot-carcass weights for lot comparisons through a series of experiments. Fewer variables are introduced than where results are based on later weights. Consideration of these factors has convinced the cooperators in the meat studies that carcass yields should be reported as in Table 11.

TABLE 11.—*Dressing percentages based on final feed-lot and hot-carcass weights*

[Lots averaged and ranked according to largest yield]

Steers	Lot designation	Dressing percentage	Difference between lots
Number			*Per cent*
29	1A, Good grade, grain on grass	57.71	1.68
30	2A, Medium grade, grain on grass	56.03	.68
30	1B, Good grade, grass alone	55.35	1.32
30	2B, Medium grade, grass alone	54.03	

NOTE.—3-year average reported.

The comparative dressing percentages of the four lots of steers for each of the three trials when arranged from highest to lowest conformed exactly to the order shown in Table 11. With the exception of a very close comparison between the grain-fed lots in the 1925–26 test the margins between the lots are also consistent with the average. These facts would indicate the very definite influence of grade and of a supplemental feed of grain on a larger dressing yield.

Based on slaughter and cold weights obtainable from this and other experiments, it is estimated that the use of those figures would have increased the dressing percentage from 2 to 4 per cent.

Unfortunately it was impossible to obtain the cutting yields in this series of tests.

PHYSICAL ANALYSIS OF RIB SAMPLES

The ninth-tenth-eleventh-rib sample was mechanically separated into bone, eye, other lean, and fat. Bone weights are subject to the normal variation in splitting the backbone. The connective tissue was removed from the eye muscle before weighing. The small multifidus dorsi muscle was included with the section of the longissimus dorsi as eye muscle. The fat sample contained but little lean, though, of course, small portions of the fat were inseparable from the other lean. Tables 12 to 16 show the physical analysis of the 32 ribs studied in the 1926–27 and 1927–28 experiments. Each item has been listed in a separate table. Yields are based on the entire ninth-tenth-eleventh-rib sample as 100 per cent.

Table 12 is included to show the weights of each part. It will be noted that the four lots compare quite closely as to the actual weight of eye muscle and of bone.

TABLE 12.—*Physical analysis of right ninth-tenth-eleventh-rib samples averaged and ranked according to lot number*

Year	Steers	Lot designation	Average weight per sample of—				
			Total rib	Eye	Other lean meat	Fat	Bone
	Number		*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Average of two years.	8	1A, Good grade, grain on grass	12.53	2.58	3.60	3.92	2.43
	8	1B, Good grade, grass alone	10.44	2.70	2.93	2.32	2.49
	8	2A, Medium grade, grain on grass	12.17	2.65	3.30	3.61	2.55
	8	2B, Medium grade, grass alone	10.35	2.53	3.21	2.25	2.36

The figures in Table 13 show a lower percentage yield of bone in the rib cuts from the steers that received a supplement of grain on grass than from those finished on grass alone, as would be expected. The results for the two years are consistent with the exception of a close similarity between the figures for both the Medium lots in 1926–27. In that instance, the individual range for the grain-fed lot dropped 1.10 per cent below the lowest figure for the lot on grass alone, although one rib from lot 2A fed grain on grass contained 0.95 per cent more bone than any from the steers without a grain supplement. The fact is of peculiar interest that the rib samples of the Good steers on grass alone contained proportionately more bone, in both tests, than any of the others.

TABLE 13.—*Percentage yield of bone in the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked in order of smallest yield]

Year	Steers	Lot designation	Bone	
			In rib sample	Range within lot
	Number		*Per cent*	*Per cent*
Average of two years	8	1A, Good grade, grain on grass	19.39	17.21–22.40
	8	2A, Medium grade, grain on grass	20.95	17.68–27.02
	8	2B, Medium grade, grass alone	22.60	18.46–26.07
	8	1B, Good grade, grass alone	23.85	20.34–30.19

Proportionate amounts of physically separable fat in the selected rib samples from the four lots of steers indicate a higher fat content in the meat from those animals that had received a supplemental feed of grain. This alignment is consistent for the two years and is reflected in the range of the fat yield of the individual steers. The range in the grass-alone steers is much greater than that of the other two lots (Table 14).

The ribs from the Good steers averaged a higher proportion of fat than those from the Medium grade. The differences, however, were not consistent between the two years' work.

TABLE 14.—*Percentage yield of physically separable fat in the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to the largest yield]

Year	Steers	Lot designation	Physically separable fat	
			In rib sample	Range of lot
	Number		*Per cent*	*Per cent*
Average of two years	8	1A, Good grade, grain on grass	31.29	27.69–33.67
	8	2A, Medium grade, grain on grass	29.66	22.13–35.06
	8	1B, Good grade, grass alone	22.22	12.12–31.32
	8	2B, Medium grade, grass alone	21.74	13.81–28.39

As might be expected, the ribs from the fatter, supplement-fed steers produced a smaller proportion of eye muscle than those from the cattle fed grass alone. These facts would indicate that fattening increases the weight of the tissues around this muscle more rapidly than it increases the weight of the eye itself. There was no consistent relationship between the yield of eye muscle from the two grades of steers (Table 15).

TABLE 15.—*Percentage yield of eye muscle in the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to the largest yield]

Year	Steers	Lot designation	Eye	
			In rib sample	Range of lot
	Number		*Per cent*	*Per cent*
Average of two years	8	1B, Good grade, grass alone	25.86	22.84–29.34
	8	2B, Medium grade, grass alone	24.44	21.67–27.42
	8	2A, Medium grade, grain on grass	21.78	18.43–26.22
	8	1A, Good grade, grain on grass	20.59	18.58–22.93

In the yield of other lean, the ranking of the four lots is most inconsistent for the two years. Individual ranges also cross and recross one another so often that no trend is indicated. Possibly there was no consistent difference between them. Possibly methods of separation need improvement (Table 16).

TABLE 16.—*Percentage yield of mechanically separable other lean in the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to largest yield]

Year	Steers	Lot designation	Other lean	
			In rib sample	Range of lot
	Number		*Per cent*	*Per cent*
Average of two years	8	2B, Medium grade, grass alone	31.02	26.16–41.65
	8	1A, Good grade, grain on grass	28.73	26.19–32.42
	8	1B, Good grade, grass alone	28.07	23.06–31.68
	8	2A, Medium grade, grain on grass	27.61	24.62–32.96

CHEMICAL COMPOSITION OF RIB SAMPLES

Chemical analysis of the rib sample establishes the basis for estimating the nutritive value of the meat and the fatness of the carcass. From the standpoint of quick determination or visual appraisal, considerable interest also attaches to the comparison of the chemical and physical analyses.

The mechanically separated tissues from the right-rib samples were ground twice through the 1/16-inch plate of a meat grinder and mixed thoroughly by hand. Samples for analysis were taken at random from several different portions of the ground meat. The Kjeldahl method was used for the determination of nitrogen, the accepted factor of 6.25 being applied to estimate the protein. Fat was extracted with ether. Moisture was determined by the Bidwell-Sterling distillation method, a water-saturated solution of toluene being used. Duplicate samples were run for each determination.

The average fat content of the rib samples, as shown in Table 17, and the comparison of the two years' experiments indicate a consistently higher fat yield in the ribs from the steers that had had a supplemental feed of grain on grass. This result would have been expected from the rations used. The average fat content of the two lots fed grain was 38.71 per cent of the edible portion of the rib sample and for the two grass-alone lots 30 per cent. Considering the small amount of grain fed to lots 1A and 2A, 6½ to 8½ pounds daily, the size of this difference, 8.71 per cent, is most striking. Of equal interest is the comparatively high fat content of the thinnest lots.

TABLE 17.—*Chemical composition of edible portion of right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to fat content]

Year	Steers	Lot designation	Water		Ether extract (fat)		Protein	
			In edible portion	Range in lot	In edible portion	Range in lot	In edible portion	Range in lot
	Number		*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Average of two years.	8	1A, Good grade, grain on grass.	45.50	39.83–49.97	40.35	34.58–47.57	13.64	11.43–15.20
	8	2A, Medium grade, grain on grass.	48.01	43.57–55.50	37.08	27.66–43.29	14.17	12.64–15.54
	8	1B, Good grade, grass alone.	52.96	45.79–60.15	30.22	19.54–39.95	15.87	13.33–18.55
	8	2B, Medium grade, grass alone.	53.29	46.41–60.16	29.73	20.50–38.86	16.17	13.77–18.07

Estimating the analysis of the entire 7-rib cut from the fat content of the ninth-tenth-eleventh-rib sample [6] the supplement-fed lots would have produced a standing rib with approximately 36.5 per cent of fat, and the grass-fed 28 per cent. Regular 7-rib cuts containing 31 per cent of fat are classed as fat by Chatfield [7] with those possessing 44 per cent as very fat. On this basis the ribs from the grass-alone lots were near the average of the fat group, with those from the supplement-fed lots almost halfway between the fat and the very fat classification.

Explanation of this comparatively high condition in all four lots would seem to lie in the age or near maturity of the steers. They were 3½ years old when the experiment closed and it would appear that cattle of that age are capable of laying on considerable finish on grass alone.

The difference in the fat content of the rib samples from the two grades of cattle was not marked or consistent. Particular attention is called to the wide range in the fat content of the samples from the different steers. The maximum and minimum percentages for each lot followed the same general order as that of their respective averages. However, the range was so wide within each lot as to present definitely the individuality of each animal as a factor to be considered in the interpretation or application of these results.

Protein and moisture percentages in the rib samples varied inversely with the fat content. This relation is consistent for both the average and for the two experiments. It also extends, with minor variations, to the respective individual ranges within each lot. This fact indicates that maturing animals increase their fat storage at a greater rate than they enlarge their muscle tissue. It also suggests a problem in both nutrition and consumer economics that must be considered in evaluating this meat. Reexamination of Table 12, showing the weight of bone and eye and other lean, reveals the fact that the actual weight of these products in the roasts from all four lots was very similar. The chief difference and principal cause for the increased total weight of the samples from lots 1A and 2A were the accumulation of fat. The calculated weights of protein from the edible portion

[6] Unpublished data.

[7] CHATFIELD, C. Op. cit.

of the rib as given in Table 18 show that the consumer would have purchased nearly the same amount of protein in the lighter cuts from the thinner cattle as he would have obtained in the heavier roasts from the fatter lot.

TABLE 18.—*Calculated weights of water, fat, and protein in edible portion of right ninth-tenth-eleventh-rib samples, based on chemical analysis*

[Lots averaged and ranked according to fat content]

Year	Steers	Lot designation	Average total weight of rib sample	Average calculated weight, in edible portion, of—		
				Water	Fat	Protein
	Number		*Pounds*	*Pounds*	*Pounds*	*Pounds*
Average of two years.	8	1A, Good grade, grain on grass	12.52	4.59	4.07	1.38
	8	2A, Medium grade, grain on grass	12.17	4.62	3.57	1.36
	8	1B, Good grade, grass alone	10.44	4.21	2.40	1.26
	8	2B, Medium grade, grass alone	10.35	4.25	2.39	1.29

The average calculated protein in the edible portion of the rib samples varied from 1.38 pounds for those from the fattest lot to 1.26 pounds for those from the thinnest. This difference of 0.12 pound is 8.6 per cent of the maximum total protein, but it includes all the protein contained in the rarely consumed fat layer. If correction is made for the protein in the fiber of this fat, the samples from lot 1A had less than 4 per cent more protein than those from lot 2B.

With such a similarity existing between the rib samples from these four lots of steers as to actual weight of protein and bone, any advantages accruing to the consumer from the extra weight of the fatter roasts would be largely from the fat itself, or from the effect that the fattening may have had in improving the desirability of the lean meat.

Reference to the dressing percentages given in Table 11 discloses the fact that the ranking of the lots in accordance with fatness was similar to their comparative dressing yield.

FAT CONTENT OF EYE MUSCLE

The development of many of the characteristics or qualities of meat often appears to be due to individual differences rather than to ration or management. The control of that development may lie in the field of genetics rather than of nutrition. The fat content of the eye muscle presented in Table 19 is a case in point. Throughout both experiments the supplement-fed lots produced an eye sample with a greater fat content than that of the grass-alone lots. This higher yield also conforms to the comparative percentage of total fat in the edible portion of the rib. However, the proportionate differences between the fat content of the eye muscle in the respective lots show only a general relation to the differences appearing between the total fat content of the edible portion of the entire sample. In addition the individual range within each lot is so extremely wide that variation due to grade or feeding appears to be unproved.

TABLE 19.—*Ether extract (fat) in the eye muscle of the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to largest yield]

Year	Steers	Lot designation	Ether extract in eye muscle	Range in lot	Ether extract in edible portion of entire rib sample
	Number		*Per cent*	*Per cent*	*Per cent*
Average of two years.	8	1A, Good grade, grain on grass	7.80	12.43–3.38	40.35
	8	2A, Medium grade, grain on grass	7.85	10.20–4.84	37.08
	8	2B, Medium grade, grass alone	6.15	9.52–3.74	29.78
	8	1B, Good grade, grass alone	5.37	9.02–2.57	30.22

It had been expected that a comparison between the fat content of the eye and the extent of the visible marbling would have been made in this study. The unfortunate grading conditions obtaining in the 1927–28 experiment made this impossible.

The fact is of interest that a statistical study of 189 carcasses studied in other experiments developed a correlation between the content of ether extract of the eye and the degree of marbling reported by the grading committee of 0.42 ± 0.04[8]. Such a figure indicates a significant correlation, but is not particularly high.

HISTOLOGICAL DETERMINATIONS

The grain, texture, consistency, and moistness of lean beef have long been used by the trade as indications of quality. Preference is shown for meat possessing a smooth, fine-grained surface that is firm and velvety to the touch. This is in contrast to a coarse, open fiber, and a soft and rather wet "leaky" consistency. It was, therefore, quite natural that especial interest should attach to the study of the structural and physical differences between samples from the steers and their relation to the composition and palatability of the meat.

It soon developed, however, that there were no established laboratory methods that would give accurate comparisons of structure. The immediate problem thus changed from one of studying the effect of ration on texture to that of establishing reliable technic.

Several histological differences between lots were noted as the work progressed, but it is not believed that the methods used for their determination were sufficiently standardized to warrant interpretation of the results. For example, the area of the cross section of muscle fibers from the steers that had a supplemental feed of grain was slightly larger than that from the steers on grass alone. However, slight variations in fixing, sectioning, mounting, and staining the same samples often produced a distortion greater than the apparent difference between lots.

Perhaps the most definite contribution that the histological research can make at this time is to record the striking variation between animals in the same lot. It has been noted that animals of similar age, breed, sex, fatness, etc., produced roasts that often differ for such characters as tenderness, flavor, and fat content of

[8] Unpublished data.

the eye. Similar unforeseen variations have appeared in the structure of the lean meat. Apparently the animals are subject to still other factors or variables. It would be logical to suppose that one of those additional variables was of genetic origin. At least this offers a lead that merits intensive investigation.

COOKING TESTS

The standard sample used for the cooking and palatability studies was composed of the ninth, tenth, and eleventh ribs from the left side. They were cut and cooked according to the methods adopted by the cooperators in the study of the factors that influence the quality and palatability of meat.[9] According to the method out-

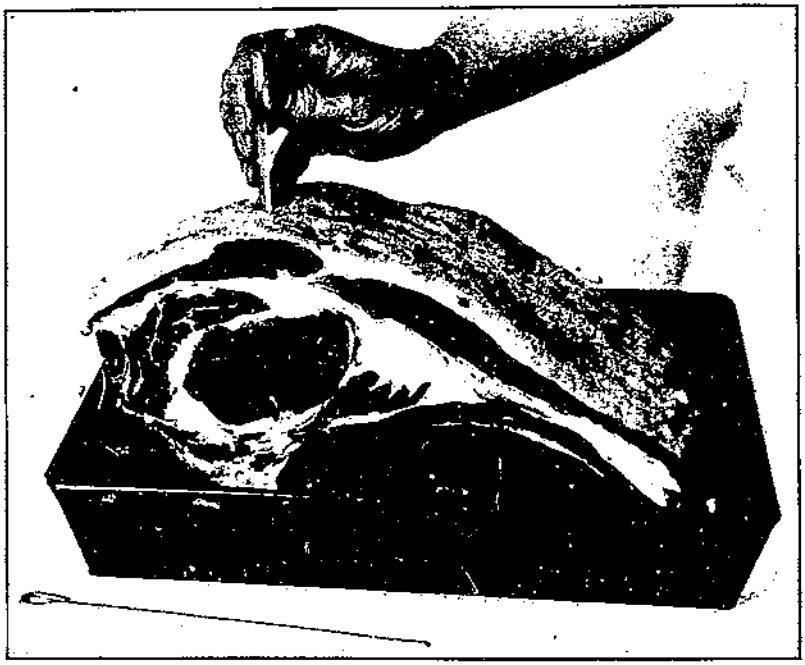


FIGURE 21.—Every experimental roast was cooked to the same stage of doneness as indicated by a roast-meat thermometer in the center of the eye

lined in this project, each roast was seared for 20 minutes at an average oven temperature of from 260° to 265° C., and then cooked at 125° until the thermometer in the meat registered 58°. (Fig. 21.) The roast was then removed from the oven and allowed to stand until the thermometer in the meat registered its maximum internal temperature, which was usually from 62° to 63°. Meat so cooked would be called rare.

All ribs were cooked as standing roasts without basting. No salt or other condiment or food was used in the cooking and sampling of the meat.

It should be noted that the standard oven temperature of 125° C. is lower than is ordinarily used in the household. This moderate

[9] See footnote 3, page 15.

heat was used because it insured uniform cooking throughout a large proportion of the roast, thus providing comparably cooked slices for the judges. Cooking losses shown in Tables 20 to 22 are less than if a higher oven temperature had been used.[10]

Total cooking loss represents the difference between the weights of a piece of meat before and after cooking. The drippings loss is the weight of the fat and meat juices which cook out of the meat and are collected in the pan. Evaporation loss is the difference between total loss and drippings.

TABLE 20.—*Cooking loss (evaporation) of left ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to smallest loss]

Year	Steers	Lot designation	Evaporation loss as percentage of uncooked roast	Range within lot
	Number		*Per cent*	*Per cent*
Average of two years.	8	1A, Good grade, grain on grass	7.1	8.4–8.4
	8	1B, Good grade, grass alone	7.4	6.0–8.5
	8	2A, Medium grade, grain on grass	7.5	6.8–8.2
	8	2B, Medium grade, grass alone	7.7	7.0–8.6

The meat from the Good supplement-fed steers showed a smaller loss from evaporation than that from the thinner cattle in the other three lots. However, the difference between the lots was small and the individual variation within each lot comparatively large.

The drippings loss is compared in Table 21 with the total fat in the edible portion of the rib.

TABLE 21.—*Cooking loss (drippings) of left ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to greatest loss]

Year	Steers	Lot designation	Drippings loss of left samples as percentage of uncooked roast	Range within lot	Total fat in edible portion of right samples
	Number		*Per cent*	*Per cent*	*Per cent*
Average of two years.	8	1A, Good grade, grain on grass	6.2	4.9–8.1	40.35
	8	2A, Medium grade, grain on grass	5.2	4.1–6.8	37.08
	8	1B, Good grade, grass alone	4.5	2.6–6.5	30.22
	8	2B, Medium grade, grass alone	4.6	2.8–6.5	29.78

There is a consistency in these figures between the greatest dripping losses and the fatter, supplement-fed cattle. This consistency also extends to the individual range. Although there is some overlapping, a comparison of the individual extremes indicates the definite trend appearing in the averages.

Study of Table 22 shows but a small average variation in the total cooking loss of the meat from the four lots. Although the two fatter, supplement-fed lots shrank the most, the difference between them is 0.7 per cent, and the range between the four lots, lot 1B with 11.9 per cent, and lot 1A with 13.3 per cent, is only 1.4 per cent.

[10] Unpublished data.

TABLE 22.—*Total cooking loss of left ninth-tenth-eleventh-rib samples and total fat of edible portion of the right ninth-tenth-eleventh-rib samples*

[Lots averaged and ranked according to greatest cooking loss]

Year	Steers	Lot designation	Total cooking loss of left rib samples as percentage of uncooked rib	Total fat of right rib samples as percentage of edible portion
	Number		*Per cent*	*Per cent*
Average of two years.	8	1A, Good grade, grain on grass	13.3	40.35
	8	2A, Medium grade, grain on grass	12.6	37.08
	8	2B, Medium grade, grass alone	12.2	29.78
	8	1B, Good grade, grass alone	11.9	30.22

The tests with this meat indicate an evaporation loss that tends to vary inversely with the fat content, a dripping loss that varies directly with fatness, and a total loss that does not vary greatly between the roasts from these four lots of cattle.

These total losses are only a little more than one-half as large as those obtained by Emmett and Grindley,[11] Moran and Smith,[12] and Grindley and Mojonnier.[13]

However, the samples used by these investigators varied widely from the cut used here. In addition, the oven temperatures used were also higher than those in these tests. No direct comparison with their cooking losses is therefore justified. Grindley and Mojonnier[14] also found a greater dripping loss from the fatter samples.

PALATABILITY RECORDS

It is but natural that interest in this project should center in the palatability of the roasts from the four lots of steers. Regardless of all else, the tenderness and flavor of the meat are the final measure of its desirability and market value.

All the sample roasts were cooked as described under cooking tests and were carved and sampled while hot.[15] The meat over the eleventh rib was removed for the mechanical test for tenderness. The portion of the eye muscle lying over the tenth rib was cut into slices about one-eighth of an inch thick, placed on hot plates, and served immediately to a trained palatability-grading committee of five persons. Each member received slices from corresponding positions in each roast. Samples of the inside unbrowned fat lying just above the eye muscle were served with each portion of lean.

A cooked-meat-grading chart was used by the committee for recording the palatability of the samples. (Fig. 22.) This chart corresponds in principle to the ones used in grading the live animals and carcasses. The various factors or elements of palatability, such as tenderness and flavor, were listed on the chart with seven subdivisions or grades

[11] EMMETT, A. D., and GRINDLEY, H. S. CHEMISTRY OF FLESH. [EIGHTH PAPER.] A PRELIMINARY STUDY OF THE EFFECT OF COLD STORAGE UPON BEEF AND POULTRY. (SECOND COMMUNICATION.) Jour. Indus. and Engin. Chem. 1: 590–597. 1909.

[12] MORAN, T., and SMITH, E. C. POSTMORTEM CHANGES IN ANIMAL TISSUES—THE CONDITIONING OR RIPENING OF BEEF. [Gt. Brit.] Dept. Sci. and Indus. Research, Food Invest. Bd. Spec. Rpt. 36, 64 p., illus. 1929.

[13] GRINDLEY, H. S., and MOJONNIER, T. EXPERIMENTS ON LOSSES IN COOKING MEAT, 1900–1903. U. S. Dept. Agr., Off. Expt. Stas. Bul. 141, 95 p.

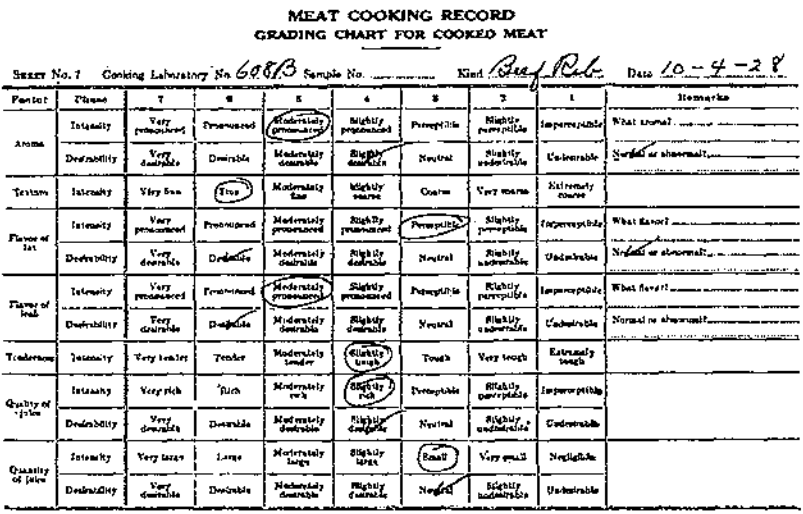
[14] GRINDLEY, H. S., and MOJONNIER, T. Op. cit.

[15] See footnote 3, page 15.

for each factor. A series of comparative adjectives was supplied to fit the subdivisions listed for each factor. For example, the seven degrees for tenderness range from "very tender" to "extremely tough."

By use of this cooked-meat-grading chart the roasts were compared for tenderness, juiciness, texture, aroma, and flavor of both lean and fat. The grading committee was asked to note the intensity of all these factors and the desirability of aroma and flavor.

Under intensity, record was made of the degree of tenderness, amount and richness of juice, fineness of grain, and the perceptibility of aroma and flavor. In comparing the desirability of aroma and flavor, the judges noted their personal preference for the kind or quality of odor and taste regardless of its intensity.



MEAT COOKING RECORD
GRADING CHART FOR COOKED MEAT

Sheet No. 7 Cooking Laboratory No. 6086 Sample No. ..... Kind Beef Rib Date 10-4-28

Factor	Phase	7	6	5	4	3	2	1	Remarks
Aroma	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What aroma? .....
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? .....
Texture	Intensity	Very fine	Fine	Moderately fine	Slightly coarse	Coarse	Very coarse	Extremely coarse	
Flavor of fat	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor? .....
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? .....
Flavor of lean	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor? .....
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	Normal or abnormal? .....
Tenderness	Intensity	Very tender	Tender	Moderately tender	Slightly tough	Tough	Very tough	Extremely tough	
Quality of juice	Intensity	Very rich	Rich	Moderately rich	Slightly rich	Perceptible	Slightly perceptible	Imperceptible	
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	
Quantity of juice	Intensity	Very large	Large	Moderately large	Slightly large	Small	Very small	Negligible	
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Neutral	Slightly undesirable	Undesirable	

Color of Lean
1. Light red.
2. Dark pink.
3. Light pink.
4. Pinkish brown.
5. Light brown.
6. Dark brown.

Color of Fat
1. White.
2. Creamy white.
3. Grayish cream.
4. Yellowish brown.
5. Yellow.
6. Amber.

Note.—Encircle the words which describe intensity; mark desirability and color with a check.

D. A. Spencer
(Signature of judge)

FIGURE 22.—Example of use of grading chart for cooked meat

This new grading chart marks a decided step forward in the method for describing the palatability of food. Although the members of the committee varied slightly in their ability to detect variations in intensity and in their appreciation of the different flavors, the average of the five decisions by factors provided a descriptive and consistent record of the characteristics of the roasts.

For summarization, arbitrary values of 1 to 7 were assigned to the seven grades listed under each factor on the cooked-meat chart. These values were used in averaging the opinions of the judges to determine the word descriptions that they considered most applicable to each sample.

In reporting the opinion of the committee (Table 23) the corresponding descriptive wording of the cooked-meat-grading chart was used as well as the average numerical grade.

TABLE 23.—*Palatability of left ninth-tenth-eleventh-rib samples as determined by the cooked-meat-grading committee*

[Lots averaged for two years and ranked according to lot number [1]]

Lot designation	Number of steers	Aroma		Texture	Flavor of fat		Flavor of lean		Tenderness	Juiciness	
		Intensity	Desirability		Intensity	Desirability	Intensity	Desirability		Quality	Quantity
1A, Good grade, grain on grass.	8	4.8 Mod. pro.[2]	4.7 Mod. des.[3]	4.5 Sli.[4] coarse.	4.7 Mod. pro.	5.3 Mod. des.	4.9 Mod. pro.	4.9 Mod. des.	4.8 Mod. tender.	4.4 Sli. rich.	5.0 Mod. large.
1B, Good grade, grass alone.	8	5.0 Mod. pro.	4.8 Mod. des.	4.6 Mod. fine.	4.7 Mod. pro.	5.1 Mod. des.	5.1 Mod. pro.	4.8 Mod. des.	4.4 Sli. tough.	4.4 Sli. rich.	5.1 Mod. large.
2A, Medium grade, grain on grass.	8	5.0 Mod. pro.	4.7 Mod. des.	4.3 Sli. coarse.	4.7 Mod. pro.	5.3 Mod. des.	5.1 Mod. pro.	5.2 Mod. des.	4.7 Mod. tender.	4.5 Mod. rich.	5.4 Mod. large.
2B, Medium grade, grass alone.	8	4.8 Mod. pro.	4.9 Mod. des.	4.4 Sli. coarse.	4.6 Mod. pro.	5.0 Mod. des.	4.9 Mod. pro.	5.0 Mod. des.	4.3 Sli. tough.	4.1 Sli. rich.	5.1 Mod. large.

[1] Maximum score for each item is 7.
[2] Moderately pronounced.
[3] Moderately desirable.
[4] Slightly coarse.

It will be noticed that no attempt has been made to combine grades of the individual items appearing on each chart, thus deriving a single figure that would represent the palatability of a roast or group of roasts. This is contrary to the method used in summarizing the cattle and carcass grading charts and to that used by Moran and Smith [16] in their palatability comparisons. Both methods have their advantages, but summary by items seemed to present a more definite description of the meat than an arbitrarily weighted average.

The report of the cooked-meat-grading committee shows the generally uniform palatability of the roasts from these four lots of steers. With the exception of a greater tenderness in the meat from the supplement-fed lots, 1A and 2A, the differences due to grade or ration were not consistent.

Although the flavor of lean meat and of fat from the grain-fed lots received higher desirability scores than that from the lots of grass alone, the significance of this difference is lessened by the desirability of the aroma. This was less for the grain-fed meat than for that fed grass only. In view of the generally accepted relation between aroma and flavor, the data on these factors would be expected to confirm each other if there were a consistent difference between meats from the several lots. Examination of the data for intensity of aroma and flavor shows a generally consistent relation between these factors in the four lots, but inconsistent relations for grain-fed and grass-alone meat.

The two Medium grade lots averaged a little greater quantity of juice, but the committee found that the ribs from the lots of each grade receiving grain possessed a little richer and less watery juice. The grain of the meat from the cattle grading Good was somewhat finer than that from the steers of lower grade.

The committee found the comparisons of texture especially difficult to make. The grain or fiber of the meat appeared to be different under various methods of examination. Moreover, there seemed to be an unexpected relation between fineness and the "tightness" or compactness of the tissues.

[16] MORAN, T., and SMITH, E. C. Op. cit.

Reference to Figure 23 reemphasizes the fact that in all cases except tenderness the contrasts between lots were too small to warrant definite conclusions.

TENDERNESS COMPARISONS

Under tenderness, the committee classified the roasts from the supplement-fed cattle as "moderately tender" and those from the grass-alone lots as "slightly tough." Although the difference between these two groups was not large, it was consistent throughout the experiment. Moreover, it conforms closely to the comparison recorded by the mechanical device that was used to measure the shearing strength of the meat. This instrument (fig. 24) consisted of a steel blade one thirty-second of an inch thick drilled with a hole slightly larger than the sample to be tested. The hole was made square instead of round to eliminate the sliding of the edge across the sample that would occur if a round hole was used. The cutting edge was milled square and then smoothed slightly to effect a standard, reproduceable dullness.

A sample of meat was cored out with a keen, steel tool 1⅛ inches inside diameter, similar to a cork borer. The sample was placed in the perforation of the steel blade and the blade led through a narrow slit in a wooden miter box. A hand-driven screw pull was used to pull the blade through the meat, the force required being recorded by a spring-type, self-recording dynamometer. When the instrument is in operation, the load on the meat builds up to a maximum and the fracture of the sample is sudden and complete.

Samples of the eye muscle of the chilled (34° to 36° F.) uncooked right and left twelfth rib and of the chilled cooked left eleventh rib were broken in this mechanical shear.

The shearing strength of the raw muscle shown in Table 24 is the average of two cuts on each of three samples from both the right and left twelfth ribs, an average of 12 tests on the raw meat from each steer.

The shearing strength of the cooked meat is the average of two tests on each of two samples from the roasted eleventh rib, an average of four cuts per steer. Cooking contracted the tissues in such manner that it was impossible to obtain more than two samples that were free from the coarse, visible, connective tissue that surrounds or lies between the muscles. The data for average tenderness, given in Table 23, are reported in Table 24, together with data showing range in tenderness in each lot.

TABLE 24.—*Shearing strength of right and left raw twelfth-rib samples and left cooked eleventh-rib samples as compared with tenderness report of cooked-meat-grading committee*

(Lots averaged for two years and ranked according to lot number)

Lot designation	Steers	Average shearing strength of samples from right and left raw twelfth rib	Range within lot	Average shearing strength of samples from left cooked eleventh rib	Range within lot	Average committee grade for tenderness (maximum, 7)	Range within lot
	Number	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
1A, Good grade, grain on grass	8	72.9	58–92	32.7	28–41	4.8	4.0–5.4
1B, Good grade, grass alone	8	72.6	63–82	30.0	23–48	4.4	3.4–5.2
2A, Medium grade, grain on grass	8	71.7	61–84	34.9	29–45	4.7	3.6–5.8
2B, Medium grade, grass alone	8	78.3	62–95	38.8	28–45	4.3	3.4–5.2

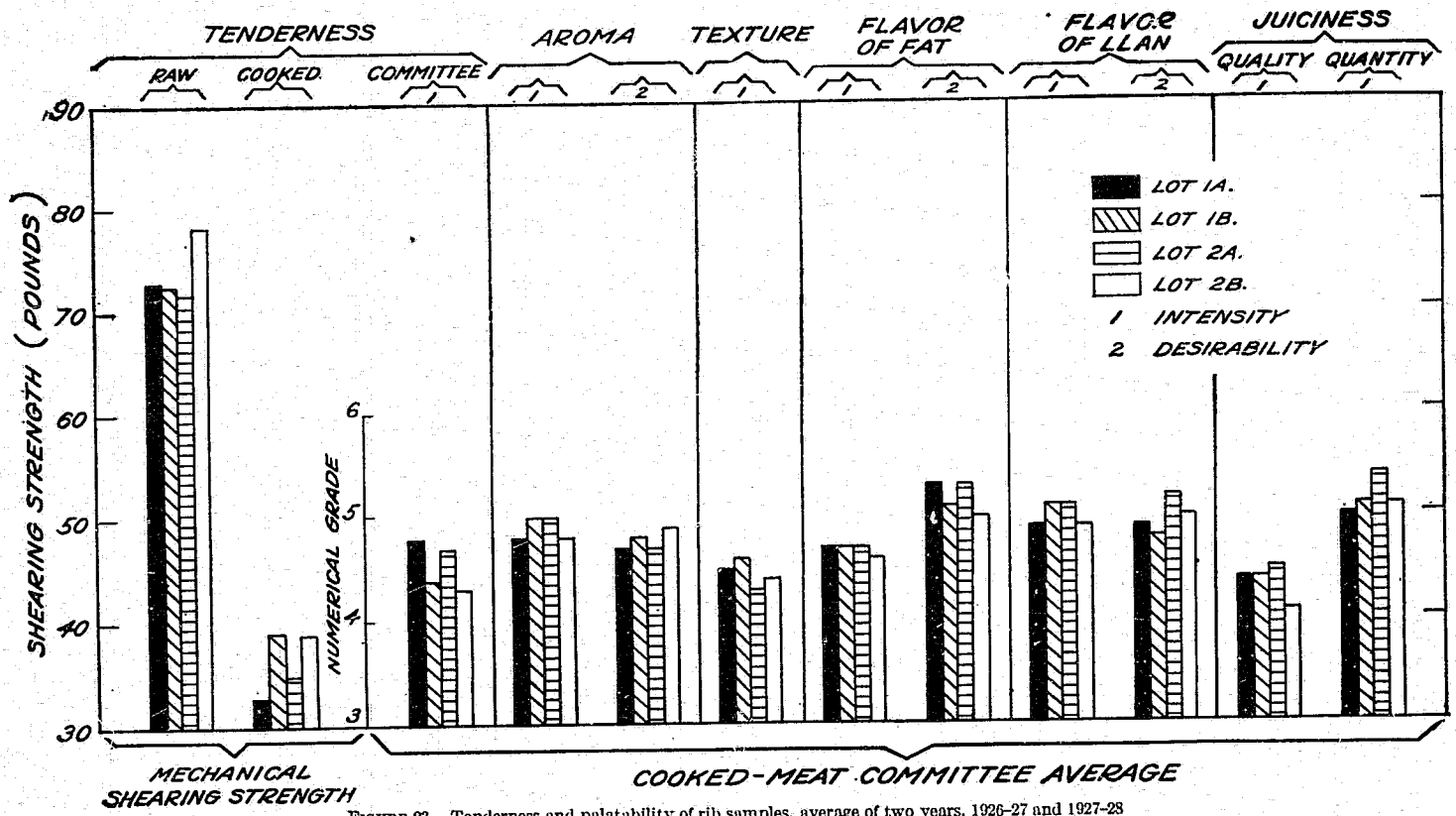


FIGURE 23.—Tenderness and palatability of rib samples, average of two years, 1926–27 and 1927–28

The shearing strength of the raw samples from the four lots of steers was very similar. That of lot 2B, the Medium grade on grass alone, was slightly greater than that of the other three. The difference, however, was comparatively small and the variability of individual averages sufficiently numerous to prevent the interpretation of this contrast as other than an indication.

In the mechanical test of the roasted-rib samples 15 per cent more force was required to pull the blade through the meat from the grass-alone cattle than through that from the supplement-fed steers. There was no consistent difference in the shearing strength of the meat from the Good and Medium grades.

Both the cooked-meat-grading committee and the mechanical shearing test for the cooked meat have shown the meat of the supplement-fed lots to be the more tender. Although neither method presents, as yet, indisputable evidence of tenderness, this agreement is significant. Tenderness tests conducted in connection with other experiments have produced a similar uniformity between the two methods.[17]

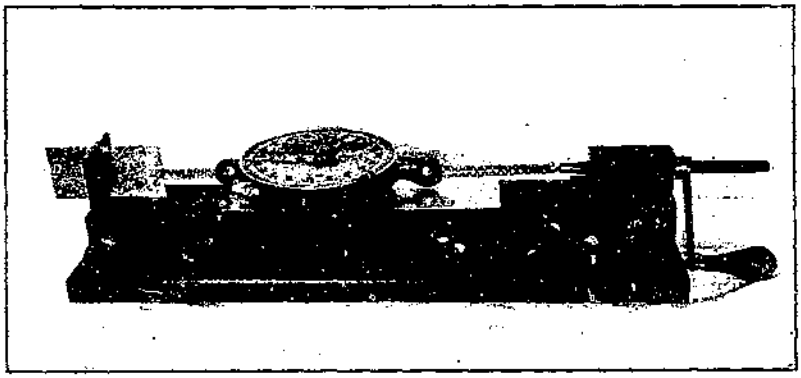


FIGURE 24.—Dynamometer or mechanical shear used to compare the shearing strength of the raw and the cooked meat. A wooden miter box was used for the tests reported

Comparison of the shearing strength of the raw and the cooked meat from the respective lots brings out the lack of correlation between them. This variation extended to the samples from the individual steers, and it was quite impossible to predict the shearing strength of the cooked meat from that of the uncooked. It is obvious that faulty technic, including methods of sampling, might have been responsible for this lack of uniformity. However, the average shearing strength of the samples from the raw right twelfth rib from 128 cattle in this and other experiments showed a correlation with that of the raw left twelfth rib from the same animal of 0.78 during one year and of 0.87 from 100 samples the year following.[17]

The degree of consistency appearing in these cases would indicate that the lack of correlation between the shearing strength of the raw and cooked-rib muscle from the same animal was due to actual differences in the meat. Evidently some characteristics of the raw meat that caused it to resist the shear were affected differently by the roasting process.

[17] Unpublished data.

It will also be noted that the shearing strength of the uncooked rib samples was always greater than that of the cooked meat. Lehmann [18] using two different types of instruments for comparing toughness, found that boiling beef loin increased the toughness for the first hour but that longer cooking rendered it more tender than the raw meat. Moran and Smith [19] quote the popular opinion that raw meat is usually more easily masticated than cooked meat.

The results obtained, however, from the use of this mechanical shear on more than 1,000 samples [20] point definitely to the fact that the shearing strength of the raw muscle is greater than that of the roasted meat.

In summarizing the palatability comparisons and tests of shearing strength one must observe the similarity of the roasts from all four lots. With the exception of the somewhat greater tenderness of the ribs from the supplement-fed lots, the differences noted by the methods used were less than might have been expected. It will be recalled, however, that the meat from all four lots was from mature, fairly well-finished steers. The thinner grass-alone lots produced a rib sample containing 30 per cent of fat, or only 8.77 per cent less than that of the grain-fed groups. Possibly 30 per cent of fat is sufficient to produce an aroma, flavor, and juiciness which compare closely with those of ribs possessing 38 per cent fat.

SUMMARY OF CATTLE-GRADING AND MEAT STUDIES [21]

Good cattle fed a grain supplement on grass graded Good both as feeders and as slaughter cattle.

Good cattle fed on grass alone graded in the middle of Good as feeders and at the bottom of Good as slaughter cattle.

Medium cattle fed a grain supplement on grass graded in the middle of Medium as feeders and at the top of Medium as slaughter cattle.

Medium cattle fed on grass alone graded in the middle of the Medium grade both as feeders and as slaughter cattle.

Both lots of supplement-fed cattle should have brought a higher selling price than those of the other lots on the basis of higher dressing yield and fatter, more attractive, salable carcasses. The Good steers had a slight, but similar, advantage over the Medium grades.

The color of the eye muscle from the supplement-fed lots was a little lighter red than that from those fed grass alone. There was extreme color variation among the individuals in each lot.

In the physical analyses, the rib samples from the grass-fed lots contain a higher percentage of bone and eye muscle and a lower percentage of fat than the supplement-fed steers. The actual weight of eye muscle and of bone in all four lots was similar. There was no significant difference in the physical analyses of the rib samples from Medium and Good cattle. Yield of "other lean" was not consistent among the four lots.

Chemical analysis of the rib samples disclosed a higher percentage of fat in the supplement-fed lots and a lower percentage of protein and water than in the meat produced on grass alone.

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[18] LEHMANN, K. B., and others. [STUDIES OF THE TOUGHNESS OF MEAT AND ITS CAUSE.] Arch. Hyg. 63: 134-179. 1907. [Abstract in Expt. Sta. Rec. 19: 1161.]

[19] MORAN, T., and SMITH, E. C. Op. cit.

[20] Unpublished data.

[21] See p. 12 for summary of production studies.

The fat content of the rib samples, as determined by the physical separation, compared closely with corresponding chemical analyses.

Chemical analyses of the eye muscle showed a slightly higher fat content in the samples from the supplement-fed lots, though there was a wide individual variation in the fat content of the eye muscle from steers in the same lot.

The considerable variation in the characteristics and composition of the rib samples from animals in the same lot indicates the influence of the individuality of the steers upon the results. This variability definitely shows the need of taking samples from a much larger proportion of the carcasses in each lot. It also suggests the desirability of using animals with a more uniform inheritance.

Cooking losses from evaporation varied through a narrow range with the fattest ribs showing the smallest loss.

Cooking losses from drippings were somewhat less than those from evaporation, but showed greater variation. The dripping loss of the fatter rib samples was proportionately more than that of the thinner ones.

The total cooking loss varied through a small range, with the fattest ribs tending to lose more than the leanest.

The mechanical tests of the shearing strength of the raw rib muscle showed but little difference among the four lots. The standard palatability committee graded the meat of the supplement-fed lots as of slightly greater tenderness; the mechanical test produced a similar grading.

There was no consistent relation between the shearing strength of the raw and the cooked meat.

There was no significant correlation between the four lots as to the flavor, juiciness, texture, and aroma of the roasted-rib samples. Whether the closeness of this comparison of the meat from 3-year-old steers was due to the feed value of grass alone or to the combined facts that the steers were mature and had been liberally pastured is not indicated by the results.

A true appraisal of meat produced by different methods must be based on its nutritive value, palatability, waste of bone and other unconsumed portions. Further information is needed about the relation between finish and quality in order to determine the most desirable degree of fatness.

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