Technical Bulletin No. 847 • *April 1943*

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Fattening Steers on Milo Grain in the Southern Great Plains[1]

By W. H. BLACK, *senior animal husbandman,* and PAUL E. HOWE, *principal chemist, Bureau of Animal Industry, United States Department of Agriculture;* J. M. JONES, *chief, Division of Range Animal Husbandry, Texas Agricultural Experiment Station;* and F. E. KEATING, *associate agronomist, Bureau of Plant Industry, United States Department of Agriculture*

CONTENTS

THE AREA AND ITS PROBLEMS

The acreage used for grain-sorghum production has increased materially in the southern Great Plains since 1919. In the United States [2] the area harvested for grain and forage purposes increased from 6,295,000 acres in 1919 to 9,856,000 acres in 1940. In the latter year, the acreage in Texas alone was approximately 3,569,000; in Kansas, 2,211,000; and in Oklahoma, 1,560,000. The principal grain sorghum producing areas are shown in figure 1.

As the production of grain sorghums increased in the southern Great Plains, the producers, many of whom were considerable distances from shipping points, began to look for ways and means of marketing the crops other than as grain. Much of the grain was produced within the region where cattle production was or had been the principal industry. Experiments in the feeding of grain sorghums indicated that they compared favorably with corn for beef production.[3] These experiments also showed that threshed milo and milo heads in both ground and unground forms could be used satisfactorily in beef cattle fattening rations. Grinding of the grain proved to be advisable, but any increased gain due to threshing was not sufficient to justify the additional cost. Fodder and silage made from the sorghums were

[1] Submitted for publication October 13, 1942.

[2] UNITED STATES DEPARTMENT OF AGRICULTURE. AGRICULTURAL STATISTICS, 1941, p. 112. 1941.

[3] BLACK, W. H., JONES, J. M., and KEATING, F. E. COMPARISON OF VARIOUS FORMS OF MILO GRAIN FOR FATTENING STEERS IN THE SOUTHERN GREAT PLAINS. U. S. Dept. Agr. Tech. Bul. 581, 16 pp., illus. 1937.

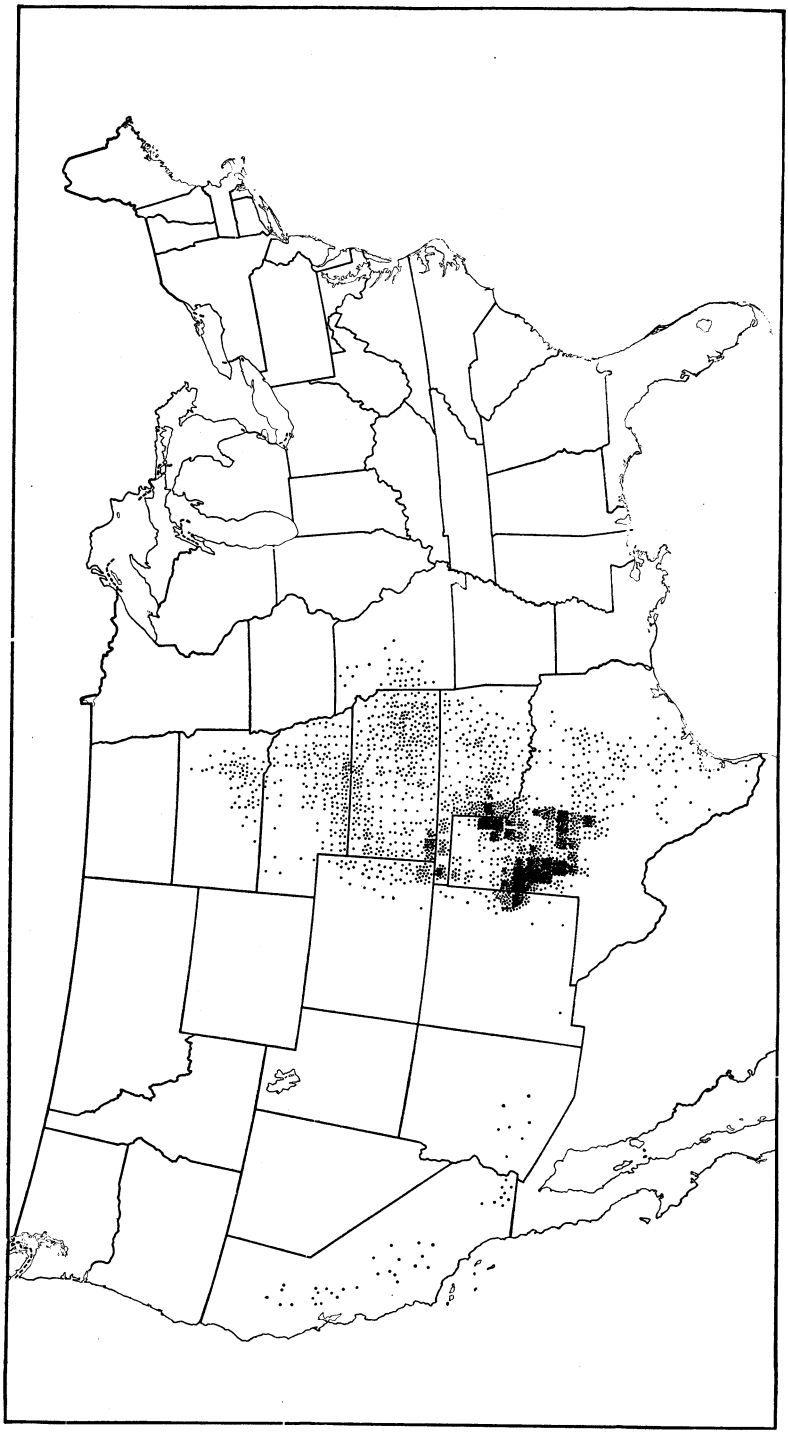

FIGURE 1.—Distribution of grain sorghums, each dot representing 2,000 acres harvested. (United States Census, 1939.)

likewise found to be valuable sources of roughage in beef cattle rations.[4] As a result of these findings, in many sections there has naturally developed the practice of feeding grain sorghums to cattle, thus marketing the grain indirectly as beef. Although this practice is gradually increasing, most of the cattle are still marketed either as feeders or as grass-fattened cattle because the quantities of sorghum are still small in comparison with the grazing resources.

The situation thus presented a number of questions concerning the fattening of cattle in those areas where the grain sorghums are available. In the first place, the market demand for beef of high quality has necessitated that a reasonable degree of fatness be attained by the animals, and in the second place, financial considerations require the production of acceptable carcasses with a minimum use of the more expensive feeds. Evidence has become available in recent years that fattening animals utilize their feed more effectively when they receive less grain than is obtained in full feeding. Limitation of the grain, however, retards the rate of fattening and tends to affect the quality of the carcasses. Since this information is based, for the most part, on the use of corn as the grain feed, similar information seemed desirable on the use of the grain sorghums.

The interpretation of results obtained with experimental animals fed in groups is often complicated by variations in performance of individual animals. The intake of insufficient essential nutrients, including vitamins and minerals, may result from a lack of appetite. Sickness and timidity at the feed trough frequently retard the growth of the animals. On the other hand, it is often said that competition at the feed trough encourages cattle to eat. Finally, and possibly most important, is the actual difference in capacity to consume and to utilize feed efficiently. In view of these various factors, experiments comparing individually fed with group-fed animals seemed decidedly worth while.

The present experiments involved a comparison of the results obtained from feeding milo at two levels, namely, at the full-fed level and at 80 percent of the full-fed level. In addition, a comparison was made of individually fed and group-fed animals on the two levels of feeding. The experiments were begun late in the fall of 1936 and continued for 3 successive years. They were conducted cooperatively at the Big Spring Field Station, Big Spring, Tex., by the Bureaus of Animal Industry and Plant Industry of the United States Department of Agriculture, and the Texas Agricultural Experiment Station.

WEATHER CONDITIONS DURING THE EXPERIMENTS

The temperatures and precipitation at the Big Spring Field Station during the experiments are shown in table 1. The range in mean temperatures was from 23° F. in January 1937 to 96° in June 1939. The range was less than during the studies made at the same station from 1931–32 to 1933–34, inclusive.[5] Temperatures for similar periods during each of the 3 years of the present experiments were very uniform, and accordingly any differences in the results of the

[4] BLACK, W. H., JONES, J. M., and KEATING, F. E. SORGO SILAGE, SORGO FODDER, AND COTTONSEED HULLS AS ROUGHAGES IN RATIONS FOR FATTENING CALVES IN THE SOUTHWEST. U. S. Dept. Agr. Tech. Bul. 43, 24 pp., illus. 1928.
———, LANTOW, J. L., and BURNHAM, D. R. FATTENING STEERS ON DRYLAND CROPS OF THE SOUTHWEST. U. S. Dept. Agr. Tech. Bul. 30, 15 pp., illus. 1927.

[5] BLACK, W. H., JONES, J. M., and KEATING, F. E. See footnote 3, p. 1.

experiments, one year with another, could hardly be attributed to differences in temperatures. Although there was considerable variation in the rainfall between years for definite periods, it was not so excessive in any instance as to interfere with the conduct of the experiment.

TABLE 1.—*Temperatures and precipitation at the Big Spring Field Station, Big Spring, Tex., during the experiments*

Month	1936–37			1937–38			1938–39		
	Mean temperatures		Precipitation	Mean temperatures		Precipitation	Mean temperatures		Precipitation
	Maximum	Minimum		Maximum	Minimum		Maximum	Minimum	
	°F.	°F.	Inches	°F.	°F.	Inches	°F.	°F.	Inches
November	60	36	0.58	63	38	1.58	66	34	0.73
December	59	33	.63	54	33	1.56	59	27	.02
January	51	23	.44	58	33	1.91	58	32	2.71
February	59	31	.09	62	38	1.76	58	26	.13
March	59	34	1.51	75	42	.33	74	41	.06
April	81	47	.63	79	48	.95	82	47	.44
May	88	59	3.36	89	58	1.80	88	59	2.90
June	93	68	1.14	91	67	6.85	96	68	2.61
Total			8.38			16.74			9.60

EXPERIMENTAL PROCEDURE

About November 1 of each year, 40 head of range steers born during the spring of that year were selected on ranches in west-central Texas for the experiments. The steers averaged Good to Choice as feeders and were of strictly beef breeding (fig. 2). They were divided into four groups as nearly alike as possible with respect to weight, type, and conformation. The cattle in group 3 were fed, as far as possible, according to a predetermined milo-and-cottonseed-meal full-feeding schedule (table 2). The quantities fed to the other groups were based on those included in this schedule. The manner in which each group was fattened is as follows:

TABLE 2.—*Predetermined full-feeding schedule of milo and cottonseed meal for each animal in group 3*

Feed	Quantity of feed during 28-day period No.—						
	1	2	3	4	5	6	7
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Ground milo	7	10	12	14	16	18	20
Cottonseed meal	1.25	1.50	2	2.25	2.75	2.75	3

Groups 1 and 3 were full fed, the former individually and the latter as a group, on ground milo, cottonseed meal, and sumac sorgo fodder or silage. Groups 2 and 4 were limited fed, the former individually and the latter as a group. These two groups received approximately 80 percent of the quantity of milo fed to group 3, the other feeds being constant. However, in the first experiment, after the first 56

FIGURE 2.—Type of steers used in the experiments. This group was used in the 1936–37 experiment and when photographed had been full fed approximately 3 months.

days the sumac fodder and cottonseed meal were limited to about 80 percent of the quantities in the predetermined feeding schedule for group 3. One ounce of limestone flour and one-half ounce of salt were mixed with the ration.

To accustom the cattle to the feeds and the environment, a preliminary feeding period of 28 days preceded the test proper each year. During this period the feeds used were the same as those in the experiment. In the first experiment, to make the ration more palatable and to encourage a greater consumption by the full-fed steers, blackstrap molasses was added to the ration at the end of the first 28-day feeding period. In the two subsequent experiments sumac silage was fed in place of sumac fodder and the feeding of molasses was discontinued. Ground threshed milo grain was fed in place of ground milo heads during the last two experiments. The concentrates were thoroughly mixed and then spread and mixed with roughage, which was placed in the bunks first.

The cattle were fed at approximately 8 a. m. and 5 p. m. each day. Any feed refused was removed previous to the next feeding and its weight was deducted from the weight of the feed fed. The prices of feeds used are given in table 3.

The steers were fed under shelter. Each individually fed steer (groups 1 and 2) had a total area of approximately 150 square feet (fig. 3), and groups 3 and 4 each had a total area of about 1,500 square feet, which was equivalent, per head, to that provided for each steer in groups 1 and 2. About half of the area was under shed.

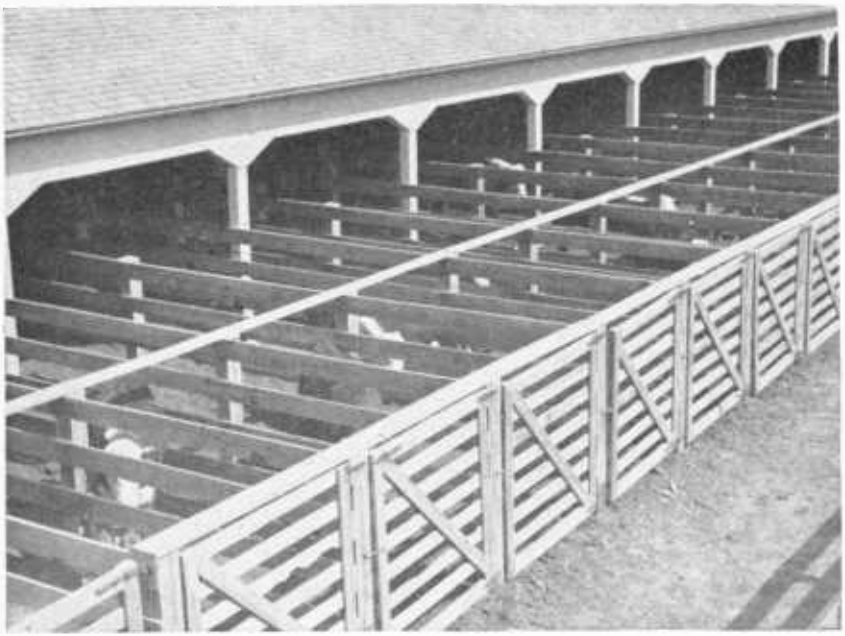

FIGURE 3.—A section of the cattle-feeding shed used in these experiments, showing the individual feeding pens, each approximately 30 by 5 feet in size.

Individual weights of steers were taken on 3 successive days at the beginning and end of each experiment and on 1 day at 28-day intervals throughout each experiment. Weighings were begun promptly at 1 p. m. and continued without interruption until they were completed. At the end of each experiment the steers were shipped to Fort Worth, Tex., a distance of approximately 275 miles, and slaughtered.

The steers were graded as feeders by a committee of three experienced judges at the beginning of each experiment. The carcasses were likewise graded after being chilled 24 hours. The ninth-tenth-eleventh rib cuts were taken from the carcasses of groups 1 and 2 for physical and chemical determinations of the percentage of fat in the edible portion.[6]

TABLE 3.—*Feed prices per ton during the experiments*

Feed	1936–37	1937–38	1938–39
Milo (ground)[1]	$21.25	$19.00	$13.25
Cottonseed meal	37.75	27.44	27.50
Sumac fodder (chopped)	8.25	----------	----------
Sumac silage	----------	4.00	2.00
Blackstrap molasses	27.00	----------	----------
Limestone flour	14.00	12.00	14.00
Common salt	14.00	21.00	17.00

[1] Milo heads were used in 1936–37 and threshed milo grain in 1937–38 and 1938–39.

[6] In all the experiments the fat studies of the rib cuts were made under the direction of Sylvia Cover, Division of Rural Home Research, Texas Agricultural Experiment Station.

RESULTS OF EXPERIMENTS

1936–37 Experiment

The average feed consumption, rations, gains, and marketing data for the steers in the first experiment are given in table 4. The average weights of the steers at the end of each period are shown graphically in figure 4.

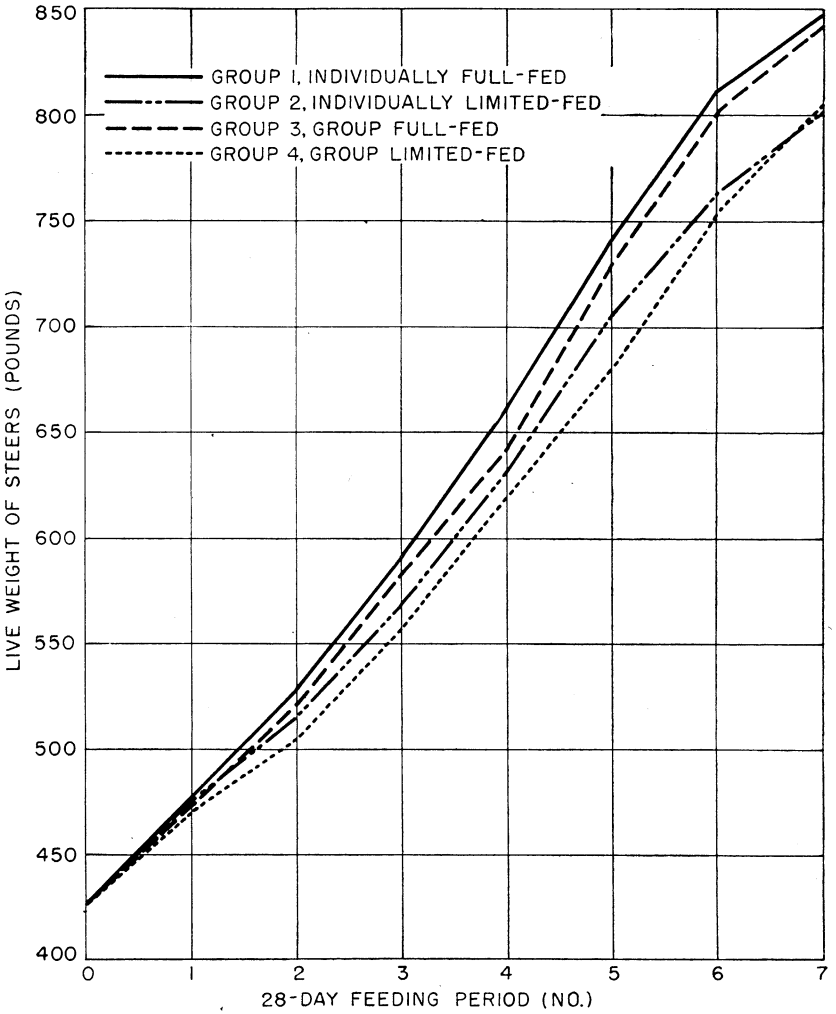

Figure 4.—Average live weights of steers by periods during the 1936–37 experiment (196 days).

The full-fed cattle (groups 1 and 3) made somewhat greater gains than the limited-fed cattle (groups 2 and 4). The differences between the gains of the individually fed cattle (groups 1 and 2) and those fed as a group (groups 3 and 4) were very small at both levels of feeding, being only 0.03 pound daily in favor of the individually fed steers at

the full-fed level and 0.01 pound in favor of the group-fed steers at the lower level. A study of the data for the individually fed cattle shows that the average daily gains of the limited-fed steers were only slightly more variable than of those full fed.

The two full-fed groups consumed more feed per 100 pounds of gain than the groups fed at the lower level and therefore were less efficient in their utilization of feeds. These differences, however, were not statistically significant ($p>0.05$).[7] Likewise, the group-fed cattle consumed more feed per 100 pounds of gain than those individually fed, but the difference in efficiency of gain was not significant at either level of feeding. The only significant difference in this respect among the four groups was between group 2, limited fed as individuals, and group 3, full fed as a group.

There was considerable variation in milo consumption among the individually full-fed steers (group 1). However, with a few excep-

TABLE 4.—*Gains, feed consumption, and efficiency of steers in the first experiment, 1936–37 (196 days)*

Item	Full-fed steers		Limited-fed steers	
	Group 1, fed individually	Group 3, fed as group	Group 2, fed individually	Group 4, fed as group
Steers—number	10	10	10	10
Average initial weight at feed lot—pounds	426	426	427	427
Average final weight at feed lot—do	847	841	801	804
Average market weight at Fort Worth—do	810	807	771	765
Average gain per head—do	421	415	374	377
Average daily gain per head—do	2.15	2.12	1.91	1.92
Average shrinkage per head during shipment—percent	4.3	4.0	3.7	4.9
Total feed consumed per head:				
Milo heads, ground—pounds	1,945	2,049	1,634	1,703
Cottonseed meal—do	396	417	335	348
Molasses—do	244	244	244	244
Sumac fodder, chopped—do	1,340	1,357	1,193	1,215
Limestone flour—do	18	18	18	18
Salt—do	6	7	8	7
Average ration:				
Milo, ground—do	9.92	10.45	8.34	8.69
Cottonseed meal—do	2.02	2.13	1.71	1.78
Molasses [1]—do	1.45	1.45	1.45	1.45
Sumac fodder, chopped—do	6.84	6.92	6.09	6.20
Feed consumed per 100 pounds of gain:				
Milo, ground—do	462	494	437	452
Cottonseed meal—do	94	100	90	92
Molasses—do	58	59	65	65
Sumac fodder, chopped—do	318	327	319	322
Efficiency of gain [2]—percent	15.95	15.12	16.43	16.04
Cost of feed per 100 pounds of gain—dollars	8.73	9.23	8.48	8.69
Initial cost per steer at 7 cents per pound—do	29.82	29.82	29.89	29.89
Cost of feed per steer [3]—do	36.77	38.32	31.73	32.78
Shipping and marketing costs per steer—do	3.50	3.50	3.50	3.50
Total cost of steer at market—do	70.09	71.64	65.12	66.17
Sales price per 100 pounds—do	11.35	10.90	10.30	10.00
Gross return per steer—do	91.93	87.96	79.41	76.50
Profit per steer—do	21.84	16.32	14.29	10.33
Feeder grade [4]—score	11.9	12.9	12.9	12
Carcass grade [4]—do	15.6	15.8	20.8	20.8
Dressing percentage [5]—percent	61.04	60.42	60.19	59.48
Fat in edible part of the ninth, tenth, eleventh rib cuts:				
Physical determination—percent	22.9	----------	20.4	----------
Chemical determination—do	36.2	----------	32.9	----------

[1] Fed for the last 168 days; ration based on the actual number of days fed.

[2] Based on pounds of steer gain produced from 100 pounds of total digestible nutrients consumed. Digestibility factors used: Milo heads, 77.4; cottonseed meal, 73.13; sumac fodder, 52.7; sumac silage, 15.1; molasses, 56.6.

[3] See table 3 for feed prices.

[4] Grade scores: Choice, 8–12, inclusive; Good, 14 18, inclusive; Medium, 20–24, inclusive; Common, 26–30, inclusive.

[5] Based on hot carcass and market weights.

[7] SNEDECOR, G. W. STATISTICAL METHODS APPLIED TO EXPERIMENTS IN AGRICULTURE AND BIOLOGY. Ed. 3, 422 pp., illus. Ames, Iowa. 1940.

tions, the steers consuming the greatest quantities of grain made the greatest gain. Furthermore, there was a definite trend for the high-gaining steers to be the most efficient and the low-gaining ones to be the least efficient.

The full-fed steers sold at sufficiently higher prices than the limited-fed steers to make them more profitable. At both levels of feeding, the individually fed steers returned greater profits than those group fed.

The average carcass grades for the full-fed groups were average Good, as compared with high Medium for the limited-fed groups. There were essentially no differences in the average carcass grades between the groups at the same level of feeding. A study of the individual data showed that the full-fed steers consuming the most feed consistently produced the highest grading carcasses and those consuming the least feed produced the lowest grading carcasses.

Both the physical and chemical determinations showed that the ribs of the full-fed steers in the individually fed group contained a somewhat higher percentage of fat, on the average, than those of the limited-fed steers. The degree of fatness, however, was not necessarily associated with rate of gain and carcass grade, but the general trend was in that direction.

1937–38 Experiment

The average feed consumption, rations, gains, and marketing data for the steers in the second experiment are given in table 5. The average weights of the steers at the end of each period are shown graphically in figure 5.

Table 5.—*Gains, feed consumption, and efficiency of steers in the second experiment, 1937–38 (170 days)*

Item		Full-fed steers		Limited-fed steers	
		Group 1, fed individually	Group 3, fed as group	Group 2, fed individually	Group 4, fed as group
Steers	number	10	10	9	10
Average initial weight at feed lot	pounds	482	487	493	484
Average final weight at feed lot	do	855	865	833	838
Average market weight at Fort Worth	do	801	807	784	787
Average gain per head	do	373	378	340	354
Average daily gain per head	do	2.19	2.22	2.00	2.08
Average shrinkage per head during shipment	percent	6.3	6.7	5.9	6.1
Total feed consumed per head:					
Milo grain, ground	pounds	1,813	1,922	1,538	1,569
Cottonseed meal	do	322	328	325	330
Sumac silage	do	2,287	2,306	2,287	2,307
Limestone flour	do	10	10	10	10
Salt	do	5	5	5	5
Average ration:					
Milo, ground	do	10.66	11.31	9.05	9.23
Cottonseed meal	do	1.89	1.93	1.91	1.94
Sumac silage	do	13.45	13.56	13.45	13.57
Feed consumed per 100 pounds of gain:					
Milo, ground	do	488	508	452	443
Cottonseed meal	do	87	87	96	93
Sumac silage	do	617	610	673	652
Efficiency of gain [1]	percent	18.38	17.72	18.65	19.12
Cost of feed per 100 pounds of gain	dollars	7.06	7.24	6.95	6.79
Initial cost per steer at 8.4 cents per pound	do	40.49	40.91	41.41	40.66

[1] See footnote 2, table 4. Digestibility factor for milo grain, 79.9; cottonseed meal, 75.5; and sumac silage, 15.1.

Item	Full-fed steers		Limited-fed steers	
	Group 1, fed individually	Group 3, fed as group	Group 2, fed individually	Group 4, fed as group
Cost of feed per steer [2] ..... do	26.21	27.37	23.64	24.05
Shipping and marketing costs per steer ..... do	3.78	3.78	3.78	3.78
Total cost of steer at market ..... do	70.48	72.06	68.83	68.49
Sales price per 100 pounds ..... do	9.50	9.50	9.25	9.35
Gross return per steer ..... do	76.09	76.67	72.52	73.58
Profit per steer ..... do	5.61	4.61	3.69	5.09
Feeder grade [3] ..... score	13.2	12.6	11.7	12.6
Carcass grade [3] ..... do	14	13.8	17.5	16.8
Dressing percentage [4] ..... percent	62.13	63.81	60.96	61.94
Fat in edible part of the ninth, tenth, eleventh rib cuts:				
Physical determination ..... percent	22.4	----------	17.0	----------
Chemical determination ..... do	35.7	----------	30.7	----------

[2] See table 3 for feed prices.
[3] See footnote 4, table 4.
[4] See footnote 5, table 4.

The two full-fed groups (groups 1 and 3) made greater gains than those limited-fed (groups 2 and 4). At both levels of feeding the group-fed steers made slightly greater gains than those individually fed, but the differences were not significant at either level ($p<0.05$). There was greater variation in the gains of the individually fed steers at the lower feeding level than at the higher level.

As measured by feed consumed per 100 pounds of gain, the limited-fed groups made lower-cost gains than did the full-fed groups, but the difference was not significant. Those individually full-fed steers (group 1) that consumed the largest quantities of feeds made the greatest gains and with few exceptions were the most efficient. There was a close relationship between high rate and efficiency of gain and high feed consumption.

The carcasses of all four groups were within the Good grade, the full-fed cattle being about two-thirds of a grade higher than the limited-fed cattle. The difference in grade was reflected in slightly higher sales prices and dressing percentages. The full-fed steers graded consistently higher in carcass than those limited fed, and there was less variation in their grades. There was a definite relationship between carcass grade and rate of gain, the trend being for the steers making the greatest gains to produce the highest grading carcasses.

As was found in the first experiment, the rib samples from the individually fed steers showed a higher average fat content for the full-fed steers than for those limited fed. Furthermore, no close relationship was found in either group between rate of gain, carcass grade, and percentage of fat.

Of the group-fed cattle in this year's test, those full fed returned less profit than those limited fed. The higher sales price and greater gains of these full-fed cattle were not sufficient to offset their greater feed requirement per 100 pounds of gain in live weight. Of the individually fed cattle, on the other hand, those full fed made greater net returns than those limited fed.

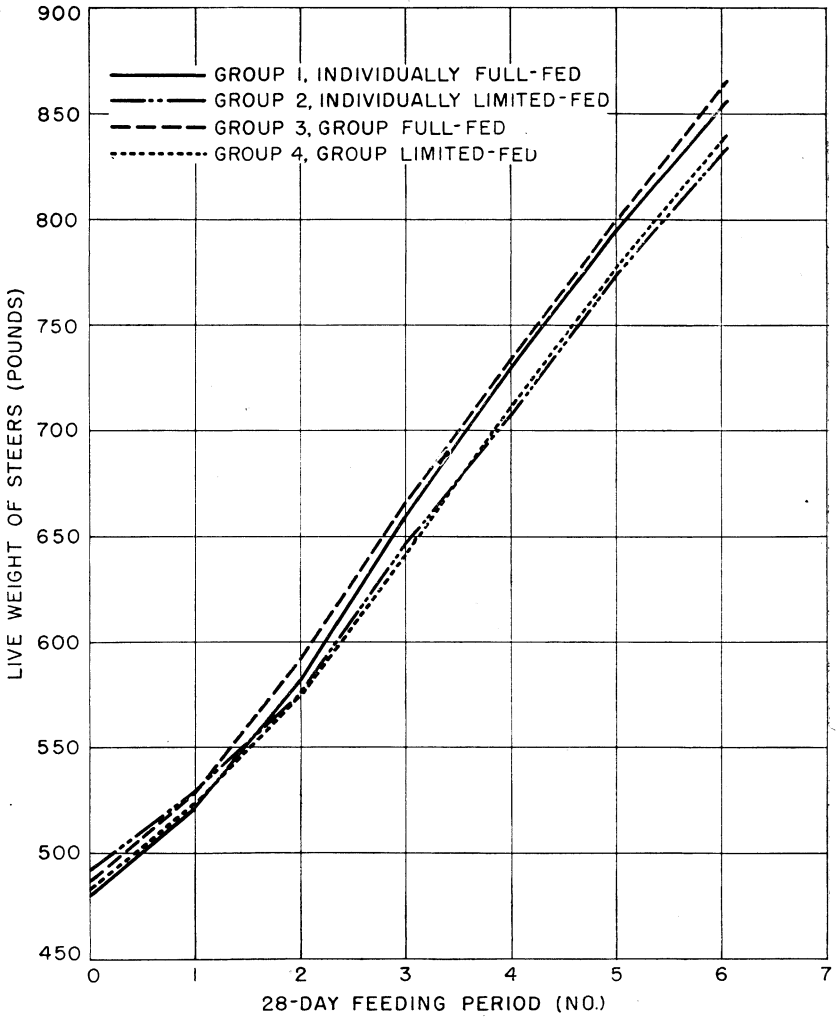

FIGURE 5.—Average live weights of steers by periods during the 1937–38 experiment (170 days).

1938–39 EXPERIMENT

The average feed consumption, rations, gains, and marketing data for the steers in the third experiment are given in table 6. The average weights of the steers at the end of each period are shown graphically in figure 6.

TABLE 6.—*Gains, feed consumption, and efficiency of steers in the third experiment, 1938–39 (196 days)*

Item	Full-fed steers		Limited-fed steers	
	Group 1, fed individually	Group 3, fed as group	Group 2, fed individually	Group 4, fed as group
Steers—number	10	10	9	10
Average initial weight at feed lot—pounds	525	525	533	525
Average final weight at feed lot—do	900	942	911	883
Average market weight at Fort Worth—do	857	883	864	839
Average gain per head—do	375	417	378	358
Average daily gain per head—do	1.92	2.13	1.93	1.83
Average shrinkage per head during shipment—percent	4.7	6.3	5.1	5.4
Total feed consumed per head:				
Milo grain, ground—pounds	1,928	2,177	1,755	1,793
Cottonseed meal—do	366	382	380	387
Sumac silage—do	2,378	2,469	2,448	2,469
Limestone flour—do	12	12	12	12
Salt—do	6	6	6	6
Average ration:				
Milo, ground—do	9.83	11.11	8.95	9.15
Cottonseed meal—do	1.87	1.95	1.93	1.97
Sumac silage—do	12.13	12.60	12.49	12.60
Feed consumed per 100 pounds of gain:				
Milo, ground—do	514	522	465	501
Cottonseed meal—do	99	92	100	108
Sumac silage—do	641	592	653	690
Efficiency of gain [1]—percent	17.28	17.43	18.48	17.17
Cost of feed per 100 pounds of gain—dollars	5.38	5.31	5.11	5.49
Initial cost per steer at 8.5 cents per pound—do	44.63	44.63	45.31	44.63
Cost of feed per steer [2]—do	20.18	22.14	19.32	19.67
Shipping and marketing costs per steer—do	4.26	4.26	4.26	4.26
Total cost of steer at market—do	69.07	71.03	68.89	68.56
Sales price per 100 pounds—do	9.15	9.50	9.25	9.18
Gross return per steer—do	78.59	83.88	79.92	77.02
Profit per steer—do	9.52	12.85	11.03	8.46
Feeder grade [3]—score	13.4	11.8	13.1	13.6
Carcass grade [3]—do	17.6	13.8	14.7	17.6
Dressing percentage [4]—percent	62.90	64.29	62.79	63.34
Fat in edible part of ninth, tenth, eleventh rib cuts:				
Physical determination—do	23.2	----------	24.9	----------
Chemical determination—do	33.9	----------	35.7	----------

[1] See footnote 2, table 4. Digestibility factor for milo grain, 79.9; cottonseed meal, 73.13; and sumac silage, 15.1.
[2] See table 3 for feed prices.
[3] See footnote 3, table 4.
[4] See footnote 4, table 4.

A comparison of figure 6 with figures 4 and 5 shows that in the third experiment the relationship of the groups with respect to gains in weight varied considerably more than in the 2 preceding years. Of the individually fed steers, those that were full fed (group 1) had greater variations in gain than those that were limited fed (group 2). The steers full fed as a group (group 3) made greater gains than any of the others, but the difference in gain was significant ($p<0.05$) only between these steers and those limited fed as a group (group 4). As in the 2 preceding years, the steers consuming the most feed made the most rapid gains, but high rate of gain and finish were not always closely associated. The steers fed individually on a limited ration had a higher efficiency of gain than the other three groups, which were essentially the same in this respect.

The steers full fed as a group (group 3) had the highest sales price, which was $0.25 per hundredweight above that of the individually fed steers at the lower level of feeding (group 2) and about $0.35 per hundredweight above that of the other two groups.

The steers full fed as a group also had the highest grading carcasses, but they were only slightly higher than the carcasses from the steers

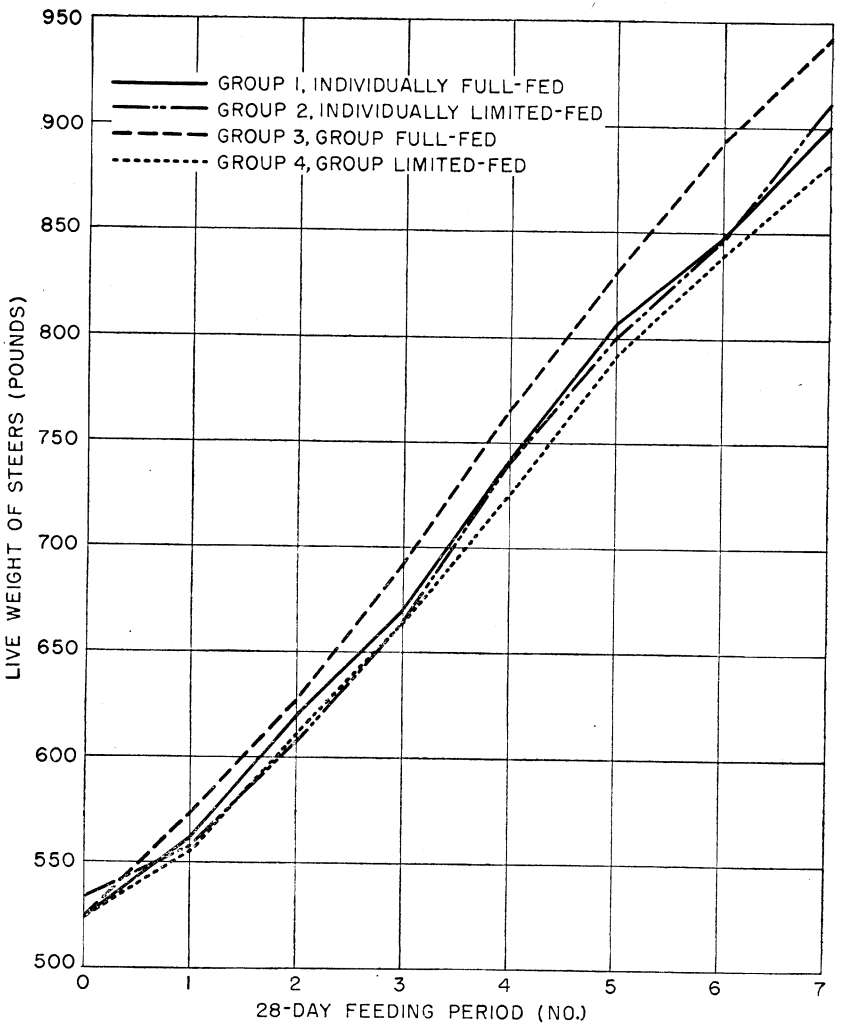

FIGURE 6.—Average live weights of steers by periods during the 1938–39 experiment (196 days).

fed individually on a limited ration. The difference between the carcass grades of group 3 and of groups 1 and 4 was significant. The average carcass grade of the steers in group 1 was significantly lower than that of group 2. This reversal of the results obtained in the 2 previous years was probably due to very low rates of gain, in the third experiment, of three steers in group 1. There was considerably less difference in average total milo consumption by the steers in these two groups than in the two previous experiments. The average daily gains were essentially the same for the two groups.

Group 3, which had the highest sales price, also had the highest average dressing percentage and the greatest profit per steer. The next most profitable steers were those in group 2, followed by groups

1 and 4. The difference in profit per steer between group 3 and groups 1 and 4 was statistically significant.

In the third experiment both the physical and chemical fat determinations showed that the ribs of the limited-fed steers had a higher fat content than those of the full-fed steers. This result was the reverse of those of the 2 previous years. The gains of the two groups were essentially the same, but the carcasses of the limited-fed steers averaged somewhat over a third of a grade higher than those of the full-fed steers. The latter were more severely affected with urinary calculi than the former, a fact which may have accounted for the higher percentage of fat in the ribs of the limited-fed cattle.

Average Results of the Three Experiments

In the 3 years' experiments, the steers fed together in groups, on the average, made slightly greater gains than those fed individually. There was essentially no difference between individually fed and group-fed steers on the limited milo ration, but the steers full fed as a group made somewhat greater gains than those individually fed. Differences between individually and group-fed steers at the same level of feeding were not statistically significant ($p>0.05$). A variance analysis of the daily gains within groups and periods showed that the most uniform gains were obtained in the individually fed animals on a limited ration and the least uniform gains in the group-fed animals on the limited ration. These results substantiate those of experiments with other classes of animals.

In the groups individually fed, the highest gaining steers consumed the most feed, but their gains were sufficiently greater to more than offset the greater feed consumption. Steers that consumed the most feed graded higher in carcass than similar steers that consumed significantly lower quantities of feeds. Statistical analyses of the data showed that in the full-fed steers high carcass grade was closely associated with high feed intake, the correlation being 0.72. Multiple correlations between carcass grade, digestible nutrients consumed, and feeder grade indicate that a large proportion of the variability in carcass grade could be attributed to variations in these factors. When the feed consumption was limited, there was no significant relationship between carcass grade and feed intake.

The average carcass grades of the full-fed cattle for the three experiments were significantly higher ($p<0.01$) than those of the cattle fed at the lower level. However, average differences between individually fed and group-fed steers at the same level of feeding were not significant, even though in the last experiment there was a considerable difference in this respect. In dressing percentages differences between individually fed and group-fed steers at the same level of feeding were small, but the full-fed group averaged 1.5 percent more than those limited fed over the 3-year period.

The full-fed groups had the highest average sales prices. There was only a slight difference between the groups at the same level of feeding. The slightly greater gains and the higher selling price of the full-fed cattle than of those limited fed were responsible for significantly greater net returns, amounting to nearly $3 more per head on the average.

Average physical and chemical fat determinations showed that the ribs of the full-fed steers contained significantly more fat than those from the limited-fed steers, even though the latter had a somewhat higher percentage of fat in the third experiment.

SUMMARY AND CONCLUSIONS

Experiments to compare the results obtained from fattening steers on milo grain individually and in groups at two levels of feeding were begun in the fall of 1936 and continued through three successive winter feeding periods. The work was conducted at the Big Spring Field Station, Big Spring, Tex.

In the initial year blackstrap molasses was added to the ration to increase consumption of feeds. In the two following years sumac silage replaced sumac fodder, which was fed during the first year, and the feeding of molasses was discontinued. Cottonseed meal constituted a part of the ration in all three experiments. Four groups of high Good to low Choice feeder steers were fed for an average period of 187 days for the three experiments.

Steers fed as closely as possible according to a predetermined full-feeding schedule averaged greater gains than similar steers fed 80 percent as much milo, with other feeds constant or nearly so. The limited-fed steers made more gain per pound of feed than the full-fed groups, and on the 3-year average the difference was significant. In the individually fed steers at the two levels of feeding, the difference in efficiency of gain was significant in favor of the limited-fed steers. Any differences in gains per 100 pounds of feed consumed, however, in favor of the limited-fed cattle were not sufficient to compensate for the greater gains and higher sale prices of the full-fed groups.

Correlation studies indicated that in the full-fed groups there was a highly significant correlation between carcass grade and feed consumed. There was a definite trend for the steers that ate the most feed to grade the highest in carcass. Multiple correlation studies indicated that a large proportion of the variability in carcass grade can be attributed to variations in feed consumption and feeder grade.

Physical and chemical fat determinations showed that the ribs of the full-fed steers contained, on the average, significantly more fat than those from the limited-fed steers.

These experiments, therefore, indicate rather definitely that steers fed in groups consume more feed and make greater gains than those fed individually, but the gains are likely to be less efficient. Limited feeding of steers tends to inhibit the development of high carcass quality, as measured by fatness, or finish. In full-fed steers, their ability to consume feed largely determines their carcass grades. The increased sales value of full-fed steers due to their greater gains and finish usually more than offsets the more economical gains of limited-fed steers.

○