SINGLE AND MIXED CEREAL GRAINS FOR FINISHING BEEF CATTLE

by

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INTRODUCTION

To be economically successful in the business of feeding cattle, the feeder must have a working knowledge of the feeding value of concentrates and roughages available at the least cost. The narrow margin of profit with which the beef producer has to work stimulates a careful study of the value of feeds available. A comparative value from a dollars and cents standpoint can be quickly derived but the feed value of components making up the ration is a more sophisticated problem.

Response of the beef animal, as measured by feed-lot performance, to a ration may be influenced by mixtures of concentrates as compared to the same concentrates fed alone. Snapp and Neumann (1963) stated: "Experienced feeders of purebred cattle greatly prefer a mixture of several grains to corn alone for fitting cattle for the show and sale ring. On the other hand, the men who feed steers for the market usually feed only corn or sorghum alone unless these grains are scarce and high in price compared with other grains. Feeding experiments indicate that grain mixtures usually are sufficiently better than single grains such as corn or barley to justify their use, even though additional labor is required in their preparation."

Corn excels as a concentrate for fattening cattle because it is highly palatable and is rich in total digestable

nutrients. It is usually considered the standard with which other grains are compared.

Sorghum grain, following the development of hybrids, has become increasingly important in cattle fattening rations, especially in regions of low rainfall. The more drought-resistant sorghum grains have replaced many acres of the drought-subject crops even in the Corn Belt. Ground sorghum grain is usually considered to be worth about 90 to 95% as much as corn.

Good wheat usually demands a price making it non-competitive with other cereal grains. Certain conditions, however, warrant consideration of wheat as a livestock feed. Damaged wheat not suitable for human consumption, low market price, and a greater demand for higher quality by the market are examples of these conditions. Wheat fed on farms where it was grown from 1919 to 1938 according to Pearson et al. (1942) varied from 2 to 18% of the total production. From 1930 to 1938, one bushel of wheat was fed for each sixteen bushels of corn over the United States. Kansas during this period fed four bushels of corn per bushel of wheat. USDA statistics show that during the period 1920-1957 from about 20,000,000 to more than 500,000,000 bushels of wheat were fed annually in the United States.

The value of wheat as a feed for non-ruminants is perhaps more firmly established than for ruminants. Although several trials have been conducted to determine the merit of wheat for finishing beef, results have been variable.

The trials in this study were designed to test the value of wheat, corn and sorghum grain fed individually and in mixtures for fattening beef cattle. These trials were part of a study to find ways of improving utilization of sorghum grain in cattle rations.

REVIEW OF LITERATURE

Nutritive Evaluation and Comparison of Cereal Grains

The nutritive characteristics of wheat, from a chemical analysis standpoint, are similar to other cereals. Wheat, when compared with corn, contains about as much nitrogen free extract and total digestible nutrients, is slightly higher in fiber and is lower in fat. Wheat contains 0.05% calcium and 0.40% phosphorus. It is deficient in vitamins A, D, and riboflavin, but is a good source of thiamine and niacin. The protein content of wheat varies according to climate, type of wheat, storage conditions and soil fertility. A summary of proximate analysis data by the National Research Council (1958) gave the following crude protein values: hard red spring grain, 14.7%; hard red winter, 13.0%; soft Pacific Coast, 9.9%; and soft red winter, 11.1%.

Weber and Connell (1933) stated, "Chemical analyses are useful because they indicate in a general way the nutritive value of feeds. But the practical feeder needs

to know the 'over all' effect of a feed in addition to how it should compare pound for pound with other feeds in producing increases in body weight".

Of the few stations reporting actual comparisons of different types of wheat, the Washington station found that Gaines, a soft white winter wheat, gave slightly higher average daily gain and required fewer pounds of feed per pound of gain than Burt, a hard white winter wheat (Dyer, 1965). In an earlier study at the same station, Turkey, a hard red winter, Jenkins, a soft white winter and Baart, a hard white spring type were compared when fed to feeder lambs. Baart out-performed the other types while Turkey ranked second (Hackedorn et al. 1937).

Brethour and Duitsman (1965) considered the protein value of wheat relative to sorghum grain in fattening steers and noted that the protein needs of the steers were apparently satisfied by replacing one pound of cottonseed meal with 6.4 pounds of wheat. Dyer and Weaver (1955) concluded that feeding wheat to fattening steers at the ratio of 20 parts to 1 part protein concentrate by weight seemed satisfactory. Morrison (1957) in comparing the protein value of wheat with corn, said: "The fact that wheat is higher than corn in protein content should be borne in mind. Less protein supplement is needed to balance the ration when wheat is the chief grain than in the case of corn". Dickson, (1938) studied the advisability of supplementing a wheat and alfalfa

ration with cottonseed cake when fattening range calves in the feedlot. He found no advantage in the addition of one pound of cottonseed cake per head per day. Rate of gain was not significantly increased and gains were more costly. A slight advantage resulted when one half the wheat was replaced with barley when fed with cottonseed cake and alfalfa. The calves ate more grain and selling value was increased.

Lamb et al. (1966) compared the nutritive value of sorghum grain and wheat by feeding rats and noting differences in body weight, food consumption and reproductive capacities. On this basis of evaluation, sorghum grain was nutritionally inferior to wheat.

Brethour (1966) made an extensive review of trials comparing wheat with corn, sorghum grain, barley and rye in feeding beef cattle. Table 1 summarizes the data he presented.

In only 3 of all comparisons did cattle eat more when fed wheat. On an air-dry basis, relative intake of wheat rations was 92% of barley and 91% of corn rations. Little difference was noted between wheat and rye consumption. The largest differences were found between wheat and sorghum grain with the wheat averaging 84% of the sorghum grain intake.

Richardson et al. (1956) conducted three trials in which sorghum grain was compared with corn in the finishing ration for heifers. They found only a slight increase in rate of gain in favor of corn. However, average daily

TABLE I

SUMMARY OF TRIALS COMPARING WHEAT
WITH OTHER FEED GRAINS

Treatment	Average daily gain			Average air-dry intake			Pounds concentrate replaced by 1 lb. wheat
	Feed grain lbs.	Wheat lbs.	Percent of feed grain	Feed grain lbs.	Wheat lbs.	Percent of feed grain	
Corn vs. wheat 30 trials	2.16	2.08	97	20.5	18.8	91	1.09
Sorghum grain vs. wheat 3 trials	2.76	2.52	90	32.9	27.4	84	1.15
Barley vs. wheat 18 trials	2.54	2.47	98	22.2	20.6	92	1.10
Rye vs. wheat 3 trials	2.20	2.28	104	16.1	15.9	98	1.06

consumption of sorghum grain was greater than corn in all tests and less corn was required per 100 pounds of gain.

Thalman (1943) compared cracked corn and cracked white kafir for fattening yearling steers. Alfalfa hay was fed in one trial and corn silage in the other. Gains made by steers fed corn were larger than those made by steers fed kafir. However, the difference between gains made on corn and kafir was less when silage rather than alfalfa hay was fed. In both comparisons, a unit of gain required approximately 90% as much corn as kafir.

Cracked corn was compared with cracked milo by Baker et al. (1958). The grain was fed according to appetite, mixed with 6.0 pounds of chopped alfalfa per head per day. The steers fed milo required 8.2% more grain per unit of live-weight gain, made almost identical gains, produced the same carcass yield and graded higher in the carcass than steers fed corn.

Nutritive Value of Damaged Wheat

Wheat not suitable for human consumption is usually fed to livestock. Even though damaged wheat is most likely to be used in this manner, few experiments have been conducted to test its value. The value of testing damaged wheat is, of course, limited to the nature and extent of damage. North Dakota researchers generalized that wheat 57 pounds per bushel or heavier should be similar to 60 pound wheat. Below

56 pounds, daily gains should be similar, but feed efficiency probably would be lower (Haugse and Dinusson, 1965).

In a Montana study, coarsely ground frost damaged wheat weighing 55 pounds per bushel appeared to be very satisfactory when compared to barley, for fattening steers. When two year old Marquis wheat, very hard and flinty, was compared to a barley ration full fed, the lot fed barley made more rapid gains, carried more finish and was valued higher per cwt. than the lot fed wheat. This was explained by the unpalatability of the wheat. During the last part of the trial soft wheat was fed resulting in somewhat greater grain consumption and greater gains (Vinke and Pearson, 1931).

The nature and extent of damage apparently determines its feed value. For frosted wheat, the stage of maturity when frosted probably affects feed value.

Problems Encountered with All-Wheat Rations

Problems encountered with all-wheat diets have ranged from apparently no abnormalities to digestive disturbances severe enough to warrant changes in the ration. Blizzard (1932) tested the value of wheat as a substitute for corn in fattening calves. In the first trial, calves fed wheat out-performed those fed corn. However, in a second trial, one-half the wheat ration was substituted with ground shelled corn at the end of 74 days in an effort to reduce bloating. Trowbridge and Moffett (1933) found that bloating, scouring and other digestive disturbances occurred more frequently

when wheat constituted the whole ration. Dyer and Weaver (1955) concluded that ground wheat as the only grain source caused frequent digestive disturbances and slow gain which resulted in carcasses of relatively low grade. When wheat was the single grain source for fattening calves, Branaman (1944) noted a reluctance to consume adequate amounts. It was necessary to keep the grain before the calves most of the time. Some problem with scouring was evident in the lots fed wheat during the first two weeks but no other complications were experienced. Brethour and Duitsman (1959) reported that a ration of one part rolled wheat to two parts Ellis sorgo silage fed to steers was not so palatable as a similar ration of sorghum grain and silage. It was difficult to keep cattle on feed when wheat was the only grain offered and scouring was frequent. In contrast, Baker (1930), Skinner and King (1932), and Good and Harris (1932) reported no difficulty with digestive disturbances or in getting the cattle on full feed.

Grain Mixtures

Refusal to eat liberal quantities of rations containing a large amount of wheat has frequently been reported. Montgomery and Baumgardt (1965) studied the regulation of food intake in ruminants when fed pelleted rations varying in energy concentrations. Holstein heifers were fed various ratios of ground corn to alfalfa meal. Daily dry matter consumption decreased as the corn increased and daily energy

consumption was similar for all rations. Similar trends in dry matter consumption were noted when lambs were fed instead of cattle. Average daily gains were not significantly different. Results of this work support the hypothesis that ruminants will adjust voluntary food intake in relation to physiological demand for energy if fill or rumen load does not limit their consumption.

Baumgardt et al. (1964) investigated hunger and satiety with Holstein cows and heifers. They noted a significant correlation between total feed intake by an individual animal and concentration of acetate in venous blood.

Using feed consumption as a measure of palatability, wheat fed as the only grain apparently is less palatable than other grains commonly fed. The usual recommendation is that wheat be mixed with other grains.

Most grain mixture studies have involved various proportions of wheat and corn. Nebraska workers have conducted several trials comparing wheat with other feed grains. Thalman (1944) contrasted a ration consisting of a mixture of two-thirds cracked shelled corn and one-third cracked wheat with a ration of shelled corn fed to three year old steers on a basal ration of alfalfa hay. The wheat-corn mixture resulted in an average daily gain of 3.61 pounds while the steers fed corn gained 3.06 pounds. In a second trial, a fattening ration of three parts corn and one part wheat and one of equal parts wheat and corn fed to yearling heifers

made slightly more rapid gains and required less grain per unit of gain than heifers fed shelled corn. However, when the ratio of wheat to corn was raised to 3:1, smaller gains and decreased efficiency resulted as compared to lots fed 50% wheat or less. Trials conducted earlier by Baker (1930) demonstrated increased consumption when fattening calves were fed equal parts by weight of corn and wheat as compared to all wheat rations but less intake than the all corn lot. Baker and Baker (1960) studied the effect of different methods of preparation of wheat for fattening cattle and the value of mixing wheat with corn or cane molasses. Steers fed corn consumed as much or more grain in every comparison except two where the steers fed equal parts corn and wheat and those fed cold-rolled wheat mixed with 10% molasses consumed slightly more. Steers fed the combination of equal parts corn and wheat consumed more grain in every comparison than steers fed either cold-rolled wheat or steam-rolled wheat or the combination of wheat and cane molasses. Trowbridge and Moffett (1933) found that wheat substituted for as much as half the full ration of shelled corn produced slightly more rapid and economical gains. Dyer and Weaver (1955) also reported that a mixture of equal parts ground wheat and shelled corn produced faster gains than all corn or all wheat rations.

In an all-concentrate study by Oltjen et al. (1966) steers were fed rations containing 90% soft red winter wheat

or 90% corn or 60:30 combinations of each grain. Steers fed the 60 or 90% corn rations gained significantly faster than steers fed the 60 or 90% wheat rations. Performance difference between groups occurred during the last 28 days of feeding during which time the steers consumed less of the high wheat rations. Carcass characteristics were not significantly different. Condemned livers were prevalent in lots fed wheat.

Weber and Connell (1933) reported that gains made by steers fed ground corn and mixtures of corn and wheat were not significantly different. From the standpoint of gains, a mixture of two-thirds wheat and one-third corn was just as satisfactory as ground corn alone. Average daily consumptions were: all corn, 14.8 pounds; one-third wheat and two-thirds corn, 13.4 pounds; two-thirds wheat and one-third corn, 13.5 pounds; and all wheat, 12 pounds. On the basis of the amount of grain required to produce 100 pounds of gain, ground corn was 86% as efficient as ground wheat. On the same basis, ground corn was 88% as efficient as a mixture of one-third corn and two-thirds wheat and 89% as efficient as a mixture of two-thirds corn and one-third wheat.

Ralston et al. (1964) studied the relative value of corn, barley and wheat in high concentrate rations. Twenty-five percent beet pulp and 5% molasses were added to all grain combinations and this concentrate mixture made up 90% of the diet and roughage the remaining 10%. The rations were

60% wheat, 20:40 wheat and barley combinations, 20:40 corn and barley combinations, 60% corn and 60% barley. The combination of corn and beet pulp produced lower gains than either wheat or barley and beet pulp. Steers fed 20:40 corn to barley gained slightly more than those fed mixtures of wheat and barley. When average daily gain was considered with feed efficiency, wheat was the most efficient of the grains considered.

Skinner and King (1932) compared corn, equal parts corn and ground wheat and a mixture of equal parts ground wheat and ground oats. Other ingredients of the ration were cottonseed meal, clover hay and corn silage. The cattle fed wheat with either corn or ground oats did not consume as much grain as those fed all corn. This was especially true during the early part of the feeding period. However, the appetites of the cattle and the ease with which they were kept on feed were not affected by the presence of wheat. The only difference noted between lots fed corn and those fed wheat was satisfaction with less feed when wheat comprised a part of the ration. The value of the cattle at the end of the experiment was greater in those lots which received wheat.

Keith et al. (1965) fed steers 30% dried molasses beet pulp in addition to steam-rolled barley, steam-rolled wheat or mixtures of equal parts barley and wheat. Calves fed barley gained 2.57 pounds per day and required 855 pounds

per 100 pounds gain while calves fed wheat gained 2.23 pounds per day and required 792 pounds of feed per 100 pounds gain. Calves fed the mixture needed 827 pounds to produce 100 pounds of gain and gained at the rate of 2.45 pounds per day. When dehydrated alfalfa meal replaced 10% of the grain, steers fed wheat performed slightly better than steers fed barley. Rate of gain and feed efficiency for the steers fed wheat were 2.45 pounds per day and 784 pounds per 100 pounds gain respectively while the steers fed barley gained 2.38 pounds daily and needed 844 pounds to produce 100 pounds of gain.

Fewer trials testing wheat-sorghum grain mixtures for fattening beef cattle have been reported. Brethour and Duitsman (1958) found that cattle fed a 1:2 grain to roughage ration performed best when equal parts by weight of sorghum grain and wheat made up the grain portion as compared to sorghum grain or rolled wheat alone. An average of 8.64 pounds dry matter was required for each pound gain by steers fed 1 part rolled wheat to 2 parts Ellis sorgo silage compared with 10.07 pounds for the steers fed sorghum grain rather than wheat. Steers that received equal parts wheat and sorghum grain consumed 8.77 pounds of dry matter for each pound of gain. Steers in this lot gained faster and more efficiently than those fed only sorghum grain and silage.

Kercher and Bishop (1963) studied the relative value of beet pulp pellets, steam-rolled barley, steam-rolled oats and steam-rolled milo when used in an all-concentrate

ration for fattening steers. Treatments were 87.5% grain and 12.5% dehydrated alfalfa, or 82.5% beet pulp pellets, 5.0% soybean meal and 12.5% dehydrated alfalfa. Considering the amount of beef produced per unit of feed and assigning barley a value of 100, oats, milo and beet pulp were worth 91.6, 95.5 and 78.4% respectively. Steers fed milo consumed the largest amount of feed follwed by steers fed oats, barley and beet pulp.

Preparation of Wheat

Since the wheat kernel is small and hard, the full feeding value of wheat fed to cattle cannot be realized until some method of preparation has been performed. This was borne out in early studies by Trowbridge and Moffett (1933). They found that cattle eating whole wheat required about 25% more grain per 100 pounds of beef produced. Whole wheat was consumed in slightly larger quantities than shelled corn but gains were slower and less economical. Coarsely grinding the wheat increased its value for fattening cattle approximately 10%. Dyer and Weaver (1955) likewise demonstrated the wastefullness of feeding whole wheat to cattle as a complete substitute for corn.

Weber and Loeffel (1931) compared shelled corn, whole wheat and ground wheat fed in conjunction with alfalfa hay to fattening lambs and found that whole wheat was almost as palatable as shelled corn but less efficient. Ground wheat fed alone was distinctly less palatable than either shelled

corn or whole wheat and was more efficient than whole wheat but less efficient than shelled corn. Darlow (1933) reported whole wheat to be equal to whole corn when fed to fattening lambs. The grinding of wheat apparently decreased its palatability. Considerable difficulty was experienced in getting the lambs to eat it.

Several trials have involved comparisons of various preparations of wheat. Baker (1930) reported that ground wheat out-performed rolled or crushed wheat when fed to fattening cattle. More ground wheat was consumed and more rapid and economical gains were made. In contrast, Darlow et al. (1946) reported that cattle hand fed rolled wheat out-gained cattle hand fed ground wheat. Rolled wheat was consumed with more relish when mixed with silage than when fed in self-feeders. Dahman et al. (1966) compared pelleted whole grain, pelleted finely ground grain and steam-rolled grain. Steers fed pellets of ground barley and pellets of equal parts ground wheat and barley made the slowest and most expensive gains. Pelleted whole barley and wheat were utilized more efficiently than finely ground pelleted barley and wheat. Little difference was noted between steam-rolled and whole pelleted rations. A Washington trial demonstrated a slight advantage to pelleted over steam-rolled and dry rolled wheat (Dyer, 1965). In contrast, intake, rate of gain and efficiency of gain were reduced when pelleted wheat was fed in a Kansas test (Brethour and Duitsman, 1959).

There seems to be no consistant difference in favor of any one particular method of preparation. However, as is pointed out by Morrison (1957), the grain should not be ground to a fine, floury meal.

Bulk in the Ration

Baker (1930) found that increasing the allowance of alfalfa hay to fattening calves increased consumption of grain, rate of gain and resulted in greater contentment. Good and Harris (1932) studied the effect of replacing 25.5 pounds of silage in a wheat ration with mixed hay. Cattle receiving the mixed hay with wheat were inclined to bloat, scour and go off feed. When corn silage was introduced, these ailments disappeared. No digestive disturbances were noted when the ration consisted of half wheat and half barley or corn even though no silage was fed. Ralston et al. (1964) examined the effects of the roughage diluents, beet pulp, alfalfa hay, corn silage and wheat straw at the 10 and 20% levels, on performance of beef steers fed a wheat diet. Overall performance was not significantly different. All roughage diluents performed satisfactorily. However, data suggest that the fiber level in wheat straw may be more critical than fiber from other sources. In a second test the same roughage diluents were compared with the exception of wheat straw at the 10% level. The roughage fed had little effect upon feed lot performance or carcass characteristics (Ralston et al., 1956).

Thalman (1944) stated that barley seemed to increase palatability of wheat and to stabilize the daily grain consumption and attributed this response to the bulk supplied by the barley. However, Dyer and Weaver (1955) observed no improvement of overall results when ground oats were added to an all-wheat ration for cattle. In the same test, mixing ground wheat with a small amount of corn silage produced slightly more rapid and efficient gains than ground wheat fed as the only grain concentrate.

Brethour (1966) in a review of data from 13 trials summarized grain roughage interactions by comparing the relative performance between corn and wheat when fed with dry roughage or mixed with silage. From this summary he concluded that neither relative air dry intake nor relative rate of gain was affected by roughage source. However, the replacement value of wheat for corn was improved in the silage rations. One pound of wheat replaced 1.08 pounds of corn in dry rations and 1.18 pounds of corn in rations containing silage. An explanation of these results may be the variations in quality of roughage. Most dry roughage comparisons included alfalfa hay.

Ruminal Changes

Digestive disturbances have been reported in several instances when wheat was the only concentrate fed. Ruminant indigestion due to over eating is accompanied by a depression of ruminal pH to 5 or lower as a result of the accumulation

of lactic acid. Allison et al. (1964) studied the role of ruminal microflora in the ability of the ruminant to adapt to sudden increases in carbohydrates in the ration. They found that after ruminal pH dropped below 5, the sheep was obviously ill. The animal had diarrhea and no appetite and ruminal motility ceased. The predominately Gram negative bacterial population was replaced with a large proportion of Gram positive rods and streptococci. The sick sheep had a much higher concentration of ruminal ethanol. The longer chained n-butyric and n-valeric acid concentrations increased.

Slyter et al. (1965) reported no significant viable bacteria count differences due to grain or diethylstilbestrol (DES) but noted counts were higher in steers fed corn plus DES and lower in steers fed wheat plus DES. Ciliated protozoa were found in 20% of the steers fed the predominantly wheat rations but none were found in the steers fed corn. None of the organisms isolated were cellulolytic whereas an average of 86% were starch utilizers. Ryan (1964) added cracked wheat to the rumen of sheep and found that the concentration of lactic acid and glucose in the rumen increased while the concentrations of acetic, propionic, butyric and valeric acids decreased. In three of four sheep there was a later increase in the ruminal concentrations of formic and succinic acids.

Kercher et al. (1963) noted that steers fed beet pulp or milo had significantly higher levels of butyric acid in the rumen fluid at the end of the feeding trial than steers

fed barley. The steers fed beet pulp had significantly lower levels of propionic acid and significantly higher levels of acetic acid in the rumen fluid. The ratio of acetic acid to the other fatty acids increased with increasing fiber levels in the diet.

Oltjen et al. (1966) found no significant differences in molar ratios of VFA when steers were fed 60 or 90% corn as compared to 60 or 90% wheat. However, as the percent of wheat increased in the ration, the percent of butyric acid as well as longer chained fatty acids tended to increase. The concentration of VFA was significantly greater when steers consumed the 60 or 90% wheat rations which was reflected in the lowered ruminal pH. Three of ten steers fed 90% wheat had pH values of 4.9. However, the steers averaged 1.3 kg. daily gain during the trial.

Carcass Evaluations

Baker (1930), Thalman (1944), Dyer and Weaver (1955), Weber and Connell (1932) and Trowbridge and Moffett (1933) reported that cattle fed wheat as the only grain produced slightly inferior carcasses as compared to those fed corn. Brethour(1965) found no significant difference between groups when sorghum grain was compared with wheat for fattening steers. Ralston et al. (1964) compared various combinations of wheat, barley and corn with beet pulp and found that the carcass characteristics were very similar in all lots. Baker and Baker (1960) reported that differences in carcass yield,

dressing percent or carcass scores for steers fed corn or wheat or both with roughage were not statistically significant. Oltjen et al. (1966) found that even though there was a significant depression in gain due to feeding 60 or 90% wheat, this was not reflected in carcass merit.

EXPERIMENTAL PROCEDURE

Trial I. Sixty-six yearling Hereford steers averaging 337 kg. were removed from pasture and divided as uniformly as possible into 6 lots of 11 steers per lot. The average of weights taken on two consecutive days for each steer was used to determine the initial and final weights. Individual weights were taken at 28 day intervals during the trial. At the beginning of the trial, all lots received 10.45 kg. of sorghum silage, 1.36 kg. of alfalfa hay, 3.30 kg. of grain and 0.45 kg. of 32% protein supplement per head per day. The percentage of the various grains for each lot is presented in Table 2.

TABLE 2

GRAIN PERCENTAGE FOR TRIAL I

Lot no.	Sorghum grain	Wheat	Corn
7	100	0	0
8	75	25	0
9	50	50	0
10	25	75	0
11	0	100	0
12	33.3	33.3	33.3

Grains were dry rolled to a coarse degree. Chemical analyses of feedstuffs are shown in Table 3. The amount of silage was gradually decreased and the grain increased until the cattle were receiving 3.30 kg. of silage daily and all the grain they would eat in 24 hours. The supplement and one-half of the grain were mixed and fed with one-half of the silage in the morning. The alfalfa hay, other half of the silage and grain were fed in the afternoon.

The cattle were marketed at the end of the 159 day feeding period. Approximately 18 hours after slaughter, USDA carcass grade, percent kidney knob and degree of marbling were determined by a USDA grader. Other data collected were rib-eye area and fat thickness at the twelfth rib.

Trial II. Sixty head of good to choice Hereford heifers averaging 276 kg. were purchased and allotted into 6 lots of 10 each. Approximately 27 days were required to place the heifers on a full feed of grain, 0.45 kg. of 32% protein supplement, 0.91 kg. prairie hay and 0.91 kg. of alfalfa hay per head per day. Chemical composition of the feedstuffs was determined by proximate analysis according to A.O.A.C. methods. Results are shown in Table 4. The percentage of various grains used in each lot is shown in Table 5.

TABLE 3

CHEMICAL ANALYSES OF FEEDS USED IN TRIAL I (%)

Description	Moisture	Protein N x 6.25	Ether extract	Crude fiber	Ash	Nitrogen free extract	Carbohydrates
100% Sorghum Grain	11.71	9.44	2.93	2.18	1.60	72.14	74.32
1/4 Wheat, 3/4 Sorghum Grain	11.58	10.13	2.63	2.13	1.55	71.98	74.11
1/2 Wheat, 1/2 Sorghum Grain	11.49	10.94	2.42	2.27	1.56	71.32	73.59
3/4 Wheat, 1/4 Sorghum Grain	11.89	11.94	1.89	2.28	1.56	70.44	72.72
100% Wheat	12.13	12.63	1.57	2.40	1.58	69.69	72.09
1/3 Wheat, 1/3 Corn, 1/3 Sorghum Grain	12.03	10.38	2.89	2.16	1.49	71.05	73.21
Alfalfa Hay	4.9	10.85	1.52	37.47	7.50	37.76	75.23
Sorghum Silage	60.7	2.09	.65	7.33	2.36	26.87	34.20
Protein supplement, AH 101	9.6	33.6	1.80	6.70	14.00	34.30	41.00

TABLE 4

CHEMICAL ANALYSES OF FEEDS USED IN TRIAL II (%)

Description	Moisture	Protein N x 6.25	Ether extract	Crude fiber	Ash	Nitrogen free extract	Carbohydrates
100% Sorghum Grain	12.40	7.83	2.83	1.62	1.39	73.93	75.55
1/4 Corn, 3/4 Sorghum Grain	11.88	7.69	3.35	1.81	1.50	73.77	75.58
1/2 Corn, 1/2 Sorghum Grain	12.19	8.12	3.07	2.20	1.67	72.75	74.95
3/4 Corn, 1/4 Sorghum Grain	12.16	8.10	3.05	1.77	1.58	73.34	75.11
100% Corn	12.18	8.19	3.73	1.91	1.62	72.37	74.28
1/3 Wheat, 1/3 Corn, 1/3 Sorghum Grain	12.35	9.21	2.44	1.64	1.32	73.04	76.68
Alfalfa Hay	7.12	19.60	1.37	23.28	8.10	40.53	68.81
Prairie Hay	6.30	4.05	2.31	32.32	7.22	47.80	80.12
Protein supplement, AH 101	10.00	28.24	2.25	7.48	15.20	36.83	44.31

TABLE 5

GRAIN PERCENTAGE FOR TRIAL II

Lot no.	Sorghum grain	Corn	Wheat
7	100	0	0
8	75	25	0
9	50	50	0
10	25	75	0
11	0	100	0
12	33.3	33.3	33.3

At the beginning of the trial, the cattle received 1.36 kg. of grain, 0.45 kg. of protein supplement, 2.73 kg. of prairie hay and 0.91 kg. of alfalfa hay. The amount of prairie hay was gradually reduced to 0.91 kg. and the grain was increased until the heifers reached full feed. The grain was fed ad libitum for the remainder of the 112 day feeding period. The prairie hay was removed from the ration after 56 days on feed. Weighing procedure was the same as in Trial I.

A separate and unrelated study was conducted with the heifers during this trial in which five heifers from each lot were implanted with 12 mg. of diethylstilbestrol (DES). Since it was convenient to observe the feedlot performance of implanted and non-implanted heifers, these data are

reported. At the end of the feeding period, the cattle were slaughtered and carcass data collected as in Trial I.

Results and Discussion

Trial I. About 28 days were required to get the steers on full feed. The amount of wheat in the ration was reflected in the acceptance and consumption during this period. Steers in lot 11 fed all wheat were first to level off in grain intake. Lots 10 (3/4 wheat - 1/4 sorghum grain) and 9 (1/2 wheat - 1/2 sorghum grain), after reaching higher levels of intake, dropped back to a level similar to lot 11. Cattle fed 1/4 wheat and 3/4 sorghum grain (lot 8) and those fed equal parts corn, wheat and sorghum grain (lot 12) were much alike in intake patterns during this period. They consumed slightly less grain than cattle in lot 7 fed all sorghum grain.

Average grain consumption for each 28 day interval is shown in figure 1. Steers fed all wheat reached a peak of 7.27 kg. per head per day during the second 28 day period and gradually dropped back to 6.6 kg. of grain by the end of the trial. Oltjen et al. (1966) fed corn, wheat, and combinations of the two grains in a 98 day feeding trial. They found animal performance to be similar for all lots during the first 70 days. However, during the last 28 days, the steers consumed less of the high-wheat rations and as a result, overall performance was lowered. Feed consumption

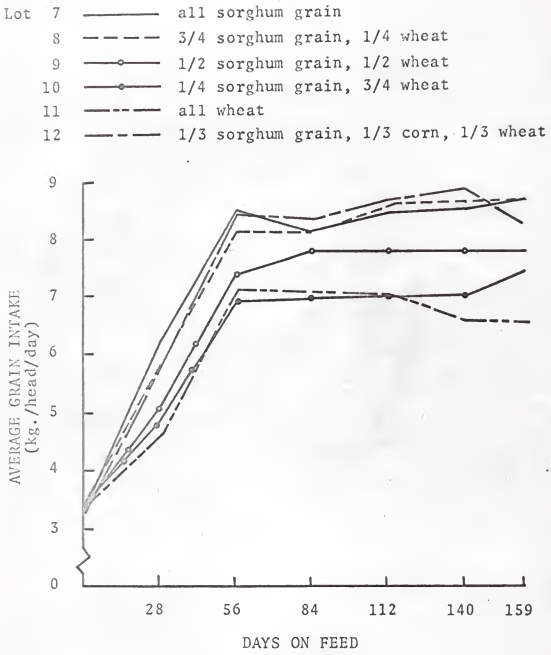

Figure 1. Average kg. grain consumed per steer by 28 day periods.

presented in Table 6 indicates that as the amount of wheat in the ration decreased, consumption per day per steer increased with the exception of lot 12. Feed requirements per unit of gain were least for lot 10 and highest for lots 7 and 8. These results are similar to the findings of Morton and Osland (1932). They reported that calves fed straight wheat were somewhat slow to go on full feed and took more time to clean up their grain than steers fed corn and barley, barley alone, or a mixture of corn and wheat. They found that wheat as the only grain in the ration showed a tendency to produce growth rather than finish.

Roughage consumed per unit of gain was largest for steers fed wheat and least for the cattle on the three grain mixtures. Baker (1930) found that calves fed ground wheat required less grain and more alfalfa hay than those fed shelled corn. Baker and Baker (1960) reported that steers fed corn or combinations of corn and wheat consumed more roughage than steers fed wheat or combinations of wheat and molasses. Thalman (1944) found that 3 year old steers fed a mixture of two-thirds cracked shelled corn and one-third cracked wheat with alfalfa hay consumed more grain and hay than steers fed shelled corn.

An analysis of variance computation indicated no significant difference in total gain between lots. Steers receiving the corn-wheat-sorghum grain mixture produced the highest daily rate of gain which was 1.39 kg. while steers

TABLE 6

AVERAGE DAILY GAIN AND FEED CONSUMPTION FOR TRIAL I

Lot number	7	8	9	10	11	12
Av. daily gain, kg.	1.29	1.28	1.26	1.29	1.20	1.39
Av. daily ration, kg.						
Silage	3.59	3.56	3.59	3.61	3.59	3.60
Alfalfa hay	1.36	1.36	1.36	1.36	1.36	1.36
Grain	8.08	8.00	7.32	6.37	6.55	8.10
Supplement	.45	.45	.45	.45	.45	.45
Kg. feed/unit gain						
Silage	2.78	2.79	2.84	2.80	3.00	2.59
Alfalfa hay	1.06	1.07	1.08	1.06	1.14	.98
Grain	6.26	6.26	5.81	5.18	5.48	5.82
Supplement	.35	.36	.36	.36	.38	.33
Total	10.45	10.48	10.09	9.40	9.99	9.71
Total feed, kg.	23591	23406	22089	19266	20898	23636
Kg. feed/day/steer	13.49	13.38	12.72	12.12	11.59	13.51

fed the all wheat ration were the slowest gainers with an average of 1.20 kg.

One steer in lot 10 went off feed after 140 days and was subsequently dropped from the test. Feed data for lot 10 were adjusted accordingly.

Carcass evaluation in Table 7 indicates that steers in lot 12 had the highest average dressing percent, 62.27% (not significant), while steers in lot 10 dressed significantly ($P<.05$) lower than all other lots with an average of 59.26%. Average hot carcass weights were significantly different at the 5% level. There were no significant differences between lots in rib-eye area, fat thickness over the twelfth rib, carcass grade or estimated kidney knob.

Cattle in lot 11, by visual observation, were not as uniformly finished as were steers in lot 7, 8 or 12. Steers in lot 7 and 12 appeared to be heavier muscled and beefier than steers in the other lots.

Trial II. Heifers in all lots followed the same feed intake pattern for the first 24 days. After this time, lot 7, fed all sorghum grain, started consuming less feed relative to the other lots. Figure 2 illustrates the lower feed consumption for the first 56 days followed by an increase to a level higher than the other lots at the end of 84 days. Lot 8 fed 3/4 sorghum grain and 1/4 corn consumed the largest amount of feed while lot 11 on all corn consumed the least amount.

TABLE 7

CARCASS DATA FOR TRIAL I

Lot number	7	8	9	10	11	12
Av. hot carcass weight, kg.	330.5^{ab}	331.8^{ab}	325.9^{b}	322.3^{b}	321.4^{b}	347.7^{a}
Est. kidney knob, %	3.00	2.95	2.91	2.95	2.82	2.91
Av. fat thickness, cm.	1.45	1.78	1.65	1.47	1.35	1.73
Av. size rib-eye, $cm.^2$	76.65	77.23	75.62	78.84	81.49	82.91
Carcass grade						
Choice, no.	6	7	8	7	5	7
Good, no.	5	4	3	3	6	4
Dressing %	60.93	61.35	60.61	59.26*	60.89	62.27

a,b,c Any two means not bearing a common superscript letter differ significantly ($P < .05$).

* $P < .05$

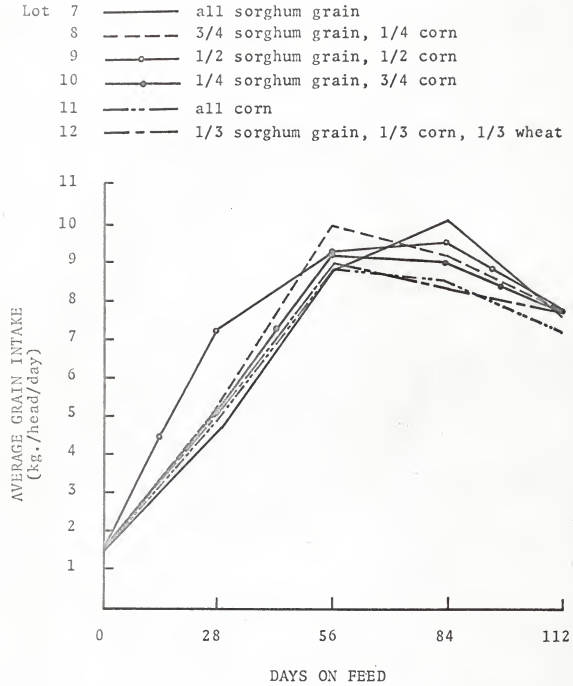

Figure 2. Average kg. grain consumed per heifer by 28 day periods.

Data in Table 8 show that with the exception of lot 7, the total amount of feed consumed decreased slightly with increasing amounts of corn substituted for sorghum grain in the diet. Baker et al. (1958) found that steers fed cracked milo consumed 9% more grain than the steers fed corn where the grains were fed according to appetite, mixed with 2.72 kg. of chopped alfalfa per head daily.

The reduced feed intake during the first half of the trial by lot 7 may be an explanation for their slow rate of gain at the beginning of the period. This lot gained significantly ($P<.10$) slower than all other lots with an average of 1.17 kg. daily and required the most feed per unit gain (8.41 kg.). Lot 9 receiving 1/2 corn and 1/2 sorghum grain produced the highest rate of gain with a daily average of 1.41 kg. Lot 10, however, was slightly more efficient than the other lots requiring 6.94 kg. of feed per kg. of gain. Lots 9, 10 and 11 required about the same amount of feed per unit of gain.

Differences between diethylstilbestrol implanted and non-implanted heifers were not significant. Table 9 shows that differences between implanted and non-implanted heifers were greatest in the lot receiving all sorghum grain. Implanted heifers in this lot had an average daily gain of 1.28 kg. while non-implanted heifers in the same lot gained at the rate of 1.06 kg. per day. High tail heads and development of the mammary system were observed in implanted heifers.

TABLE 8

AVERAGE DAILY GAIN AND FEED CONSUMPTION FOR TRIAL II

Lot number	7	8	9	10	11	12
Av. daily gain, kg.	1.17[a]	1.33	1.41	1.37	1.33	1.32
Av. daily ration, kg.						
Grain	7.74	7.99	7.95	7.38	7.35	7.55
Supplement	.45	.45	.45	.45	.45	.45
Prairie hay	.77	.77	.77	.77	.77	.77
Alfalfa hay	.91	.91	.91	.91	.91	.91
Total	9.87	10.12	10.09	9.51	9.49	9.68
Av. kg. feed per unit gain						
Grain	6.58	6.00	5.65	5.38	5.53	5.70
Supplement	.39	.34	.32	.33	.34	.34
Prairie hay	.67	.59	.56	.57	.59	.59
Alfalfa hay	.77	.68	.65	.66	.68	.69
Total	8.41	7.61	7.17	6.94	7.14	7.33
Total kg. feed	11069	11348	11315	10670	10643	10854

[a] Significantly lower ($P < .10$)

Researchers at Minnesota studied the effect of feeding three levels of hay to fattening heifers fed ground shelled corn and found that heifers reimplanted with 12 mg. stilbestrol had an average of 0.11 kg. higher daily gain than those non-implanted. No high tail heads or low loins were observed in the heifers implanted with stilbestrol (Kolari et al., 1960).

TABLE 9

IMPLANTED VS. NON-IMPLANTED HEIFERS

	Average daily gain, kg.						
Lot no.	7	8	9	10	11	12	Ave.
Implanted[a]	1.29	1.36	1.42	1.41	1.32	1.34	1.36
Non-implanted	1.06	1.30	1.40	1.33	1.33	1.31	1.29

[a] 12 mg. diethystilbestrol pellet

All carcass characteristics except yield grade were not significantly different. Lot 8 dressed 62.5% for the high and had an average rib-eye area of 73.36 sq. cm. which was largest of all lots. Lot 7 dressed 60.5% for the low and had the smallest rib-eye average of 68.00 sq. cm. Duncan's New Multiple Range test applied to the yield grade means demonstrated that the yield grade for lot 9 was greater than lots 7, 8, 10 and 12 but not lot 11. Table 10 shows the carcass data for Trial II.

TABLE 10

CARCASS DATE FOR TRIAL II

Lot number	7	8	9	10	11	12
Av. hot carcass weight, kg.	246.8	265.9	261.8	265.0	262.3	260.0
Est. kidney knob %	2.15	2.35	2.45	2.22	2.32	2.17
Av. fat thickness, cm.	1.42	1.50	1.78	1.45	1.47	1.42
Av. size rib-eye, $cm.^2$	68.00	73.36	72.07	71.81	71.74	69.29
Carcass grade						
Choice, no.	3	6	3	2	6	1
Good, no.	7	4	7	8	4	9
Av. yield grade	2.3^b	2.4^b	2.9^a	2.1^b	2.5^{ab}	2.4^b
Av. dressing %	60.53	62.50	61.53	61.63	61.71	61.11

a,b,c Any two means not bearing a common superscript letter differ significantly ($P < .05$).

GENERAL DISCUSSION

Average daily gain is often the prime criteria in evaluating the nutritive value of a ration. When rate of gain increases, feed efficiency and carcass value generally increase.

Results of the first trial indicated a possible benefit in mixing corn, wheat and sorghum grain in equal amounts. The lot fed the three-grain mixture had the highest average daily gain and was second to the cattle fed 3/4 wheat and 1/4 sorghum grain in efficiency. As increasing amounts of wheat were substituted for sorghum grain in lots 8 through 11, relative rates of gain were not appreciably changed until all the sorghum grain was replaced by wheat. Brethour and Duitsman (1958) reported that steers fed equal parts wheat and sorghum grain gained 1.60 kg. per day while those receiving all sorghum grain or all wheat gained 1.51 and 1.44 kg. per day respectively. Larger proportions of wheat to sorghum grain were not studied. Oltjen et al. (1966) found that steers fed 60 or 90% corn rations gained significantly faster than steers fed the 60 or 90% wheat rations. Weber and Connell (1933) noted that steers fed a mixture of 2/3 wheat and 1/3 corn produced as satisfactory gains as those fed ground corn alone.

The second trial was conducted to further test the possibility of a favorable interaction when grains were

mixed. Results of this trial failed to demonstrate as favorable a response from the three-grain mixture, lot 12, as was noted in Trial I. However, the heifers in lot 12 gained faster and more efficiently than did those fed all-sorghum grain, lot 7.

When corn was substituted for the sorghum grain in Trial II, average daily gain increased slightly, although the all-corn diet did not produce the highest daily gain. Thalman (1943) found that steers fed corn gained faster than those fed kafir. Baker et al. (1958) and Richardson et al. (1956) reported that steers on milo made almost identical gains to those fed corn. No mixtures of grains were tested in these trials.

Feed efficiency is especially useful in comparing the relative value of two grains but does not yield readily to a common denominator. This is because the amount of roughage per unit of gain may typically increase while amount of grain decreases when the substitute grain is included in the ration. Also nutritive values of feedstuffs differ.

Relative feed efficiency is reported here as the amount of concentrate equivalent replaced when the substituted grain is fed. Table 11 demonstrated the procedure used in calculating relative feed efficiency.

Lofgreen et al. (1963) found that for production the net energy value of alfalfa hay was about 50% that of concentrate. Based on this work, the concentrate equivalent

TABLE 11

METHOD OF CALCULATING KILOGRAMS OF CONCENTRATE REPLACED BY ONE KILOGRAM OF WHEAT

Item	Average kg. feed required per kg. gain		Total feed replaced by wheat		Grain equivalent replaced by wheat
	Sorghum grain ration	Wheat ration			
Sorghum silage	278.45	299.89	-21.44/6	=	-3.57
Sorghum grain	625.98		625.98		625.98
Wheat		547.50			
Alfalfa hay	105.68	114.07	-8.39/2	=	-4.19
Supplement AH 101	35.23	38.02	-2.79		-2.79

$$\frac{\text{kg. concentrate replaced by wheat}}{\text{kg. wheat per 100 kg. gain}} = \frac{615.43}{547.50} = 1.12$$

Each kilogram of wheat replaced 1.12 kg. concentrate equivalent.

of hay and silage was established by dividing the silage differences by 6 and hay by 2.

The substitution of either corn or wheat for sorghum grain in general increased efficiency. In Trial I, concentrate equivalent replaced by wheat for lots 9, 10, 11 and 12 were 1.14, 1.28, 1.12 and 1.28 respectively. The all-sorghum grain ration was slightly more efficient than the 3/4 sorghum grain, 1/4 wheat.

In the second trial, 1 kg. of wheat in the three-grain mixture replaced 1.53 kg. of concentrate equivalent in the all-sorghum grain ration. Brethour (1966) reported the relative efficiency of wheat and sorghum grain in three different trials. He found that wheat fed alone replaced 1.27, 1.19 and 1.14 kg. of concentrate equivalent. When the two grains were combined in equal parts in the first of these three trials, 1 kg. of wheat replaced 1.43 kg. concentrate equivalent.

When assessing the relative efficiency of corn and sorghum grain, 1 kg. of corn replaced 1.21 kg. of concentrate equivalent. Eighty-four percent as much corn as sorghum grain was required to produce 1 kg. of gain. Thalman (1943) found that calves fed Early kalo consumed slightly more grain than calves fed corn. Those fed corn required approximately 91% as much grain per unit of gain as the calves fed Early kalo. When cracked corn was compared with cracked Sooner milo, cracked Day milo, and cracked Atlas

sorgo grain for fattening heifer calves in different trials, efficiency of gain favored corn since from about 90 to 96.5% as much corn as sorghum grain was required per unit of gain in the different trials.

Cost of gain is presented in Table 12. In the first trial, cattle fed all-wheat produced the most expensive gains while those fed 3/4 wheat and 1/4 corn produced the cheapest gains. Cost per kg. gain was $0.396 and $0.360 respectively.

In the second trial, cost of feed per kg. gain ranged from $0.327 for lot 10 to $0.364 for lot 7.

TABLE 12

COST OF FEED PER KG. GAIN FOR TRIALS I AND II[a]

Trial I						
Lot no.	7	8	9	10	11	12
Grain	$0.275	$0.292	$0.288	$0.270	$0.301	$0.290
Suppl.	.035	.035	.036	.036	.037	.032
Alf. hay	.029	.029	.030	.029	.031	.027
Silage	.024	.025	.025	.025	.026	.023
Total	.364	.381	.378	.360	.396	.372
Trial II						
Lot no.	7	8	9	10	11	12
Grain	$0.290	$0.274	$0.267	$0.263	$0.280	$0.281
Suppl.	.038	.034	.032	.033	.034	.034
Pr. hay	.015	.013	.012	.013	.013	.013
Alf. hay	.021	.019	.018	.018	.019	.019
Total	.364	.339	.329	.327	.345	.347

[a] Price of feeds used/kg.: Sorghum grain, $0.044; corn, $0.051; wheat, $0.055; supplement, $0.099; sorghum silage, $0.009; alfalfa hay, $0.028; and prairie hay, $0.022.

SUMMARY

Two cattle feeding experiments were conducted to compare separate and mixed feeding of wheat, sorghum grain and corn. In the first trial 66 head of yearling Hereford steers were fed a basal ration of sorghum silage, alfalfa hay and supplement. The grains or grain mixtures compared were all-wheat, all-sorghum grain, equal parts wheat, corn and sorghum grain and combinations of 75:25 and 50:50 wheat and sorghum grain. There were no significant differences in total gain between lots. The lot receiving the three-grain mixture had the highest daily gain and gained more efficiently than the cattle fed all-sorghum grain but were less efficient than steers fed 3/4 wheat and 1/4 sorghum grain. With the exception of the steers fed the three-grain mixture, substitution of wheat for sorghum grain did not change rate of gain appreciably until all the sorghum grain was replaced by wheat. The steers fed all-wheat were the slowest gainers and required the largest amount of roughage per unit of gain. The steers fed high-wheat rations consumed the least total feed.

In Trial II, 60 head of yearling Hereford heifers were placed on a full feed of grain, alfalfa hay, prairie hay and supplement. With the exception of the three-grain mixture, the grain composition differed from the first trial

in that the grain substituted for sorghum grain was corn. The differences in average total gain for each lot was significant at the 10% level. Heifers fed all-sorghum grain were slowest to reach maximum consumption and gained significantly slower than the other lots. Heifers fed equal parts sorghum grain and corn produced the highest rate of gain.

The substitution of either corn or wheat for a part of the sorghum grain increased efficiency of gain. In the first trial, steers fed all-sorghum grain required 10.45 kg. of feed per kg. of gain while the steers fed 3/4 wheat and 1/4 sorghum grain and those fed equal parts wheat, corn and sorghum grain required 9.40 and 9.71 kg. feed per kg. gain respectively. When 3/4 sorghum grain was replaced by corn in the second trial, efficiency of gain was improved from 8.41 to 6.94 kg. feed per kg. gain.

In Trial I, steers fed the three-grain mixture produced the largest average rib-eye area (82.91 sq. cm.) and were similar to the steers fed 3/4 sorghum grain and 1/4 wheat in having the most fat over the twelfth rib. The smallest average rib-eye area was 75.62 sq. cm. produced by the lot fed equal parts wheat and sorghum grain. These differences were not significant. However, the lot fed 3/4 wheat and 1/4 sorghum grain had a significantly ($P < .05$) lower dressing percentage (59.26%) than all other lots. The lot which received the three-grain mixture dressed 62.27% for the high.

Differences in all carcass characteristics except yield grade were not significant within the second trial. The heifers fed 3/4 corn and 1/4 sorghum grain dressed 62.5% for the high and had an average rib-eye area of 73.36 sq. cm. which was the largest of all lots. The lot fed all-sorghum grain had the lowest dressing percentage, 60.53%, and the smallest average rib-eye area, 68.0 sq. cm. The yield grade for the lot fed equal parts corn and sorghum grain was significantly ($P < .05$) greater than for all other lots except the one fed all corn.

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SINGLE AND MIXED CEREAL GRAINS FOR FINISHING BEEF CATTLE

by

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Genetic improvement of feeder cattle, improved feed lot management techniques and more adequate finishing rations have constantly improved gains. These improvements have stimulated further evaluation and comparison of grains and grain mixtures.

This work involved two trials designed to evaluate wheat, corn and sorghum grain when fed separately or in various combinations to beef cattle. These trials were part of a study to find ways of improving utilization of sorghum grain in cattle rations.

In the first trial, 66 Hereford steers were divided into 6 lots and fed a basal ration of sorghum silage, alfalfa hay and protein supplement and single or mixed grains. The grains or grain mixtures considered were wheat, sorghum grain, 75-25 combinations of wheat and sorghum grain, equal parts wheat and sorghum grain and equal parts wheat, sorghum grain and corn. No significant differences were found in total gain between lots. The highest average daily gain was produced by the steers fed the three-grain mixture and the least average daily gain by those fed all-sorghum grain. The all-sorghum grain lot was also the least efficient while the steers fed 75-25 wheat to sorghum grain were the most efficient. All lots produced carcasses in the choice or good grade. With the exception of dressing percentage, differences between lots in carcass merits were not

significant. The steers fed 3/4 wheat and 1/4 sorghum grain were significantly lower in dressing percentage.

In the second trial, 60 Hereford heifers were divided into 6 lots and fed alfalfa hay, prairie hay, protein supplement and grain. Grains or grain mixtures were sorghum grain, corn, 75-25 combinations of corn and sorghum grain, equal parts corn and sorghum grain and equal parts corn, sorghum grain and wheat. The lot fed all-sorghum grain produced the lowest average daily gain, significant at the 10% level, and was the least efficient. The heifers fed equal parts corn and sorghum grain had the highest average daily gain. The most efficient gainers were those that received 75:25 corn to sorghum grain. Differences in carcasses produced between lots were not significant.

In both trials, wheat or corn improved gain and efficiency slightly when substituted in part for sorghum grain.