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The Use and Value of Wheat In Beef Cattle Feeding

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Since wheat is used predominantly for human food, there is not as much information about feeding wheat to beef cattle as has been accumulated about other grains. However, the failure of domestic usage and export demand to keep pace with expanded production potential (29) has stimulated interest in feeding wheat to livestock. Even though this seems a logical outlet for wheat when prices are low, feed usage has not been greatly increased. Probably this is due to several factors. Orderly marketing channels for feed wheat are absent because of low levels of "free" wheat not under government loan and because wheat has a greater tendency to move into terminal storage than other grains. There is some reluctance to consider wheat as a feed grain rather than human food (for ethical reasons as well as possible changes in federal agricultural programs). Uncertainty as to proper management of wheat in beef cattle rations probably decreases its usage. The depressed intake of wheat-containing rations, even though associated with increased efficiency, can be disconcerting to the cattle feeder. It is difficult to assign a definite relative value to wheat to determine if it is competitively priced. Wheat does not seem to respond to the various heat treatments that are readily available for processing other grains.

When an oversupply of wheat caused it to be priced competitively with other feed grains, interest in feeding wheat has brought spurts of wheat-feeding research. These efforts have become more intense in recent years. The purpose of this paper is to briefly review and' attempt to amalgamate the results of these experiments.

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Table 1. Relative Performance of Wheat and Other Feed Grains—Summary of 87 Comparisons.

Control grain	Average daily gain, %		Average air-dry intake, %		Pounds concentrate replaced by 1 pound wheat		Number of comparisons	
	Wheat alone	Wheat mixed	Wheat alone	Wheat mixed	Wheat alone	Wheat mixed	Wheat alone	Wheat mixed
Corn	97	102	91	96	1.09	1.17	30	12
Milo	90	96	84	90	1.15	1.22	4	9
Barley	98	98	92	97	1.10	1.04	18	11
Rye	104	---	98	---	1.06	---	3	---

References:

Control grain	*Wheat alone*	*Wheat mixed*
Corn	1, 3, 4, 5, 23, 24, 39, 40, 41, 59, 64, 66, 67, 72	1, 4, 66, 72
Milo	9, 10, 39, 61	6, 9, 10, 12, 61
Barley	21, 28, 39, 41, 42, 55, 57 58 59, 71	21, 28, 42, 55, 59, 71
Rye	2	

Most experimental trials with wheat have been comparisons with other grains to define the relative value of wheat for feeding beef cattle. A summary of 87 such comparisons is shown in Table 1. These were conducted prior to 1966, involved rations relatively high in fiber content, and are detailed in a Kansas review bulletin (6). The list includes all comparisons that could be located in the literature up to that time except a few that were excluded because the wheat was not ground (34, 35, 62, 65, 68, 70) or there seemed to be flaws in the experimental design (44, 45, 53, 56). The data were standardized by adjusting average gains for differences in dressing precent, relating intake on an air-dry basis, and reducing relative feed efficiency to a common denominator by citing the pounds concentrate replaced by substituting 1 pound wheat into the ration. Approximate concentrate equivalents of other ration ingredients were estimated from net energy values (48). However, the relative values of wheat presented in Table 1 would also include nutritional effects other than net energy.

Wheat has been compared with corn more frequently than with other grains. As shown in Table 1 total consumption of wheat rations was 91% of corn rations and average daily gain was slightly reduced; however, wheat-containing rations were more efficient and an average of 1.09 pounds corn was replaced by each pound of wheat used. (Morrison (52) summarized nine comparisons and concluded wheat was worth 9% more than corn.) In only two of the 30 comparisons was more wheat than corn required per unit gain. The relative gain of wheat rations ranged from 80% to 108% of corn rations.

Most comparisons of wheat and barley have been made in the Northwest. In the 18 trials there was practically no difference in rates of gain for cattle fed barley or wheat. Cattle receiving wheat averaged 1.6 pounds less intake per day and were 10% more efficient than those fed barley (Table 1).

In three Nebraska trials (2) feed value of wheat was greater than rye (Table 1). Rye was definitely inferior to wheat in a Minnesota test (43) but this rye contained ergot. Indirect evidence (46) suggests wheat and triticale are about equal in feeding value.

The most consistent observation in comparisons of wheat with other grains is the reduced intake with wheat. In only three of the 55 comparisons (Table 1) did cattle eat more when fed wheat alone and in those instances the difference was negligible. This was especially apparent in comparisons of wheat and milo (Tables 2, 3 and 4). When wheat alone was fed, the 16% average reduction in intake was enough to depress rate of gain 10%, although wheat rations were more efficient. However, by limiting wheat to 50 percent of the grain in the ration, feed intake was maintained at more satisfactory levels and rate of gain was not depressed.

Table 2. Comparison of 50% Wheat and 100% Wheat in Steer Fattening Rations (Summary of 2 Fort Hays Trials—9, 10).

Treatment	Milo	50% Milo & 50% Wheat	Wheat
Average intake, lb.	35.8	32.0	29.3
Average daily gain, lb.	3.12	3.10	2.88
Average feed efficiency			
Average feed efficiency (Lb. feed/cwt gain)	1146.	1034.	1018.
Lb. milo replaced by 1 lb. wheat		1.32	1.20

Table 3. Graded Levels of Wheat in Steer Fattening Rations (61).

Treatment					
Milo, %	100.	75.	50.	25.	-----
Wheat, %	-----	25.	50.	75.	100.
Average intake, lb.	24.4	24.2	22.7	20.7	21.0
Average daily gain, lb.	2.83	2.85	2.72	2.60	2.62
Average feed efficiency	863.	848.	835.	792.	801.
Lb. milo replaced by 1 lb. wheat	-----	1.09	1.11	1.20	1.13

Table 4. Comparison of Sorghum Grain and a Mixture of Wheat and Sorghum Grain in High-Roughage (43 Percent) Fattening Rations. (Summary of 6 Fort Hays Trials—6, 9, 10, 12).

Treatment	Milo	50% Milo & 50% Wheat
Average intake, lb.	29.5	26.6
Average daily gain, lb.	2.77	2.70
Average feed efficiency	1065.	985.
Lb. milo replaced by 1 lb. wheat		1.24

When wheat is mixed with other grains and fed in limited amounts, it improves feed efficiency proportionately more (Table 1) than when fed alone. This seems especially true of corn-wheat and milo-wheat combinations, and recent data from California (27) (not included in Table 1) shows a mixture of barley and wheat to stimulate gain compared to either grain fed alone.

Attempts to improve palatability by using high levels of silage (1, 5, 22, 59, 66, 67, 72) or adding molasses (1, 25, 60, 64) have been unfruitful. Adding 4% fat to wheat rations has improved performance (19, 58) but appears to involve other factors than intake. In an Idaho study (19) the response to fat was greater when added to a ration containing 70% rather than 50%.

Palatability does not seem to be as much a problem with softer wheats used in California and the Pacific Northwest. In a Washington test (28) Gaines, a soft white winter wheat, was more readily consumed and produced better performance than Burt, a hard red winter (both

are weak gluten wheats) (Table 5). Soft wheats have been satisfactorily used as the only grain in high-concentrate and all-concentrate rations (19, 21, 27, 32, 33, 37, 47, 54, 57, 58, 59). Nearly all reports of digestive upset and difficulty in keeping cattle on feed have come from the hard wheat areas (3, 9, 10, 70, 73, 74). Recent Nebraska studies (75) indicate lactic acid production, a factor in rumen acidosis, may be higher with hard than soft wheats.

Table 5. Gaines vs. Burt Wheat (28).

Treatment	Gaines	Burt
Average intake, lb.	23.4	21.8
Average daily gain, lb.	2.89	2.51
Average feed efficiency	810.	870.

Table 6. Golden-50 vs. Red Chief Wheat (16).

Treatment	Milo	Golden-50	Red Chief
Average intake, lb.	25.7	26.3	25.5
Average daily gain, lb.	2.77	3.20	2.93
Average feed efficiency	925.	820.	873.

Factors other than kernel softness may cause differences in feeding value among types and varieties of wheat. Lambs in a Washington study (36) grew faster and more efficiently when fed Baart, a hard white spring, than Turkey, a hard red winter, or Jenkins, a soft white winter. At the Hays station performance on Golden-50 was superior to Red Chief wheat (Table 6). Both are hard red winter wheats although the Golden-50 was superior to Red Chief wheat (Table 6). Both are hard red winter wheats although the Golden-50 used was much softer than the Red Chief. On the other hand, the former is also a stronger gluten wheat though crude protein content was the same. When fed to sheep, nitrogen retention was greater with Golden-50. Ration dry matter digestibility was significantly increased when Golden-50 was compared with Gaines, a soft white winter (preliminary data from our laboratory). In this study wheat comprised 18% of a high-roughage ration. A general observation of the accumulated data suggests that soft wheats may not improve efficiency of gains as much as wheats of the Great Plains; however, this observation may be confounded by differences in overall management such as ration crude fiber content.

In 1958 the National Research Council (49) published a compilation of feedstuff analyses that listed the average crude protein content of 1663 samples of wheat as 12.5% (87.5% dry matter). These samples represented the several wheat-growing sections of the United States and the various types of wheat. The same publication reported that 1873 samples of corn contained 9% protein, 1400 samples barley, 11.5%, and 1160 samples milo, 11%. A more recent survey (50) reflects the reduction in crude protein content (to 9%) of milo since the advent of irrigation and hybrids. While similar changes in wheat production may decrease its average crude protein content and while advances in ruminant nutrition may create greater reliance on cheaper non-protein-nitrogen sources, savings can often be effected by reducing supplemental protein when wheat is a ration ingredient. Several feeding trials (1, 10, 12, 13, 67) prove that wheat protein is well utilized by cattle (Table 7). When wheat is used in feed formulations, protein values calculated by the milling industry (N times 5.7) should be adjusted to values comparable to other feedstuffs (N times 6.25). Adding low levels of wheat seemed to improve both urea and biuret utilization in high-silage growing rations (Table 8).

Table 7. Effect of Omitting Supplemental Protein in Wheat Containing Fattening Rations. (Summary of 3 Fort Hays Trials—10, 12, 13).

Treatment	50% Milo & 50% Wheat	50% Milo 50% Wheat 1½ lb. cottonseed meal
Average intake, lb.	25.8	25.9
Average daily gain, lb.	2.63	2.67
Average feed efficiency	973.	963.

Table 8. Effect of Substituting Wheat for Milo on Utilization of Urea or Biuret in High-Roughage Rations (17).

Nitrogen source	Biuret		Urea		CSM	
Grain	Milo	Wheat	Milo	Wheat	Milo	Wheat
Average intake, lb.	17.3	17.7	17.4	17.6	18.1	18.4
Average daily gain, lb.	1.53	1.81	1.61	1.80	1.84	1.98
Average feed efficiency	1132.	979.	1078.	979.	987.	927.
Percent change when wheat replaced milo:						
Average daily gain		+18%		+11%		+8%
Average feed per unit gain		—14%		— 9%		—6%

Wheat does not appear to respond to heat processing (20, 32, 33). California workers (Table 9) found that popping and steam pressure processing slightly increased dry matter digestibility but did not improve feedlot performance. Arizona workers (38) reported that a thin flake broke down during mixing and resulted in reduced intake. They recommended steam treated wheat be rolled more thickly than milo. In a Texas study (20) neither steam flaked nor micronized flaked processing

Table 9. Effect of Steam Pressure Processing and Popping on Wheat. (32).

Processing Treatment	Popped	1.5 min. 50 psi	1.5 min. 80 psi	8 min. ap
Average intake, lb.	15.0	14.3	14.3	15.8
Average daily gain, lb.	2.79	2.56	2.59	2.83
Average feed efficiency	536.	562.	556.	560.
Energy efficiency (kcal feed per 100 kcal gain-assuming 4 kcal/gm feed)	465.	502.	510.	439.
DM digestibility, %	78.3	78.3	79.3	76.1

methods improved wheat digestibility over dry rolling. Pelleting wheat was unsatisfactory for us (10) but seemed advantageous in a Washington test (18). Steam rolled wheat (not flaked) has the same feed value as dry rolled wheat (1, 18, 60). Likewise there has been little difference between rolled wheat and ground wheat (2, 23, 24) although differences in particle size were not described in those tests. Research at Hays has shown no response from feeding reconstituted and ensiled wheat or to ensiling 10% wheat with forage sorghum; however, the results are inconclusive (15 and unpublished data). Sheep may do better on whole wheat (22, 36, 73); and in a Missouri test (70), although efficiency of gain was 7% less, cattle made faster gains on whole wheat (2.28 versus 1.73 pounds per day). However, recent experiences with feeding whole wheat have been so unsatisfactory the tests were not completed. One would have to conclude, until convinced otherwise, that coarse rolling is the most efficient and satisfactory method of preparing wheat for cattle.

Damaged wheat is often available for feeding but few feeding experiments have been conducted with it. Results of such tests would be applicable only to wheat similar to that studied. In a North Dakota test (63) steers fed rejected wheat gained only half as much as those fed corn meal. The authors did not specify the exact condition of the wheat. In a Montana study (71) frosted wheat appeared to be a satisfactory feed, but two-year-old Marquis wheat, which was hard and flinty, was less palatable. Idaho workers (31) substituted low-test-weight, sprouted wheat for normal wheat without affecting performance.

There has been no difference in carcass quality caused by including wheat in the fattening ration except when wheat-fed cattle gained significantly less because hard wheat was fed by itself (10, 12, 39, 40). Differences between wheat-fed and other cattle in marbling score, rib-eye area, backfat thickness, and fat color have been either small and inconsistent or non-existent (1, 19, 32, 38, 51, 54, 61, 69 and personal observation). However, the incidence of abcessed livers has often been increased when wheat was fed (1, 51, 54). On the other hand, urinary calculi may occur less frequently when wheat is substituted for milo (69).

Table 10. Fifty Percent Wheat in All-Concentrate Rations. (Summary of 5 Fort Hays Trials—14, 30).

Treatment	Milo	50% Milo & 50% Wheat
Average intake, lb.	23.2	20.8
Average daily gain, lb.	2.70	2.44
Average feed efficiency	862.	855.
Lb. milo replaced by 1 lb. wheat		1.01

Table 11. Use of Wheat in High-Silage Growing Rations. (Summary of 4 Fort Hays Trials—7, 8, 10, 11).

Treatment	1.9 lb. milo 4.0 lb. alfalfa silage, ad lib	4.0 lb. milo 4.0 lb. alfalfa silage, ad lib	1.9 lb. wheat 4.0 lb. alfalfa silage, ad lib
Average intake, lb.	16.0	17.3	16.5
Average daily gain, lb.	1.18	1.43	1.39
Average feed efficiency	1378.	1222.	1198.

In recent years there has been a trend to reduce roughage in fattening rations to a bare minimum. In five comparisons at Hays (Table 10), substituting 50% wheat for milo in all-concentrate rations has resulted in significantly reduced gain and no improvement in feed efficiency. Similar results were obtained by the Beltsville workers (54).

Wheat has shown the largest advantage in high-silage wintering rations (7, 8, 10, 11, 17, 26). In 4 of our tests an average of 1.68 pounds milo was replaced by 1 pound wheat (Table 11). There appears to be a relationship of relative value of wheat and percent roughage in ration. Wheat appears most valuable in high-roughage rations. The 30 Kansas comparisons of wheat and milo are plotted in Figure 1 with percent roughage in the ration on the abscissa and pounds milo replaced by 100 pounds wheat as the ordinate. The two variables have a high degree of correlation ($r = .71 - p < .01$) and a steep regression ($b = .76$). The regression line crosses ordinate at 95%. When 7% roughage is fed, rolled wheat and rolled milo seem equivalent.

This regression may partially explain why wheat has been nearly equal to other grains in recent comparison (27, 37, 38, 42, 47, 54, 59, 69), all of which involved high-concentrate diets, while earlier comparisons (6) indicated that wheat was superior to other grains. It tends to substantiate the findings of Bris and Dyer (18) that fiber levels in wheat rations may be critical and should be above 6%. Crude fiber levels may have been too low for optimal wheat performance in some of the above comparisons. Furthermore, this regression predicts the results of two large tests using over 3200 cattle conducted at a commercial feedlot (51). In these tests 20% to 35% wheat was substituted for corn in a fattening ration containing about 15% roughage. At this level of roughage the

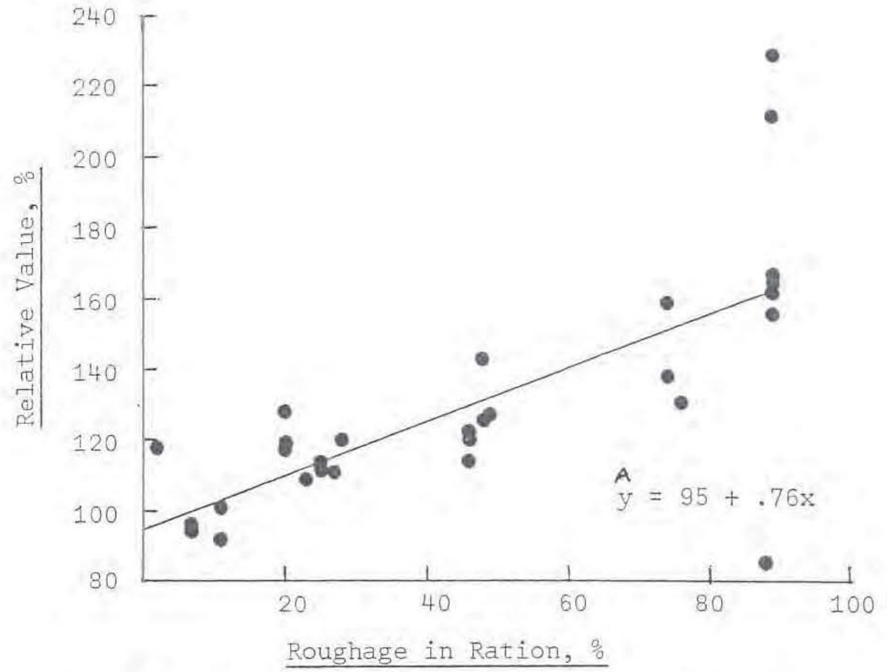

Figure 1. Regression of relative value of wheat to milo on percent roughage in ration based on 30 Kansas comparisons (6117, 30, 61).

regression in Figure 1 indicates one pound of wheat would be equivalent to 1.06 pounds milo. If corn is 8% superior to milo, nearly identical performance would be expected from substituting wheat for corn. Actual average daily gain of 1000 cattle fed cracked corn was 2.66 pounds and of 2200 cattle fed 20% to 35% cracked wheat was 2.65 pounds. Average feed required for 100 pounds gain was 786 and 792 pounds, respectively.

Summary

The relative feeding value of wheat to other grains is affected by processing methods used, type and variety of wheat available, and the conditions under which it is to be fed. It is impossible to assign a fixed relative value applicable to all situations. In typical high-concentrate fattening rations, it appears that wheat has been about equal, pound for pound, to corn, barley, or steam flaked milo. In high-roughage growing rations wheat may be worth considerable more than other feed grains.

Because of its potential to cause rumen acidosis, wheat requires more management than other feed grains. Best results are achieved when it is fed mixed with another grain. Possibly, roughage levels should be in-

creased slightly when wheat is added to fattening rations. To obtain maximum value from wheat, the extra protein content should be considered when rations are formulated. The evidence suggests coarse rolling is the best preparation, but more research in processing wheat is warranted. Type and varietial differences apparently affect feed value so there may be an opportunity to develop improved wheats for beef cattle feeding.

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Comparative Net Energy Values of Rations Containing Wheat and Other Grains for Beef Cattle

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Introduction

Historically wheat has not been used extensively as a feed for beef cattle in comparison to other grains such as corn, barley, and sorghum grains. This is partially responsible for the almost complete lack of information on the net energy (NE) value of wheat. Morrison (1956) lists an estimated net energy for maintenance plus production (NEm+p) of 80 megcal. per 100 lb. The comparable values for corn (dent. No. 2), barley and milo are 80.1, 70.5, and 77.8. Morrison states that in the hands of an experienced feeder wheat may be fully equal to corn in value although no direct NE comparisons are reported. Brethour (1966) presents an excellent review of results of trials in which wheat has been compared to other grains for beef cattle. He has calculated the amount of grain replaced by one pound of wheat by converting other feeds to a grain equivalent. Although these replacement values will vary depending on the factors used to convert non-grain ingredients to the grain equivalent, his comparisons are of interest. In these tests one pound of wheat replaced the equivalent of 1.10 pounds of barley, 1.09 pounds of corn, 1.06 pounds of rye, and 1.15 pounds of sorghum grain. With wheat as 100 the other grains would, therefore, have relative values of 91, 92, 94, and 87 for barley, corn, rye, and sorghum grain, respectively. Although NE was not determined in any of these trials, the comparisons certainly demonstate wheat is a very good energy source for beef cattle.

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