5-1-1930

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BULLETIN NO. 252 MAY, 1930

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VALUE OF GRINDING FEED FOR LIVESTOCK

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INTRODUCTION

This experiment was conducted in cooperation with the departments of Agricultural Engineering, Animal Husbandry and Dairy Husbandry of South Dakota State College. The department of Agricultural Engineering ground the grains and roughages with a burr grinder. For power a tractor was used, such as is found on any farm where grinding is practiced. The departments of Animal Husbandry and Dairy Husbandry fed these ground grains and roughages to livestock of the different kinds.

There has been for some time, and there is today a demand for information along these lines because some farmers who have purchased tractors to assist with the farm work are eager to utilize this machinery to the best advantage during the idle period. Naturally, the question of grinding all the roughages and grains grown on the farm before feeding to all kinds of livestock is suggested.

This experiment did not include all of the grains and roughages but only some of those that are more commonly grown in the state. We know there are feeds that would be more palatable for some livestock if ground than unground. Palatability is an important factor in all feeding operations.

The practice of mixing ground grains and roughages at the time of grinding has been advocated by some; because of this we fed the ground feeds mixed, as well as in separate troughs, to learn whether there was any great advantage in feeding in this manner. Therefore, this bulletin not only includes the advantages and disadvantages of feeding ground grains and ground roughages, as such, in separate troughs but the advantages and disadvantages of feeding the ground feeds mixed.

There are more mixed feeds for sale at the present time than ever before. In some cases feeds are mixed while being ground, but in our mixing we aimed to mix the same quantity of each as animals were consuming when the ground feeds were fed in separate troughs. It required time to mix these feeds daily but in figuring the cost of producing 100 pounds of gain we have not included anything for this chore.

THE OBJECT

The object of this investigation is to furnish reliable information to feeders of livestock in South Dakota.

1. Does it pay to grind feed for all kinds of livestock?

2. Does the mixing of ground grains and ground roughages save grain?

To answer these questions we have included the results of the cost of grinding, the results of feeding this ground material for the production of beef, pork, mutton and milk. In some instances we have included the individual gains to show how some animals respond when fed different feeds.

For convenience the results are reported in three different parts as follows:

Part I. By the department of Agricultural Engineering. This department had charge of ascertaining the actual cost of grinding grains and roughages under farm conditions. This cost of grinding was used in figuring all our cost of producing 100 pounds of gain with the different lots of animals.

Part II. The Department of Animal Husbandry has charge of feeding the whole and the ground roughages to cattle, sheep and swine, and also the mixed ground feeds.

Part III. The department of Dairy Husbandry fed the whole and ground roughages with ground grain to dairy cows. The digestiblity of the feeds was also determined by this department.

PART I

THE COST OF GRINDING GRAINS AND ROUGHAGES

RALPH L. PATTY*

In this experimental work to determine the practicability of grinding various feeds for livestock, the Agricultural Engineering department had charge of the machinery operation. The purpose of this part of the experimental work was to get accurate figures on the cost of grinding the different feeds.

The practicability of grinding feeds for feeding livestock has been studied by the Animal Husbandry and Dairy departments of the college with which we have cooperated in the experiment.

A 2-cylinder 15-27 horse power tractor was used for power for grinding, and a grinder of good capacity was used. This was a combination mill, commonly called a re-cutter, equipped with spiral knives and 12 inch burrs. The machine will cut roughage and grind grain at the same time, mixing the two feeds if desired. In this experimental work only one kind of feed was ground at a time.

The study extended over a period of three feeding seasons, 1927, 1928, and 1929. The first year only three feeds were ground, alfalfa hay, sweet clover hay, and barley (grain). All hay used in the test was loose, unbaled hay. The second year alfalfa hay, corn stover (fodder from which the corn had been husked), corn husks alone, and shelled corn was ground. The third year alfalfa hay, prairie hay, corn stover, ear corn, and oats were ground. The feeds were ground under average conditions so far as moisture is concerned. No artificial drying of the feeds was made. When grinding dry hay a considerable amount of dust made it unpleasant for the operators.

Accurate records were kept on the cost of operating the tractor and grinder throughout the test. Accurate records were also kept of the cost of labor used in grinding. In 1927 gasoline cost 21 cents per gallon, in 1928 it cost 18 cents per gallon, and in 1929 it cost 18 cents per gallon. In 1927 oil cost 45 cents per gallon, in 1928 it cost 80 cents per gallon, and in 1929 it cost 60 cents per gallon. Labor used in grinding cost 35 cents per hour. The figures were not modified to average conditions but are given as they were. They were taken each year by a different operator, a senior student, under the supervision of the instructor in the courses "Farm Machinery" and "Farm Power." Their figures on depreciation and repairs for the tractor and grinder vary slightly according to their judgment as to the number of days' work which should be credited to the machine. All of them, however, used the same authority for figuring this depreciation and repair charge. It was Farmers' Bulletin No. 1297 on "The Cost of Operating Tractors in the Corn Belt States."

*Acknowledgment for services rendered by J. F. Goss, D. E. Wiant, Henry DeLong, Jerald Kotas and Fred Kaiser in determining the costs of grinding is hereby made.

As shown in the following table, the average cost of grinding alfalfa hay for the three seasons was 13.61c per hundred, sweet clover (ground in 1927) 23.9c per hundred, corn stover 9.07c per hundred, prairie hay 8.31c per hundred, corn husks 7.89c per hundred, ear corn 3.71c per hundred, shelled corn 2.64c per hundred, oats 3.2c per hundred and barley 7.3c per hundred.

Table No. I

COST OF GRINDING 100 POUNDS OF FEED WITH COMBINATION MILL, INCLUDING COST OF FUEL, OIL, LABOR AND USE OF MACHINERY

Kind of feed	Year ground	Cost of Grinding for year—per 100 pounds	Number of lbs. ground	Average or final cost per 100 pounds	Average cost per ton
Alfalfa	1927	*26.13 cents	12,016		
Alfalfa	1928	7.15 cents	18,419		
Alfalfa	1929	7.56 cents	10,767	13.61 cents	$2.72
Sweet Clover ...	1927	*23.9 cents	4,628	23.9 cents	$4.78
Corn Stover ...	1928	8.26 cents	7,283		
Corn Stover ...	1929	9.96 cents	5,576	9.07 cents	$1.81
Corn Husks	1928	7.89 cents	1,454	7.89 cents	$1.58
Prairie Hay	1929	8.3 cents	928	8.3 cents	$1.66
Ear Corn	1929	3.71 cents	7,342	3.71 cents	$0.74
Shelled Corn ...	1928	2.64 cents	28,470	2.64 cents	$0.59
Oats	1929	3.21 cents	1,918	3.21 cents	$0.64
Barley	1927	* 7.3 cents	26,057	7.3 cents	$1.46

*The figures for 1927 were unusually high because of the inability of the operators to feed the grinder to capacity. The capacity was greatly increased after the first year. A slight improvement was also made in the grinder by the manufacturer after the first year.

Cost Figures From Other Stations

Work carried on at the Minnesota Experiment Station gave an average cost figure of $2.48 per ton for grinding alfalfa hay and $1.96 per ton for grinding bundle corn fodder. The same make and size of grinder was used as that used in this work and the same make and size of tractor. At that station the average cost of grinding dry alfalfa hay was $1.93 and for wet alfalfa hay was $3.03, or an average of $2.48 per ton as given above.

At the Indiana Experiment Station at Lafayette, Indiana, cost figures were obtained for grinding alfalfa hay with the same grinder but with a five horsepower electric motor. The average cost figure found at that station was $2.67 per ton.

In figuring the average cost of grinding alfalfa hay for the three years the amount of alfalfa ground each year, at that particular cost figure for that year, was used in figuring the average cost and arriving at the average cost figure of 13.61 cents per hundred.

In obtaining the cost of grinding feed there is an opportunity for a wide variation. This is due to several factors. The most important one is the capacity or speed that is obtained in the grinding. With roughage this is very likely to depend quite largely upon the rate of feeding the grinder. Other factors that vary the result figures materially are the condition of the feed, and the figuring of the interest, depreciation and repairs on the machines. The interest and depreciation figure would be enormous if a $350 grinder, for instance, were bought and only used five or six days during the year, while if the same grinder were used 30 or 40 days during the year the cost per hundred pounds due to interest, depreciation and repairs would be much smaller. The average figure for interest, depreciation and repairs, as figured by the operators in this test, was probably slightly lower than the actual average under farm conditions. This item would not affect the cost figures for the farm tractor so much, as it is used for other farm work and the average number of days' work that is done by the farm tractor in this section was used in obtaining the interest, depreciation and repair item for the tractor used.

Following is a sample data sheet as used in the test for finding the actual operating costs of grinding. This includes the cost of fuel, lubricating oil and man labor. The cost is figured for 100 pounds.

Column No. 1 records the date of the grinding; column No. 2 gives the number of the test; column No. 3 records the kind of feed ground; column No. 4 gives the amount of feed ground for that run. The time for each run is recorded in column No. 5, while the speed of the grinder and of the motor are given in columns Nos. 6 and 7, respectively. These speeds were taken at least three times during each test and the average speed for each test was recorded. The amount of fuel (gasoline) and lubricating oil was recorded in columns Nos. 8 and 9, respectively. In figuring the man labor for doing this grinding the time of the official who was taking the records was not charged against the cost of the grinding except when he was actually helping with the grinding. Two men will usually be able to operate this grinding outfit after the motor is warmed up and operating smoothly, although constant attendance of the tractor by the tractor operator would be preferable. The ground feed is elevated directly into the bin or hay loft under farm conditions and will not usually require an extra full-time man to handle it. He will have time to help around the machine at other work. Column No. 11 gives the amount of fuel used in the tractor for each 100 pounds of feed ground. Gasoline was used for fuel and the price made to local farmers for tractor use was figured. Column No. 12 gives the amount of time required for each 100 pounds of feed ground. This figure is of course necessary in figuring the labor charge against the grinding. The last column shows the cost per 100 pounds of feed ground. This is not the total cost, however. It is the cost of fuel, oil and labor only. To this must be added the depreciation and interest on the tractor, the depreciation and interest on the grinder and the proportional part of the repair charges against both machines.

Table No. II

COST OF FUEL, OIL AND LABOR FOR GRINDING FEEDS WITH COMBINATION MILL. COST PER 100 POUNDS

1	2	3	4	5	6	7	8	9	10	11	12	13
Date	Test No.	Kind of feed	Weight ground lbs.	Time grinding	Speed of grinder	Speed of motor	Fuel used gal.	Oil used gal.	Man labor	Gal. fuel per 100 lbs.	Hours per 100 lbs.	Cost per 100 lbs.
1927				Hr.-Min.								
Dec. 29	5	Alfalfa	1168	25	803	860	1.2	.128	2	.103	.0593	.07
1928												
Jan. 2	6	"	1362	1–	621	787	2.25	.333	2	.165	.0741	.10
Jan. 21	10	"	1290	44	880	940	2.	.242	2	.155	.0568	.08
Jan. 25	11	"	2283	1–13	845	910	3.5	.402	1	.153	.0525	.06
Feb. 1	13	"	1861	53	875	940	2.8	.292	1	.111	.0450	.06
Feb. 22	15	"	1176	30	830	910	1.25	.165	2	.106	.0425	.06
Feb. 22	17	"	853	19	830	910	.8	.105	2	.093	.0370	.05
Feb. 25	18	"	1983	46	855	935	1.8	.253	2	.090	.0390	.05
March 3	21	"	1406	32	815	890	1 25	.176	2	.081	.0380	.05
March 3	22	"	1073	23	865	930	1.3	.127	2	.121	.0340	.06
March 10	24	"	2124	1–28	815	890	3.7	.484	1	.174	.0691	.07
March 31	32	"	1001	36	807	855	1.5	.195	2	.149	.0590	.08
April 14	34	"	1035	50	910	975	1.5	.265	1	.141	.006	.07
Average												.0615
1927		Corn										
Dec. 29	1	Stover	797	40	770	810	1.5	.220	2	.192	.0830	.11
Dec. 29	2	"	2538	1–14	756	856	3.5	.407	2	.137	.0483	.07
Dec. 29	3	"	414	13	855	890	.5	.064	2	.120	.0533	.07
1928												
Feb. 25	19	"	490	15	855	935	.7	.083	1	.143	.0510	.06
March 3	20	"	1573	53	810	892	2.0	.290	1	.127	.0550	.07
March 21	26	"	1531	41	810	890	1.5	.225	1	.098	.0446	.05
Average												.0716

Note: This data sheet was taken from the second year's run. Record by Kotas.

Following is the data sheet showing the method used for finding the final or total cost of grinding per 100 pounds. The table shows the figures for alfalfa—the average for the three years. For the total cost figures for other feeds, see Table I. The cost figure shown in the last column of this table, then, is the total cost figure.

Table No. III

SAMPLE DATA SHEET SHOWING ALL ITEMS USED IN FIGURING FINAL COST FIGURES FOR GRINDING FEED WITH COMBINATION MILL PER 100 POUNDS

Kind of feed	Labor, fuel, lubricating oil	Depreciation on tractor	Depreciation on grinder	Interest on both machines	Average repair charge	Total cost per 100 lbs.	Total cost per ton
Alfalfa	$.1057	$.018	$.00455	$.00432	$.00356	$.13613	$2.72
	(For other total cost figures see Table I)						

Note. The cost for all feeds was figured in this same manner.

PART II

THE VALUE OF FEEDING GROUND GRAINS AND GROUND ALFALFA HAY TO CATTLE, SHEEP AND SWINE

JAMES W. WILSON AND TURNER WRIGHT

BEEF CATTLE

Two different lots of cattle were used during the two years. For the 1927 test, fifteen head of two-year-old steers that averaged 792 pounds were divided into three different lots of five head each. For the 1928 test 30 head of choice Black Hills grade Hereford calves that averaged 372 pounds were divided into three lots of ten head each. Barley and alfalfa hay were used for the 1927 test and corn and alfalfa hay for the 1928 test.

The 1927 Test—Fattening Two-Year-Old Steers

The five steers in lot No. 1 received whole barley and whole alfalfa hay for a period of 30 days. For the second 31 days these steers received ground barley and ground alfalfa hay fed in separate troughs, and for the third period of 29 days they received ground barley and ground alfalfa hay mixed. The feeds were mixed before feeding and not while grinding. An effort was made to mix the feed in the same proportion as steers were eating in lot that received the ground grain and the ground hay fed in separate troughs. One steer died after being changed to the ration of whole barley and whole alfalfa hay.

The following tables, numbered I, II and III, include the number of the steer, the weight at beginning, the weight at the close, the total gain per head and the average gain per head daily for each ration fed and for the three different periods. We present the results in this manner so individual animals can be traced for the 90 days. It will be noted that different lots of cattle received different feeds for each period of the experiment.

Table No. I

WEIGHTS AND GAINS—WHOLE BARLEY AND WHOLE ALFALFA HAY

First 30 Days

No. of Steer	January 12th	February 11th	Gain	Gain per head daily
6	882	936	54	1.80
17	840	920	80	2.66
30	801	896	95	3.16
23	794	838	44	1.46
16	634	720	86	2.86
	3951	4310	359	2.39

Second 31 Days

No. of Steer	February 11th	March 14th	Gain	Gain per head daily
28	964	1070	106	3.41
24	814	860	46	1.48
26	874	984	110	3.54
14	848	918	70	2.25
	3500	3832	332	2.67

Third 29 Days

No. of Steer	March 14th	April 12th	Gain	Gain per head daily
39	734	826	92	3.17
29	1018	1036	18	.62
33	1030	1070	40	1.37
25	922	1000	78	2 68
45	870	930	60	2.06
	4574	4862	288	1.98

The 14 steers, during the 90 days' feeding period, while receiving the whole barley and the whole alfalfa hay, made a total gain of 979 pounds. These gains varied from .62 to 3.41 pounds per head daily, as can be seen in above table. The smallest gains were made during the third period, as would be expected.

There is a difference in the gaining ability of cattle while receiving the same kind of feed and under the same conditions. Of the many steers that have been weighed individually in experiments at this station the largest gainer was in a lot of steers that received ear corn and alfalfa hay. This gain was 3.74 pounds per day for a feeding period of 118 days.

Table No. II

WEIGHTS AND GAINS—GROUND BARLEY AND GROUND ALFALFA FED IN SEPARATE TROUGHS

First 30 Days

No. of Steer	January 12th	February 11th	Gain	Gain per head daily
39	597	710	113	3.76
29	868	926	58	1.93
33	909	964	55	1.83
25	771	866	95	3.16
45	765	830	65	2.16
	3910	4296	386	2.57

Second 31 Days

No. of Steer	February 11th	March 14th	Gain	Gain per head daily
6	936	1038	102	3.29
17	920	982	62	2.00
30	896	946	50	1.61
23	838	914	76	2.45
16	720	764	44	1.41
	4310	4644	334	2.15

Third 29 Days

No. of Steer	March 14th	April 12th	Gain	Gain per head daily
28	1070	1108	38	1.31
24	860	918	58	2.00
26	984	988	4	.13
14	918	930	12	.41
	3832	3944	112	.96

The total gain for the 14 steers while receiving ground barley and ground alfalfa hay fed in separate troughs was 832 pounds or 147 pounds less than for the same steers when they received whole barley and whole alfalfa hay. (See Table I). There were more small gaining steers while they received all the ground feed they wanted than when they received the whole feeds. (See Tables I and II, above). During the last 29 days the gains were the smallest for the three lots.

Table No. III

WEIGHTS AND GAINS—GROUND BARLEY AND GROUND ALFALFA HAY MIXED

First 30 Days

No. of Steer	January 12th	February 11th	Gain	Gain per head daily
28	899	964	65	2.16
24	713	814	101	3.33
26	839	874	35	1.16
14	784	848	64	2.13
	3235	3500	265	2.20

Second 31 Days

No. of Steer	February 11th	March 14th	Gain	Gain per head daily
39	710	734	24	.77
29	926	1018	92	2.96
33	964	1030	66	2.12
25	866	922	56	1.80
45	830	870	40	1.29
	4296	4574	278	1.79

Third 29 Days

No. of Steer	March 14th	April 12th	Gain	Gain per head daily
6	1038	1050	12	.41
17	982	1008	26	.89
30	946	976	30	1.03
23	914	950	36	1.24
16	764	802	38	1.31
	4644	4786	142	.97

When these same cattle received the whole barley and whole alfalfa hay they returned a total gain of 979 pounds during the 90 days. When they received all they wanted of the ground barley and hay fed in separate troughs they made a gain of 832 pounds, and when they were forced to eat the ground feed mixed they made only 685 pounds, or 294 pounds less than when they were eating the natural feeds.

Results of this test shows that it was a disadvantage to mix the ground feeds as it required time to do it and gains were much smaller.

We are often asked how these mixed feeds compare in feeding value with the whole feeds for fattening livestock. Not knowing anything about the digestibility of the different ingredients the mixed feeds contain we are at a loss to furnish an intelligent reply.

Table No. IV

FEEDS, GAINS AND COST OF GAINS

Whole Barley and Whole Alfalfa Hay

	No. steer	Total barley	Total alfalfa hay	Gain	Barley for pound gain	Alfalfa for pound gain	Av. gain per head daily	Cost of pound gain	Pork lbs. produced
First 30 days...	5	2195	1062	359	6.11	2.95	2.39	$ 9.81	
Second 31 days.	4	2072	829	332	6.24	2.49	2.67	9.67	
Third 29 days..	5	2476	1041	288	8.59	3.61	1.98	13.45	115
419 steer days..	*	6743	2932	979	6.89	2.99	2.34	$ 9.92	

Ground Barley and Ground Alfalfa in Separate Troughs

	No. steer	Total barley	Total alfalfa hay	Gain	Barley for pound gain	Alfalfa for pound gain	Av. gain per head daily	Cost of pound gain	Pork lbs. produced
First 30 days..	5	1834	914	386	4.75	2.36	2.57	$ 8.38	
Second 31 days.	5	1983	871	334	5.93	2.60	2.15	10.14	
Third 29 days..	4	1578	793	112	14.08	7.08	.96	24.90	
421 steer days..		5395	2578	832	6.48	3.10	1.98	$11.32	

Ground Barley and Ground Alfalfa Fed Mixed

	No. steer	Total barley	Total alfalfa hay	Gain	Barley for pound gain	Alfalfa for pound gain	Av. gain per head daily	Cost of pound gain	Pork lbs. produced
First 30 days..	4	1492	810	265	5.63	3.05	2.20	$10.15	
Second 31 days.	5	2019	882	278	7.26	3.17	1.79	12.41	
Third 29 days..	5	2150	796	142	15.14	5.60	.97	25.00	
420 steer days..		5661	2488	685	8.26	3.63	1.63	$14.15	

*Without crediting pork produced by hogs, 100 pounds of gain would have cost $10.85.
Valuing barley at 60c a bushel or $1.25 a cwt.
Alfalfa hay at 15.00 per ton or 75c a cwt.
Grinding barley at .073 a cwt.
Grinding alfalfa at .1361 a cwt.

Table No. IV includes feeds, gains and costs of gains for the 14 head of cattle during the three periods. In the lots that received the whole feeds, 115 pounds of pork were produced. We put one pig in each of the other lots but at the end of 60 days it was found that neither pig had held its original weight so both were taken out.

From a study of the table it is noticeable that the steers did not do as well during the third period as they did for the first and second periods.

By mixing the ground feeds it did not save grain or ground hay for 100 pounds of gain.

The 1928 Test—Fattening Calves

For this test 30 head of high grade Hereford calves averaging 372 pounds at the beginning were divided into three lots of ten head each. To calves of lot I was fed shelled corn and whole alfalfa hay; to calves of lot II ground corn and ground alfalfa hay in separate troughs; to calves of lot III ground corn and ground alfalfa hay mixed. These rations were continued for the 91 days' feeding period, or the end of the experiment. About the time the calves were on full feed, one in the lot that was receiving ground corn and ground alfalfa hay fed in separate troughs died from bloat. Because of this one-tenth of the feed was deducted for this lot.

WEIGHTS AND GAINS

Shelled Corn and Alfalfa Hay

No. calf	Weight January 17	Weight April 17	Gain	Gain per head daily
1	497	722	225	2.47
37	364	604	240	2.63
46	279	488	209	2.29
50	423	631	208	2.28
35	428	623	195	2.14
39	326	552	226	2.48
36	328	585	257	2.82
43	307	490	183	2.01
41	416	608	192	2.11
45	318	492	174	1.91
	3686	5795	2109	2.31
Averages	368.6	579.5	210.9	

Ground Corn and Ground Alfalfa Hay in Separate Troughs

No. calf	Weight January 17	Weight April 17	Gain	Gain per head daily
32	370	616	246	2.70
38	310	550	240	2.63
2	404	596	192	2.11
27	334	596	262	2.87
34	382	597	215	2.36
4	330	548	218	2.39
29	381	620	239	2.62
31	290	488	198	2.17
26	506	738	232	2.54
	3307	5349	2042	2.49
Averages	367.4	594.3	226.8	

Ground Corn and Ground Alfalfa Hay Mixed

No. calf	Weight January 17	Weight April 17	Gain	Gain per head daily
19	486	722	236	2.59
24	312	513	201	2.20
25	398	614	216	2.37
21	348	561	213	2.34
22	378	595	217	2.38
20	344	546	202	2.22
16	472	696	224	2.46
17	400	618	218	2.39
15	352	548	196	2.15
12	276	502	226	2.48
	3766	5915	2149	2.36
Averages	376.6	591.5	214.9	

These 29 calves averaged 370 at the beginning and 588 pounds at the end of the experiment. They made an average gain per head of over 217 pounds in 91 days.

The records show that the calves receiving the ground corn and the ground alfalfa hay fed in separate troughs made the largest gains per head. This extra gain was sufficient to cause these calves to be rated by the numerous people who saw them, as the best of the three lots. They were filled out better and presented a smoother appearance than calves in the other two lots. A full load on the market would have brought a few cents more per pound, although none of these calves was finished baby beeves. To finish them would have required from 60 to 90 days additional feeding. The record shows that there was no advantage as far as gains are concerned in mixing the ground corn and ground alfalfa hay. In fact, there are more large gaining calves in the lot where the calf could eat all it wanted of the feed fed in separate troughs than when feeds were mixed.*

*See Table V.

Table No. VI

	Whole corn and whole alfalfa hay	Ground corn and ground alfalfa hay fed in separate troughs	Ground corn and ground alfalfa hay fed mixed
Average weight at beginning.....	368	366	376
Average final weight end 91 days..	579	594	591
Average gain per head daily.....	2.31	2.49	2.36
Average ration per head daily:			
Shelled corn	10.42		
Ground corn		10.34	10.42
Whole alfalfa hay.....	4.70		
Ground alfalfa hay.....		5.87	4.82
Feed required for 100 pounds gain:			
Shelled corn	449.97		
Ground corn		414.96	441.60
Whole alfalfa hay.....	197.91		
Ground alfalfa hay.....		235.65	204.46
Cost of feed for 100 pounds of gain	$ 8.23	$ 8.42	$ 8.55

Shelled corn at .015 a pound.
Alfalfa hay at .75 a hundred.
Grinding corn at .0264 a hundred.
Grinding alfalfa at .1361 a hundred.

The results of this test do not show that grain was saved by mixing the feeds. It required 26.64 pounds more of the ground corn for 100 pounds of gain when it was mixed with the ground alfalfa hay than it did when the ground corn and ground alfalfa hay were fed in separate troughs.

Both lots receiving the ground feeds made more rapid gains, consumed less grain than the lot that received the whole feeds, but the cost of making the gains is larger in each case.

SHEEP

1927 Test—Fattening Lambs

On January 8, 1927, 30 head of lambs were divided into three lots of ten head each for the experiment. To lambs in lot No. I were fed whole barley and whole alfalfa hay; to lambs in lot No. II ground barley and ground alfalfa hay, in separate troughs; to lambs in lot No. 3 ground barley and ground alfalfa hay mixed. These different lambs were given these rations for the first 30 days. For the second 30 days the feeds were changed, and for the third 30 days also the feeds were changed. By this arrangement all of the lambs received all of the feeds and the benefits if there were any in the different ways of feeding.

In fattening a flock of lambs it is better to underfeed than to overfeed. The way a flock of lambs takes to feed is an indication of how they are doing. Unless lambs are contented while eating there is something wrong. It might be that the feed is not palatable. It was noticeable that lambs receiving the ground grain and the ground hay were restless. By their actions they evidently did not appreciate all the extra labor we had done in preparing their feeds; however, since this was an experiment we fed these lots receiving the ground feeds in the same manner as we fed the lots receiving the whole feeds—all we could induce them to eat.

From the records reported herein it may be seen that when the lambs received the whole barley and the whole alfalfa hay they made much larger gains during each period than they did when they received the ground feeds fed in separate troughs, or when the ground barley and ground alfalfa hay was fed mixed. Because of the refusal of the lambs to clean up all the feeds it was necessary to weigh back. This weigh back consisted mostly of the finest particles. The quantity of ground mixture fed was regulated by quantity consumed by the lambs fed in separate troughs. An observation note made on February 8, by Mr. Hugh Lewis, the feeder, at the beginning of the second 30 day period, is as follows: "The lambs that had been receiving ground feeds in separate troughs for the first 30 days apparently took a new lease on life and ate the whole barley and whole alfalfa hay greedily. The next morning they were waiting for their morning feed. This was the first time this lot was of this disposition."

The records of this experiment show that when these different lots of lambs of ten head each received the whole barley and the whole alfalfa hay irrespective of whether it was the first, second or third 30 day period, they made good gains.* This average gain varied from .31 to .33 of a pound daily and every lamb made a gain. While with the same lambs receiving the ground barley and the ground alfalfa hay, fed in separate troughs, the gains varied from .12 to .21 of a pound per head daily, and one-third of the lambs did not gain anything.

The following is the record of the weights and gains for the lambs during the 90 days while receiving the different feeds.

*See Table VII.

Table No. VII

TOTAL WEIGHTS AND GAINS OF LAMBS IN 1927 TEST

First Period—Whole Barley and Whole Alfalfa Hay

Weight at beginning	Weight at close	Gain	Average gain per head daily
73	84	11	.36
62	71	9	.30
74	88	14	.46
76	84	8	.26
72	80	8	.26
64	73	9	.30
65	77	12	.40
74	82	8	.26
60	71	11	.36
65	70	5	.16
Totals 685	780	95	
Averages ..68.5	78.0	9.5	.31

Second Period—Whole Barley and Whole Alfalfa Hay

Weight at beginning	Weight at close	Gain	Average gain per head daily
72	81	8	.26
32	106	14	.46
73	82	9	.30
70	83	13	.43
68	80	12	.40
74	83	9	.30
77	88	11	.36
80	87	7	.23
65	72	7	.23
87	96	9	.30
Totals 759	858	99	
Averages ..75.9	85.8	9.9	.33

Third Period—Whole Barley and Whole Alfalfa Hay

Weight at beginning	Weight at close	Gain	Average gain per head daily
54	62	8	.26
62	73	11	.36
86	95	9	.30
83	90	7	.23
82	91	9	.30
72	84	12	.40
79	95	16	.53
85	90	5	.16
78	92	14	.46
89	91	2	.06
Totals 770	863	93	
Averages ..77.0	86.3	9.3	.31

Table No. VIII

TOTAL WEIGHTS AND GAINS OF LAMBS IN 1927 TEST

Ground Barley and Ground Hay in Separate Troughs

First Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
65	73	8	.26
83	92	9	.30
71	73	2	.06
62	70	8	.26
58	68	10	.33
75	74	−1	.00
68	77	9	.30
76	80	4	.13
62	65	3	.10
75	87	12	.40
695	759	64	.21

Second Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
64	54	−10	
60	62	2	.06
74	86	12	.40
76	83	7	.23
82	82	0	.00
69	72	3	.10
78	79	1	.03
76	85	9	.30
74	78	4	.13
79	89	10	.33
732	770	38	.12

Third Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
93	100	7	.23
75	75	0	.00
88	93	5	.16
85	94	9	.30
78	87	9	.30
70	74	4	.13
86	95	9	.30
88	91	3	.10
79	79	0	.00
64	60	−4	.00
806	848	42	.14

Compare gains of lambs in above table with gains made by same lambs while receiving the whole feeds in Table No. VII. One-fifth of them did not make any gain, but when they were getting the whole feeds all gained during all the periods and the average gain for each period is as large as one would expect.

In 1904 the writer conducted an experiment at this station in feeding whole barley and whole Bromus inermis and wild hay to lambs with a view of ascertaining how barley compared with corn. The results show that barley produced an average gain of .26 of a pound per head, while shelled corn gave a gain of .29 of a pound, daily. Gains produced by lambs in this experiment when the whole feeds were fed are as large as could be expected, feeds considered.

Table No. IX

TOTAL WEIGHTS AND GAINS OF LAMBS IN 1927 TEST

Ground Barley and Ground Alfalfa Hay Fed Mixed

First Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
56	64	8	.26
55	60	5	.16
70	74	4	.13
70	76	6	.20
72	82	10	.33
67	69	2	.06
75	78	3	.10
69	76	7	.23
68	74	6	.20
70	79	9	.30
672	732	60	.20

Second Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
84	93	9	.30
71	75	4	.13
88	88	0	.00
84	85	1	.03
80	78	−2	.00
73	70	−3	.00
77	86	9	.30
82	88	6	.20
71	79	8	.26
70	64	−6	.00
780	806	26	.08

Third Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
81	84	3	.10
106	115	9	.30
82	85	3	.10
83	85	2	.06
80	78	−2	.00
83	85	2	.06
88	90	2	.06
87	98	11	.36
72	77	5	.16
96	101	5	.16
858	898	40	.13

After studying the above tables of weights and gains any experienced feeder of lambs can see that there was something materially wrong with either the lambs or the feeds while they were getting the ground feeds. The gains per head for the lambs while receiving the whole barley and the whole alfalfa hay for the three periods* are what one would expect, between nine and ten pounds for each of the 30 day periods, while with the same lambs when they received the ground feeds there were only 15 of the 30 head that made average gains.

The 30 lambs while receiving whole barley and whole alfalfa hay made a total gain of 287 pounds, or an average gain per head of 9.56 pounds during the 90 days. The same 30 lambs that received ground barley and ground alfalfa hay fed in separate troughs, and ground barley and ground alfalfa hay mixed, made an average of only 4.8 and 4.2 pounds per head respectively, or about one-half as much as when the feeds were not ground. These results indicate that we reduced the feeding value of barley and alfalfa hay for lambs over 50 per cent by grinding.

In this connection, we quote from Henry and Morrison in their book on feeds and feeding as follows. "Of all farm animals, the sheep is best able to do its own grinding, and with few exceptions whole grains only should be furnished. Except in the case of small or hard seeds, sheep with good teeth should grind their own grain."

*See Table VII.

Table No. X

FEEDS, GAINS AND COST OF GAINS

Whole Barley and Whole Alfalfa Hay

	No. head	Total barley	Total hay	gain	Barley pound gain	Alfalfa pound gain	Av. gain per head daily	Cost of 100 pounds gain
First 30 days.	10	874.2	497.6	95	9.20	5.23	.31	
Second 30 days	10	958.	420.	99	9.67	4.24	.33	
Third 30 days	10	517.6	364.8	93	5.56	3.92	.31	
Total and Averages ...		2349.8	1282.4	287	8.18	4.46	.31	$13.58
Weighed back		28.2	69.2					

Ground Barley and Ground Alfalfa Hay in Separate Troughs

	No. head	Total barley	Total hay	gain	Barley pound gain	Alfalfa pound gain	Av. gain per head daily	Cost of 100 pounds gain
First 30 days.	10	324.1	429.8	64	5.06	6.71	.21	
Second 30 days	10	385.8	283.7	38	10.15	7.46	.12	
Third 30 days	10	409.7	270.6	42	9.75	6.44	.14	
Total and Averages ...		1119.6	984.1	144	7.77	6.83	.16	$16.34
Weighed back		51.4	132.9					

Ground Barley and Ground Alfalfa Hay Mixed

	No. head	Total barley	Total hay	gain	Barley pound gain	Alfalfa pound gain	Av. gain per head daily	Cost of 100 pounds gain
First 30 days.	10	777.5		60	12.95		.20	
Second 30 days	10	710.3		26	27.30		.08	
Third 30 days	10	713.7		40	17.84		.13	
Total and Averages ...		2201.5		126	17.47		.14	$19.51
Weighed back		78.						

Lambs in lots receiving ground feeds did not require as much for a pound of gain as lambs in lots receiving the whole feeds but the gains cost more and they were not as large gains as a successful feeder of lambs would expect.

The feed that was weighed back is an important factor in lamb feeding. If all conditions are ideal lambs should clean up at each feeding time.

1928 Test—Fattening Yearling Wethers

For the 1928 test we used 21 yearling wethers. They were divided into three lots of seven head each and fed in the same manner the lambs were fed the year before, only corn was used as the grain instead of barley At the end of the first 30 day period one of the wethers that had been receiving shelled corn and alfalfa hay lost 19 pounds, but all the others made good gains. Of the 51 head of sheep receiving the whole feeds this was the only one during both tests that did not return a gain. Why this condition was we are unable to explain. This sheep was kept in the lot and the following 30 days he received ground corn and ground alfalfa in separate troughs—gained 26 pounds and was largest gaining sheep for this lot. (See Table No. XII, 2nd 30 days).

Results show that while these 21 yearling wethers were receiving shelled corn and whole alfalfa hay they made a total gain of 253 pounds and with the one exception they all made fair gains. When the same sheep were receiving the ground corn and the ground alfalfa hay fed in separate troughs they made a total gain of 269 pounds, or 16 pounds more than when they received the whole feeds, but five of them did not make any gain during this period and the individual gains varied from seven to 28 pounds per head during the 90 days. This condition did not exist when the same sheep received the whole feeds. When one-fifth of the sheep did not make any gains and some of them lost weight, the profit of the enterprise would be reduced accordingly.

When these same sheep were fed ground feeds mixed there were six head that made gains from minus seven to two pounds during the 90 day period.

Every sheep feeder can afford to make a close study of these tables of weights and gains and then decide for himself whether he desires to grind feed for sheep.

Table No. XI

YEARLING WETHERS

Shelled Corn and Whole Alfalfa Hay

First Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
129	149	20	.66
142	153	11	.36
129	110	–19	.00
160	165	5	.16
134	146	12	.40
130	139	9	.30
120	137	17	.56
944	999	55	.26

Second Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
131	147	16	.53
153	164	11	.36
144	158	14	.46
147	159	12	.40
142	154	12	.40
128	138	10	.33
128	136	8	.26
973	1056	83	.39

Third Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
149	158	9	.30
142	175	33	1.10
177	188	11	.36
161	180	19	.63
152	157	5	.16
161	180	19	.63
148	167	19	.63
1090	1205	115	.54

Table No. XII

YEARLING WETHERS

Ground Corn and Ground Alfalfa Hay Fed in Separate Troughs

First Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
138	136	−2	.00
125	137	12	.40
163	157	−6	.00
133	160	27	.90
122	139	17	.56
122	146	24	.80
119	146	27	.90
922	1021	99	.47

Second Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
149	149	0	.00
153	142	−11	.00
110	136	26	.86
165	182	17	.56
146	153	7	.23
139	159	20	.66
137	151	14	.46
999	1072	73	.34

Third Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
147	158	11	.36
164	192	28	.93
158	174	16	.53
159	175	16	.53
154	152	−2	.00
138	155	17	.56
136	147	11	.36
1056	1153	97	.46

Table No. XIII

YEARLING WETHERS

Ground Corn and Ground Alfalfa Hay Mixed

First Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
129	131	2	.06
143	153	10	.33
138	144	6	.20
154	147	−7	.00
129	142	13	.43
115	128	13	.43
132	128	−4	.00
940	973	33	.11

Second Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
136	149	13	.43
137	142	5	.16
157	177	20	.66
160	161	1	.03
139	152	13	.43
146	161	15	.50
146	148	2	.06
1021	1090	69	.32

Third Thirty Days

Weight at beginning	Weight at close	Gain	Average gain per head daily
149	173	24	.80
142	184	42	1.40
136	137	1	.03
182	199	17	.56
153	165	12	.40
159	170	11	.36
151	164	13	.43
1072	1192	120	.57

Table No. XIV

FEEDS, GAINS AND COST OF GAINS

Lot 1—Whole Corn and Whole Alfalfa Hay

	No. sheep	Total corn	Total alfalfa hay	Gain	Corn for pound gain	Alfalfa for pound of gain	Av. gain per head daily	Cost of pound of gain
First 30 days.	7	465.4	447.	55	8.46	8.12	.26	
Second 30 days	7	584.7	354.5	83	7.04	4.27	.39	
Third 30 days	7	673.3	306.5	115	5.85	2.66	.54	
Total and averages ...	21	1723.4	1108.	253	6.85	4.37	.40	13.50
Weighed back		48.9	27.2					

Lot 2—Ground Corn and Ground Alfalfa Hay in Separate Troughs

	No. sheep	Total corn	Total alfalfa hay	Gain	Corn for pound gain	Alfalfa for pound of gain	Av. gain per head daily	Cost of pound of gain
First 30 days.	7	419.7	439.5	99	4.24	4.44	.47	
Second 30 days	7	631.4	297.7	73	8.65	4.08	.34	
Third 30 days	7	595.1	280.0	97	6.13	2.80	.46	
Total and averages ...	21	1646.2	1017.2	269	6.11	3.78	.42	12.69
Weighed back		117.5	97.5					

Lot 3—Ground Corn and Ground Alfalfa Hay Mixed

	No. sheep	Total corn	Total alfalfa hay	Gain	Corn for pound gain	Alfalfa for pound of gain	Av. gain per head daily	Cost of pound of gain
First 30 days.	7	860.3		33	26.07		.15	
Second 30 days	7	915.8		69	13.27		.32	
Third 30 days	7	923.8		120	7.69		.57	
Total and averages ...	21	2699.9		222	12.15		.35	15.37
Weighed back		179.6						

As sheep in lot III received practically the same quantity of ground feed as when they were in lot II the total cost of making this gain is based on value of feeds for lot II. The gains, however, for sheep when in lot III are not as large as when in lot II hence, the increased cost per hundred pounds of gain.

The results show that it did not pay to mix the feeds.

SWINE

The experiments in grinding feed for swine were conducted during the winter and spring months of 1927 and during the winter and spring months of 1928. The hogs were housed, during the 1927 experiment, in a steer feeding barn having a dirt floor, and had free access to small yards located on the south side of this barn. They had good, dry beds in which to sleep but the outside yards became muddy at times during the early spring. The hogs were housed, during the 1928 experiment, in the hog barn used for experimental feeding. This barn has a concrete floor. It also has a rather large overhead space and for that reason does not provide the most desirable housing condition for winter feeding. The hogs had access, during suitable weather, to small outside yards which had been covered with cinders. The inside pens were kept well bedded at all times in order to overcome the chill and dampness from the concrete floors.

The 1927 Test—Fattening Swine

The hogs used in the 1927 experiment were Duroc Jerseys farrowed in the spring of 1926 and raised by the Animal Husbandry Department of the College. They were well grown but thin in flesh at the time the experiment was started. They were divided as uniformly as possible with regard to sex and weight into three lots of five hogs each. They were fed on barley and alfalfa, three rations being made as follows:

Ration No. 1—Whole barley and whole alfalfa hay, each fed in separate feeders or free choice.

Ration No. 2—Ground barley and ground alfalfa hay, each fed in separate feeders or free choice.

Ration No. 3—Ground barley and ground alfalfa hay mixed each week in the proportion as consumed by the hogs getting ground barley and ground alfalfa hay fed in separate feeders the preceding week.

The three lots of hogs were alternated on the foregoing rations during three successive periods of 30 days, 31 days and 29 days each. For example, the hogs in lot No. I were fed on whole barley and whole alfalfa hay during the first period, on ground barley and ground alfalfa hay fed free choice during the second period, and on ground barley and ground alfalfa hay mixed during the third period. The barley and hay used was the same as was fed in the cattle and sheep feeding experiments conducted during the same year. The barley was of good quality and the alfalfa hay was of medium to good quality.

Individual weights and gains of the hogs for each of the three rations are shown in tables Nos. XV, XVI and XVII. A comparison of the gains made while the hogs were fed the ration of whole barley and whole alfalfa hay with those made while they were fed the ration of ground barley and ground alfalfa hay in separate feeders shows that the rate of gain while on the ground feed was

slightly more than twice the rate of gain while on the unground feed. Likewise the total gain made from the ground feed was slightly more than double that made from the unground feed. It is noted also that the gains for the individual hogs were slightly more uniform with the ground feed than with the unground feed. The gains made from the ground feed, mixed, also were more rapid than for the unground feed.

The total feed eaten, the feed eaten for 100 pounds gain, and the cost of each 100 pounds gain for each ration are shown in table No. XVIII. A comparison of the results obtained from the use of the ration of whole barley and whole alfalfa hay fed in separate feeders with those obtained from the use of the ration of ground barley and ground alfalfa hay fed in separate feeders shows a feed requirement of 806 pounds of barley and 14 pounds of alfalfa costing $10.20 for each 100 pounds gain produced by the unground feed, and a feed requirement of only 472 pounds of barley and 7.3 pounds of alfalfa costing $6.30 for each 100 pounds of gain produced by the ground feed. Mixing the ground barley and the ground alfalfa hay proved a disadvantage rather than an advantage in this experiment. A comparison obtained from feeding the ground feed in separate feeders with those obtained from feeding the ground feed mixed shows that mixing the feed resulted in an increase of 33 pounds of ground barley and 2.4 pounds of ground alfalfa and an additional cost of 46 cents in producing each 100 pounds of gain.

Conclusions

1. The results of this experiment indicate that it pays to grind barley for hogs. The difference in the amount of feed required to produce 100 pounds of gain and the cost of 100 pounds of gain for the ration containing ground barley as compared with the ration containing unground barley are great enough to be significant. This result is comparable to results obtained in other experiments in feeding barley to hogs which have been conducted at this and other experiment stations.

2. The difference in the total amount of ground alfalfa hay consumed as compared with the total amount of whole alfalfa hay consumed, when each was fed free choice, was not enough to be significant.

3. Mixing the ground barley and ground alfalfa hay did not increase the palatability of the ration or decrease the cost of gains.

SWINE—1927

Table No. XV

INDIVIDUAL WEIGHTS AND GAINS FOR EACH RATION FED

Ration No. 1—Whole Barley, Self-fed; Whole Alfalfa Hay, Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 1	1	174.0	210.0	36.0	1.20
	2	164.0	202.0	38.0	1.26
	3	202.0	232.0	30.0	1.00
	4	162.0	192.0	30.0	1.00
	5	155.0	184.0	29.0	.96
Total for lot..		857.0	1020.0	163.0	
Average		171.4	204.0	32.6	1.09

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 31 days Lot No. 3	11	238.0	262.0	24.0	.77
	12	200.0	218.0	18.0	.55
	13	216.0	262.0	46.0	1.48
	14	250.0	276.0	26.0	.83
	15	224.0	264.0	40.0	1.29
Total for lot..		1128.0	1282.0	154.0	
Average		225.6	256.4	30.8	.99

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 29 days Lot No. 2	6	288.0	312.0	24.0	.82
	8	304.0	320.0	16.0	.55
	9	268.0	282.0	14.0	.48
	10	234.0	248.0	14.0	.48
Total for lot..		1094.0	1162.0	68.0	
Average		273.5	290.5	17.0	.59
Total for Three Periods				385.9	
Average for Three Periods				27.14	.91

SWINE—1927

Table No. XVI

INDIVIDUAL WEIGHTS AND GAINS OF HOGS FOR EACH RATION FED

Ration No. 2—Ground Barley and Ground Alfalfa Hay, Each Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 2	6	187.0	242.0	55.0	1.83
	7	177.0	226.0	49.0	1.63
	8	190.0	242.0	52.0	1.73
	9	172.0	226 0	54.0	1.80
	10	136.0	188.0	52.0	1.73
Total for lot..		862.0	1124.0	262.0	
Average		172.4	224.8	52.4	1.75

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 31 days Lot No. 1	1	210.0	250.0	40.0	1.29
	2	202.0	252.0	50.0	1.61
	3	232.0	296.0	64.0	2.06
	4	192.0	274.0	82.0	2.64
	5	184.0	254.0	70.0	2.25
Total for lot..		1020.0	1326.0	306.0	
Average		204.0	265.2	61.2	1.97

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 29 days Lot No. 3	11	262.0	324.0	62.0	2.13
	12	218.0	266.0	48.0	1.65
	13	262.0	306.0	44.0	1.51
	14	276.0	332.0	56.0	1.93
	15	264.0	328.0	64.0	2.20
Total for lot..		1282.0	1556.0	274.0	
Average		256.4	311.2	54.8	1.89
Total for Three Periods				842.0	
Average for Three Periods				56.13	1.87

SWINE—1927

Table No. XVII

INDIVIDUAL WEIGHTS AND GAINS OF HOGS FOR EACH RATION FED

Ration No. 3—Ground Barley and Ground Alfalfa Hay Mixed in the Proportion as Consumed by the Hogs Fed Ground Barley and Ground Alfalfa Hay Fed in Separate Feeders During the Corresponding Period, and the Mixture Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 3	11	179.0	238.0	59.0	1.96
	12	156.0	200.0	44.0	1.46
	13	169.0	216.0	47.0	1.56
	14	186.0	250.0	64.0	2.13
	15	164.0	224.0	60.0	2.00
Total for lot..		854.0	1128.0	274.0	
Average		170.8	225.6	54.8	1.83

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 31 days Lot No. 2	6	242.0	288.0	46.0	1.48
	7	226.0	262.0	36.0	1.16
	8	242.0	304.0	62.0	2.00
	9	226.0	268.0	42.0	1.35
	10	188.0	234.0	46.0	1.48
Total for lot..		1124.0	1356.0	232.0	
Average		224.8	271.2	46.4	1.50

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 29 days Lot No. 1	1	250.0	308.0	58.0	2.00
	2	252.0	322.0	70.0	2.41
	3	296 0	340.0	44.0	1.51
	4	274.0	302.0	28.0	.96
	5	254.0	304.0	50.0	1.72
Total for lot..		1326.0	1576.0	250.0	
Average		265.2	315.2	50.0	1.72
Total for Three Periods				756.0	
Average for Three Periods				50.4	1.68

SWINE—1927

Table No. XVIII

GAINS, FEEDS AND COST OF GAINS

Whole Barley and Whole Alfalfa Hay, Each Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten		Feed eaten for 100 lbs. gain		Cost of 100 lbs. gain
				Barley	Alfalfa hay	Barley	Alfalfa hay	
First period, 30 days	5	163.0	1.08	1077.0	29.0	660	17	$ 8.39
Second period, 31 days	5	154.0	.99	1208.0	15.0	784	9	9.88
Third period, 29 days	4	68.0	.58	824.0	11.0	1217	16	15.27
Total		385.0		3109.0	55.0			
Average			.91			806	14	10.20

Ground Barley and Ground Alfalfa Hay, Each Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten		Feed eaten for 100 lbs. gain		Cost of 100 lbs. gain
				Barley	Alfalfa hay	Barley	Alfalfa hay	
First period, 30 days	4	213.0	1.77	920.0	26.0	431	12	$ 5.82
Second period, 31 days	5	306.	1.97	1370.0	20.5	447	6.6	5.98
Third period, 29 days	5	274.	1.88	1457.0	11.5	531	4.1	7.07
Total		793.0		3747.0	58.0			
Average			1.89			472	7.3	6.32

Ground Barley and Ground Alfalfa Hay Mixed and the Mixture Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten		Feed eaten for 100 lbs. gain		Cost of 100 lbs. gain
				Barley	Alfalfa hay	Barley	Alfalfa hay	
First period, 30 days	5	274.0	1.82	1079.0	13.4	394	4.9	$ 5.25
Second period, 31 days	4	196.0	1.58	1107.0	27.6	564	14	7.59
Third period, 29 days	5	250.0	1.72	1457.0	29.0	582	11	7.81
Total		720.0		3646.0	70.0			
Average			1.72			505	9.7	6.78

The 1928 Test—Fattening Swine

The second experiment in grinding feed for swine was started February 23, 1928. Five Chester White, four Poland China and three grade Duroc Jersey barrows and three grade Hampshire sows, all of which were farrowed in August and September, 1927, were used. These animals were separated as uniformly as possible with reference to breed, sex and weight into three lots of five each. The feeds used were corn and alfalfa hay. The corn was of good quality, testing 13.5 per cent moisture at the beginning of the experiment, and the hay was of medium quality but fairly leafy and green. Three rations were made up as follows:

Ration No. 1—Whole shelled corn and whole alfalfa hay, each fed in separate feeders or free choice.

Ration No. 2—Ground corn and ground alfalfa hay, each fed in separate feeders or free choice.

Ration No. 3—Ground corn and ground alfalfa hay mixed each week in the proportion as consumed by the hogs getting whole shelled corn and whole alfalfa hay the preceding week.

According to the original plan, the ground feeds were to have been mixed in the same proportion as the hogs ate of the ground feeds fed in separate feeders as was done in the 1927 experiment. The hogs ate such a small amount of the ground alfalfa, however, that it was thought the hogs would be on practically a ration of ground corn alone and for that reason the amounts eaten of the unground feeds was made the basis for mixing the ground feeds in ration number 3. Each of the foregoing rations was supplemented with a mixture of ordinary coarse white salt and soft coal ashes mixed at the rate of one pound of salt to five pounds of ashes. All of the hogs had free access to this mixture of salt and ashes at all times. The three lots of hogs were fed successively on the three rations named, as was done in the experiment conducted in 1927 during three successive periods of 30, 34 and 28 days each.

The individual weights and gains of the hogs for each ration fed are shown in tables XIX, XX and XXI. It will be seen that the hogs while on the ration of ground corn and ground alfalfa fed in separate feeders made a greater total gain and a higher average daily gain than they did while on either of the other two rations.

Every hog, while on this ration, made an average daily gain of more than a pound a day. There were two hogs that made an average gain of less than a pound a day while on the whole corn and whole alfalfa, and three that made less than a pound a day while on the ration of ground corn and ground alfalfa mixed.

There was considerable variation in the results obtained from the different groups, or lots of hogs, on the different rations. This is shown in tables XXII, XXIII and XXIV. Every hog in lot 1 made more than a pound of gain a day while on each of the three rations. The most rapid gain was made by this group of

hogs during the first period while being fed whole corn and whole alfalfa hay in separate feeders. Every hog in lot 2 made more than a pound of gain a day during the first period while being fed ground corn and ground alfalfa in separate feeders. They also made the most rapid gain during this period. When put on the ground feed mixed, however, all of them made slower gains. Hog number 8, a Chester barrow, went off feed soon after the change in feed was made and while appearing in good physical condition gained slowly, and did not seem to relish the feed at any time during the period. When changed to whole corn and whole alfalfa he ate with better appetite and made a more satisfactory gain. The grade Hampshire sow in this lot also gained slowly during the second period but improved when put on unground feed. The average daily gain for this lot, number 2, was lower on the ground feed mixed than on either of the other two rations. The hogs in lot 3 made the most rapid gains during the first period, as did the hogs in lots 1 and 2. The grade Hampshire sow in this lot, however, made less than a pound a day gain during this period, when fed on the ground feed mixed. This was the only hog in the experiment which made less than a pound a day gain during the first period. This hog also made a slow gain during the second period when fed whole corn and whole hay and a more rapid gain during the third period when fed the ground feed in separate feeders.

The total amounts of feed consumed, the feed required to produce 100 pounds of gain, and the cost per 100 pounds of gain produced for each of the three rations are shown in Table XXV. The average for the three periods shows the unground feed in the lead with the lowest feed requirement for 100 pounds of gain and the ground feed mixed taking third place with the highest feed requirement for 100 pounds of gain. The cost of 100 pounds of gain, likewise, was lowest for the unground feeds and highest for the ground feeds mixed.

Conclusions

1. In this experiment, grinding the feed and feeding it in separate feeders, free choice method, increased the rate of gain but also increased the feed requirement for 100 pounds of gain and the cost of 100 pounds of gain as compared with feeding the unground feeds in separate feeders.

2. Mixing the ground feeds did not increase the palatability of the feeds or the rate of gain nor lower the cost of the gain made.

SWINE—1928

Table No. XIX

INDIVIDUAL WEIGHTS AND GAINS FOR EACH RATION FED

Ration No. 1—Whole Shelled Corn, Self-fed; Whole Alfalfa Hay, Self Fed, and Salt and Ashes Mixture, Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 1	1	156.0	200.3	44.3	1.48
	2	138.0	182.7	44.7	1.49
	3	161.7	215.3	53.6	1.79
	4	133.3	179 3	46.0	1.53
	5	162.0	214.7	52.7	1.76
Total for lot..		751.0	992.3	241.3	
Average		150.2	198.46	48.26	1.61

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 34 days Lot No. 3	11	180.7	205.0	24.3	.71
	12	165.3	216.7	51.4	1.51
	13	205.3	248.7	43.4	1.28
	14	198.0	238.0	40.0	1.18
	15	238.4	289.3	50.9	1.50
Total for lot..	5	987.7	1197.7	210.0	
Average		197.54	239.54	42.0	1.24

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 28 days Lot No. 2	6	228.3	259.7	31.4	1.12
	7	294.3	344.0	49.7	1.78
	8	165.3	192.0	26.7	.95
	9	255.7	299.3	43.6	1.56
	10	229.3	264.3	35.0	1.25
Total for lot..	5	1173.0	1359.3	186.3	
Average		234.6	271.86	37.26	1.33
Total for Three Periods	5			637.6	
Average for Three Periods				127.52	1.40

SWINE—1928

Table No. XX

INDIVIDUAL WEIGHTS AND GAINS FOR EACH RATION FED

Ration No. 2—Ground Corn, Self-fed; Ground Alfalfa Hay, Self-fed, and Salt and Ashes Mixture, Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 2	6	167.3	201.3	34.	1.13
	7	156.7	229.7	73.	2.43
	8	123.0	159.7	36.7	1.22
	9	146.3	212.7	66.4	2.21
	10	143.0	189.6	46.6	1.55
Total for lot..		736.3	993.0	256.7	
Average			198 6	51.34	1.71

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 34 days Lot No. 1	1	200.3	237.7	37.4	1.10
	2	182.7	243.0	60.3	1.77
	3	215.3	261.0	45.7	1.34
	4	179.3	223.3	44.0	1.29
	5	214.7	266.3	51.6	1.52
Total for lot..		992.3	1231.3	239.0	
Average		198.46	246.26	47.8	1.41

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 28 days Lot No. 3	11	205.0	234.0	29.0	1.04
	12	216.7	264.3	47.6	1.70
	13	248.7	284 0	35.3	1.26
	14	238.0	280.3	42.3	1.51
	15	289.3	325.0	35.7	1.28
Total for lot..		1197.7	1387.7	190.0	
Average		239.54	277.54	38.0	1.36
Total for Three Periods				685.7	
Average for Three Periods				137.14	1.49

SWINE—1928

Table No. XXI

INDIVIDUAL WEIGHTS AND GAINS FOR EACH RATION FED

Ration No. 3—Ground Corn and Ground Alfalfa Hay Mixed in the Same Proportion as Consumed by the Hogs Fed Shelled Corn and Whole Alfalfa Hay During Each Corresponding Period and the Mixture Self-fed, and Salt and Ashes Mixture, Self-fed

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
First Period 30 days Lot No. 3	11	154.7	180.7	26.0	.87
	12	128.3	165.3	37.0	1.23
	13	146.0	205.3	59.3	1.98
	14	143.0	198.0	55.0	1.83
	15	182.7	238 4	55.7	1.86
Total for lot..		754.7	987.7	233.0	
Average		150.94	197.54	46.6	1.55

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Second Period 34 days Lot No. 2	6	201.3	228.3	27.0	.79
	7	229.7	294.3	64.6	1.90
	8	159.7	165.3	5 6	.16
	9	212.7	255.7	43.0	1.26
	10	189.6	229.3	39.7	1.17
Total for lot..		993.0	1173.0	180.0	
Average		198.6	234.6	36.0	1.06

	Hog No.	Average initial weight	Average final weight	Total gain per hog	Average daily gain per hog
Third Period 28 days Lot No. 1	1	237.3	273 7	36.0	1.29
	2	243.0	312.7	69.7	2.48
	3	261.0	298.0	37.0	1.32
	4	223.3	263.7	40.0	1.44
	5	266.3	300.0	33.7	1.20
Total for lot..		1231.3	1448 0	216.8	
Average		246.26	289.6	43.36	1.55
Total for Three Periods				629.0	
Average for Three Periods				125.8	1.34

SWINE—1928

Table No. XXII

INDIVIDUAL GAINS FOR EACH PERIOD BY LOTS

Lot No. 2

Ration—First period, 30 days: Ground corn, self-fed; ground alfalfa hay, self-fed; salt and ashes mixture, self-fed.
Second period, 34 days: Ground corn and ground alfalfa hay mixed in the proportion as consumed by the hogs getting unground feed during the same period, and the mixture self-fed; salt and ashes mixture, self-fed.
Third period, 28 days: Whole shelled corn, self-fed; whole alfalfa hay, self-fed, and salt and ashes mixture, self-fed.

		First period		Second period		Third period		Three periods combined	
	Hog No.	Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain
	6	34.0	1.13	27.0	.79	31.4	1.12	92.4	1.00
	7	73.9	2.43	64.6	1.90	49.7	1.78	187.3	2.04
	8	36.7	1.22	5.6	.16	26.7	.95	69.0	.75
	9	66.4	2.21	48.6	1.26	43.6	1.56	153.6	1.66
	10	46.6	1.55	39.7	1.17	35.0	1.25	121.3	1.32
Total per lot.	5	256.7		180.0		186.3		623 0	
Av. per hog.		51.34	1.71	36.0	1.06	37.3	1.33	124.6	1.35

SWINE—1928

Table No. XXIII

INDIVIDUAL GAINS FOR EACH PERIOD BY LOTS

Lot No. 1

Ration—First period, 30 days. Whole shelled corn, self-fed; whole alfalfa hay, self-fed, and salt and ashes mixture, self-fed.
Second period, 34 days: Ground corn, self-fed; ground alfalfa hay, self-fed, and salt and ashes mixture, self-fed.
Third period, 28 days: Ground corn and ground alfalfa hay mixed in the proportion as consumed by the hogs getting unground feed during the same period, and the mixture self-fed; salt and ashes mixture, self-fed.

		First period		Second period		Third period		Three periods combined	
	Hog No.	Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain
	1	44.3	1.48	37 4	1.10	36.0	1.29	117.0	1.28
	2	44.7	1.49	60.3	1.77	69.7	2.48	174.7	1.90
	3	53.6	1.79	45 7	1.34	37.0	1.32	136.3	1.48
	4	46.0	1 53	44.0	1.29	40.4	1.44	130.4	1.42
	5	52.7	1.76	51.6	1.52	33.7	1.20	138.0	1.50
Total per lot.		241.3		239.0		216.8		697 0	
Av. per hog.		48.26	1.61	47.8	1.41	43.36	1.55	139 4	1.52

SWINE—1928

Table No. XXIV

INDIVIDUAL GAINS FOR EACH PERIOD BY LOTS

Lot No. 3

Ration—First period, 30 days: Ground corn and ground alfalfa hay mixed in the proportion as consumed by the hogs getting unground feed during the same period, and the mixture self-fed; salt and ashes mixture, self-fed.
Second period, 34 days: Shelled corn, self-fed; whole alfalfa hay, self-fed; salt and ashes mixture, self-fed.
Third period, 28 days: Ground corn, self-fed; ground alfalfa hay, self-fed, and salt and ashes mixture, self-fed.

	Hog No.	First period		Second period		Third period		Three periods combined	
		Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain	Total gain	Av. daily gain
	11	26 0	.87	24.3	.71	29.0	1.04	79.3	.80
	12	37.0	1.23	51.4	1.51	47.6	1.70	136.0	1.48
	13	59.3	1.98	43.4	1.28	35.3	1.26	138.0	1.50
	14	55.0	1.83	40.0	1.18	42 3	1.51	137.3	1.49
	15	55.7	1.86	50.9	1.50	35.7	1.28	142.3	1.55
Total per lot.	5	233.0		210.0		190.0		633.0	
Av. per hog.		46.6	1.55	42.0	1.24	38.0	1.36	126 6	1.38

SWINE—1928

Table No. XXV

GAINS, FEEDS AND COSTS OF GAINS

Whole Shelled Corn and Whole Alfalfa Hay, Each Self-fed; Salt and Ashes Mixture Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten			Feed eaten for 100 lbs. gain			Cost of 100 lbs. gain
				Corn	Alfalfa hay	Salt and ashes	Corn	Alfalfa hay	Salt and ashes	
First period, 30 days.....	5	241.3	1.61	1201.2	7.8	8.2	497.8	3.23	3.40	$ 7.53
Second period, 34 days.....	5	210.0	1.24	1170.2	4.8	13.6	557.2	2.29	6 48	8.44
Third period, 28 days.....	5	186.3	1.33	967.6	1.6	1.8	519.3	.76	.86	7.79
Total		637.6		3339.0	14.2	23.6				
Average			1.40				523.7	2.23	3.70	$ 7.91

Ground Corn and Ground Alfalfa Hay, Each Self-fed; Salt and Ashes Mixture, Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten			Feed eaten for 100 lbs. gain			Cost of 100 lbs. gain
				Corn	Alfalfa hay	Salt and ashes	Corn	Alfalfa hay	Salt and ashes	
First period, 30 days.....	5	256.7	1.71	1241.0	0.4	12.0	483.4	.15	4.67	$ 7.43
Second period, 34 days.....	5	239.0	1.41	1354.0	1 0	11.2	566.5	.42	4.68	8.69
Third period, 28 days.....	5	190.0	1.36	1050.2	1.0	5.0	552.7	.53	2.63	8.47
Total		685.7		3644.6	2.4	28 2				
Average			1.49				531.5	.35	3.33	$ 8.16

Ground Corn and Ground Alfalfa Hay Mixed in Proportion as Corn and Hay Eaten by Hogs Getting Unground Feed and the Mixture Self-fed; Salt and Ashes Mixture Self-fed

	No. of hogs	Total gain per lot	Av. daily gain per hog	Total feed eaten			Feed eaten for 100 lbs. gain			Cost of 100 lbs. gain
				Corn	Alfalfa hay	Salt and ashes	Corn	Alfalfa hay	Salt and ashes	
First period, 30 days.....	5	233.0	1.55	1119.5	21.3	12.0	480.4	9.14	5.15	$ 7.47
Second period, 34 days.....	5	180.0	1.06	1087.3	5.0	7.4	604.7	2.78	4.11	9.30
Third period, 28 days.....	5	216.8	1.55	1238.9	7.1	5.0	571.4	3.27	2.3	8.77
Total		629.8		3445.7	33.4	24.4				
Average			1.34				547.1	5.30	3.87	$ 8.44

PART III

FEEDING GROUND ROUGHAGES TO DAIRY COWS

THOMAS M. OLSON*

The roughage in a ration usually constitutes the cheapest source of feed nutrients. Profitable feeding therefore requires that roughage be fed in liberal amounts. Any processing or treatment of the roughage which enhances its feeding value without materially increasing the cost of the roughage can be recommended in the interest of more efficient feeding practices. The questions therefore to determine are to what extent if any can roughage be improved in nutritional value by grinding, and whether the increased nutritional value is sufficient to offset the cost of grinding.

The purposes of the work undertaken in this project are:

a. To determine the productive value of whole vs. ground roughages.

b. To determine the digestibility of whole and ground roughage when fed alone, and when fed with ground concentrates.

c. To determine the economy of milk production with whole vs. ground roughage.

d. To note results of ground vs. whole roughage on weight of cows and their physiological condition.

EXPERIMENTAL METHOD

Four 90-day feeding trials were conducted using the alternative method.

The cows were fed and milked twice a day at regular intervals, and weighed every ten days. Ten day composite milk samples were taken during all trials. A digestion trial was conducted at the close of the second and third 30-day periods of each trial. Salt and water were kept before the cows at all times in suitable containers. The cows were allowed to exercise in a dry lot when the weather was fit.

During the first trial whole alfalfa hay of good quality was compared with ground alfalfa hay of the same quality. A grain mixture consisting of four parts of ground corn, four parts ground oats, one part of old process linseed oil meal, one part wheat bran was fed. Corn silage was fed twice a day.

Before the feeding trial was begun the exact amount of whole roughage each animal would eat was determined by a preliminary feeding trial. This amount of roughage was fed during the entire trial. The concentrate mixture was fed according to milk production. Records were kept of the amount of concentrates and roughages fed. Thirty pounds of silage were fed to each cow per day.

During the whole roughage period the grain was fed on the silage and the hay was fed separate in the manger. During the ground roughage period the hay, grain mixtures and silage were thoroughly mixed and fed in one large container (two-bushel basket). Three cows were used in the first trial.

*The feeding and care of the animals in the feeding trials were done by advanced students in Dairy Husbandry.

Sweet clover was used in the second trial, in place of alfalfa, and four instead of three cows were used; otherwise all conditions were identical with the first trial. The sweet clover was of good quality and no difficulty was experienced in getting the cows to eat it when it was fed whole or ground.

For the third trial whole alfalfa hay and corn fodder with the ears snapped, were used as roughage. These roughages were fed in equal amounts by weight. The following concentrates were used, corn, oats, wheat, bran, and old process oil meal. The entire ration was balanced according to the Morrison standard. The concentrates were fed in a separate container for the whole roughage period. During the ground roughage periods, the concentrates were thoroughly mixed with the roughage and fed in a two-bushel basket. No silage was fed during this trial. The alfalfa hay and corn fodder were of fair quality, the fodder being somewhat mature for good roughage. Seven cows were used for the third trial.

The fourth trial was a repetition of the third, the only difference being that a concentrate mixture was used and the ration balanced according to the Morrison standard. The mixture consisted of 8 lbs. ground corn, 2 lbs. ground oats, ¼ lb. wheat bran, ¼ lb. oil meal. The quality of alfalfa and corn fodder was superior to that used in the third trial.

REVIEW OF LITERATURE

Rupel and Roche at the Wisconsin Station (1) found that there was no advantage in grinding good quality alfalfa hay, but there may be in grinding a poorer quality of hay.

Two feeding trials were conducted at the Illinois Station (2) to test the value of grinding soybean hay and alfalfa hay for dairy cows. It was noted that the grinding of the hay did not increase production sufficiently to pay for the cost of grinding. The grinding and handling of the ground hay was irritating to the workers and not conducive to the production of high quality milk.

The work at the Maryland Station (3) by Ingham, indicated slight gains in production due to grinding soybean hay. An increase of 1.3 per cent in milk production and 4.8 per cent in fat production were recorded. It was further noted that 88.93 per cent of the ground soybean hay was eaten, whereas 70.8 per cent of the unground soybean hay was eaten. However the increase in production when ground roughages were fed was not sufficient to offset the cost of grinding.

Nevens (4) found that when finely ground and whole alfalfa hay were fed, no appreciable difference was noted in the amount of material found in the rumen. When the ground grain was fed with the ground hay the same results were obtained as when these feeds were fed separately.

At the Texas Station (5) a ration in which chopped and whole sorghum fodder was fed to steers along with milo heads and cotton seed meal showed that chopping the fodder resulted in a 7 per cent increase in the consumption of the roughage, but did not increase the rate of gain.

In studies on the comparison of the net energy values of alfalfa hay and alfalfa meal by Forbes et al. at the Penn Station (6) it was

found that on a dry matter basis the ground hay was 2.2 per cent less digestible than the coarsely cut hay. Their explanation was that the meal when swallowed did not stop at the rumen, and consequently escaped the prolonged soaking and fermentation in the paunch. This theory is not borne out by the work of Nevens (4). He states that there was no difference in the amount of dry matter of the rumen content, or other parts of the alimentary canal when whole and ground alfalfa were fed.

Bechdel et. al. at the Penn. Station (8) found in two digestion trials that the grinding of alfalfa hay tended to increase the digestibility of the total ration, except crude fiber when the ground hay was mixed with the grain. It was also observed that the regurgitation, and the time devoted to rumination was on the average 27 per cent less in each case when ground hay was mixed with the grain, than when it was unground, and fed separate from the grain.

Morrow and LaMaster at the South Carolina Station (9) report that the physical preparation of the hay has no effect on the quality or quantity of milk produced. Grinding did not increase the digestibility of alfalfa, soybean, oat, and vetch hay. Somewhat more of the whole roughage was refused—68 per cent as compared to 21 per cent of the alfalfa; 23.39 per cent as compared to 10.04 per cent of the soybean hay; and 10.79 per cent as compared to 4.14 per cent of the oat hay. "The practice of grinding hay for dairy cows may be profitable when coarse stemmy hay is fed. The great difference in feed utilized may justify the expense of grinding."

Weaver, Ely and Matthews at the Iowa Station (10) report that grinding roughage did not increase its palatability. Finely ground alfalfa hay was less palatable than whole hay. No appreciable effect on digestibility was noted with ground as compared to unground alfalfa hay. A trial in which ground corn fodder was used with alfalfa hay as roughage, resulted in a slight increase in milk, but not sufficient to offset the cost of grinding.

Waters (16) in Missouri bulletin 75 states that shredded stover was less efficient than the unshredded material for yearling cattle. Shredding appeared to depreciate the feeding value of stover.

"Shredding makes available the pith, which is almost pure cellulose and worthless as a feed. Shredding of the stover so intermingles the blades, husks, outer shell, and pith of the plant as to give the animal less opportunity for the selection of those portions which are palatable and for the discarding of the others than when the plant is fed whole. Therefore even against the wishes and perhaps welfare of the animal, it is forced to eat more or less of the pith.'

The pith exerts a deleterious effect in two important ways namely:

It swells enormously when moistened. The tendency among animals in consuming coarse fodder of this sort is to drink frequently and to drink immediately after eating. The material swells to such an extent as to fill the paunch and the animal has no desire to eat more.

Second, the energy required for mastication, digestion and assimilation of the pith is greater than the energy the animal gets out of it.

Eckles in his text "Dairy Cattle and Milk Production" states the cutting and grinding of hay has no influence upon proportion of the hay digested. Cut hay is not thrown from the manger and wasted by tramping to the same extent as the uncut. A larger proportion of the coarser parts are also eaten. It is only under exceptional conditions however, that the cutting of hay is economical."

Reed and Burnett (12) at the Michigan Station fed unground and ground alfalfa hay in comparative rations to dairy cows for a period of 90 days. They concluded that the grinding of alfalfa hay for dairy cows is neither necessary nor profitable.

At the Indiana Station (13) it was found that grinding alfalfa hay resulted in slightly higher milk production and increases in body weight, when compared to the whole alfalfa but the increase was not sufficient to offset the cost of grinding.

Work at the Ohio Station (14) in which ground and unground alfalfa hay were fed to two groups of six cows in each group, showed only slight advantage for grinding. The increase in milk on the ground alfalfa ration was not sufficient to offset the cost of grinding.

Armsby (15) states, "The digestibility of coarse fodder is not increased by cutting, and indeed it would be difficult to conceive how that process could have such an effect, since in either case the feed is comminuted during mastication to practically the same extent."

DISCUSSION OF RESULTS

The productive value of a feed is reflected in the increase or decrease in production and weight of mature dairy cows. If the cows increase in production or weight on the same total pounds of feed nutrients when the roughage is fed ground over whole roughage, one may assume that the grinding enhanced the productive value of the roughage.

During the first trial in which whole vs. ground alfalfa were used as roughage, with silage and the same concentrates in both periods, a total production for three cows of 3933 pounds of milk, and 171.18 pounds of fat were produced in the first and third 30 day periods, or an average of 1966.5 pounds of milk and 85.59 pounds of fat for the 30 day period.

During the whole roughage period of 30 days, the same three cows produced 2025.4 pounds of milk and 89 pounds of fat. This is an increase of 59.1 pounds of milk and 3.41 pounds of fat for three cows, in 30 days in favor of the whole roughage period.

To produce the milk and fat given above the three cows during the first and third 30 day period consumed 2861 pounds of alfalfa, 5400 pounds of silage and 1505 pounds of concentrates consisting of four parts ground corn, four parts ground oats, one part wheat bran, one part old process oil meal, fed according to production allowing one pound of concentrates to three pounds of milk for Holsteins and one pound of concentrates to two and one-half pounds of milk for Jerseys. During the second 30 day period, or whole alfalfa period, 1480 pounds of alfalfa, 2700 pounds of silage, 725 pounds concentrates were fed.

When the feeds fed are reduced to a 30 day basis, there was

a saving of 49 pounds of alfalfa, during the ground roughage periods, but an increase of 28 pounds of concentrates. The silage remained the same for all periods.

The first trial indicated a slight increase in both milk and fat during the whole roughage period on somewhat less concentrates, but with more roughages.

It is apparent therefore that the grinding of alfalfa of good quality does not increase the production when fed to dairy cows. The average weight of the three cows for the ground roughage period was 1417 pounds as compared to 1396 pounds for the whole roughage period.

During the second trial sweet clover hay was used instead of alfalfa, otherwise the trial was the same as the first. Four instead of three cows were used.

The total milk production during the first and third 30 day periods was 7203.2 pounds of milk and 306.10 pounds of fat, or an average for 30 days of 3601.6 pounds of milk and 153.05 pounds of fat. During the whole sweet clover period of 30 days, the same cows produced 3545.8 pounds of milk and 144.47 pounds of fat. There was an increase of 55.8 pounds in the milk and 8.58 pounds in fat in favor of the ground sweet clover periods.

The total feed required during the ground roughage periods of 60 days was 3596 pounds of sweet clover, 7200 pounds of corn silage, 2568 pounds of concentrates composed of the same grains as was fed during the first trial. This is an average for a 30 day period of 1798 pounds of sweet clover, 3600 pounds of corn silage, and 1284 pounds of concentrates. During the whole sweet clover period of 30 days, the same cows consumed 1860 pounds of sweet clover, 3600 pounds of corn silage and 1255 pounds of the concentrates mixture. There was a saving of 62 pounds of sweet clover during the ground period, but an increase of 29 pounds of concentrates. The amount of corn silage fed being the same in all periods.

The slight increase in milk and fat during the ground sweet clover periods with a slight decrease in roughage, and an increase in concentrates, consumption is not significant.

So far as grinding of sweet clover is concerned, the data indicate that grinding does not increase its productive value appreciably. During the third trial when alfalfa hay and corn fodder comprised the roughage fed the total production for 30 days of the seven cows on ground roughages was 3559.1 pounds of milk and 153.26 pounds of fat. For a similar period when whole roughages were fed, the same cows produced a total of 3312.7 pounds of milk and 140.22 pounds of fat, or an increase during the ground roughage period of 246.4 pounds of milk and 13.04 pounds of fat.

This production resulted in a feed consumption of 2602 pounds of alfalfa hay, 2602 pounds of corn fodder and 1418 pounds of concentrates during the 30 day feeding period of ground roughage, and 2750 pounds of alfalfa hay, 2750 pounds of corn fodder and 1265 pounds of concentrates during the 30 day feeding trial when whole roughages were fed.

We note a slight increase in production of both milk and fat during the ground roughage periods, with a lower consumption of roughage, but a higher consumption of concentrates.

The data in this trial indicate a small advantage for grinding of the roughages. All of the corn fodder was eaten when fed ground, while 36 per cent by weight of the fodder was refused when fed whole. The refused part, however, was the lower, coarser part of the corn plant.

During the fourth trial alfalfa hay and corn stover were used as a roughage. A concentrate mixture composed of eight parts of ground corn, two parts ground oats, one-fourth part wheat bran and one-fourth oil meal was used. The concentrate mixture with the roughages was balanced for each cow every ten days. Seven cows were used, and the trial continued for 90 days.

The seven cows produced 2923.6 pounds of milk and 123.63 pounds of fat in 30 days during the ground roughage period, and 2707.9 pounds of milk and 113.95 pounds of fat in 30 days during the whole roughage period. This is an increase of 215.7 pounds of milk and 9.68 pounds of fat in favor of the ground roughage periods.

For the 30 day ground roughage period the seven cows consumed 2220 pounds of alfalfa hay, 2250 pounds of corn stover and 1615 pounds of concentrates. For the whole roughage period the same cows consumed in 30 days 2220 pounds of alfalfa hay, 2260 pounds of corn fodder and 1540 pounds of concentrates. The roughage consumption was about the same in both periods. During the ground roughage period, however, 75 pounds more concentrates were eaten.

The increase in production was in favor of the ground roughage; however, it should be noted that there was also an increase in consumption of concentrates. The data therefore would seem to indicate no material advantage due to grinding of the roughage.

Thirty-six per cent by weight of the corn fodder fed was refused. This was the same percentage of refuse as was obtained in the third trial. The refused fodder consisted of the lower parts of the corn plant. All the leaves and finer parts of the plant were eaten.

In feeding alfalfa hay with corn fodder the cows were observed to throw the fodder out of the manger and eat the alfalfa first. This was done despite the fact that the alfalfa was placed on top of the fodder in the manger. The fodder thrown from the manger became more or less soiled and even though it was placed back in the mangers the cows refused to eat it. This accounts in part for the rather large percentage of whole fodder refused.

During the feeding of the ground roughage all of the roughage was eaten, thus facilitating greatly the handling of the corn fodder, as well as the performance of other barn practices. No particular inconvenience was noted due to dust from the finely ground alfalfa.

The data in the four trials do not seem to indicate any advantage in grinding roughage so far as its nutritional or feeding value is concerned. It is well to keep in mind, however, that when such coarse roughage as corn fodder is fed that it is all eaten, whereas when the whole roughage is fed, about one-third of the roughage by weight is thrown out of the manger. This is important from the

standpoint of barn practice. When the cornstalks become embedded in the manure the latter is more difficult to handle, and the tidy appearance of the barn is marred. When grinding of roughages is being considered the facility of handling and the performance of other barn practices should not be overlooked. Where corn fodder or stover is fed in large quantities to cows in stanchions, the saving in labor in feeding the ground over whole roughages may compensate one for the added cost of grinding.

Feed Cost of 100 Pounds of Milk and One Pound of Fat

Ordinarily the feed cost of the milk and fat is the deciding factor in adding costs to feeds. It would not be good dairy management to add a cost to a feed unless such added cost increased production or in other ways resulted in increased benefits.

In arriving at the feed cost of production one must use arbitrary prices for the feeds. Obviously the prices used affect the final results. However, when the same feeds are used throughout all trials, the relative cost of production with the various feeds is significant.

The data indicate an average feed cost for 100 pounds of milk for the four trials of $1.44 for the ground roughage and $1.39 for the whole roughage.

As was previously pointed out this small increase in feed cost of production when ground roughages are fed would in many instances be offset by the saving in labor in feeding the ground roughage and handling of the manure. The difference in feed cost of fat production during the various trials is not significant.

The milk and fat increased slightly during the feeding of the ground roughage.

There was an increase of about 3.9 per cent in milk and 5.6 per cent in fat. The increase during the ground roughage periods, though not very large, is consistent throughout all the trials. The increase in production, however, was not sufficient to offset the increase in feed cost of the milk due to grinding.

Table 1 shows the cost of milk and fat production for the various trials.

The cost of grinding the roughages is discussed fully in another section of this bulletin hence no explanation is necessary here to account for the difference in cost of grinding in different years. The same price was used in the first three trials, and a somewhat higher price for both alfalfa and fodder was used in the fourth trial.

The Digestibility of Ground Roughages

The digestibility of ground roughages is a very important question, and one which was given careful study in these trials.

Prior to beginning the feeding trials, three digestion trials of five days each were conducted, first on whole alfalfa, then ground alfalfa and last ground alfalfa and ground barley. These were thoroughly mixed and fed in a tight manger.*

*These trials were supervised by E. O. Herried.

Four cows were used, and each feed was fed for five days with a three day preliminary period. The results indicated a decrease in digestibility when the roughage was ground. When the ground barley was mixed with the ground roughage, a still further decrease in the coefficients of digestibility was noted, except in the case of N.F.E. Because of the relatively high per cent of nitrogen free extract in barley, a higher coefficient would be expected in this nutrient.

Digestion trials were conducted on each feeding trial. The trials were of five days duration, and taken the last five days of the second and third periods of each trial. Hence the cows had been receiving the ration 25 days previous to the time the trials were started.

To get additional data on the question of digestibility, three trials of ten days duration were conducted.*

In the first trial four dry cows were used, and corn stover constituted the only feed. First whole stover was fed for ten days, then ground stover. The roughages were carefully weighed, and all refuse collected, weighed and analyzed. The rest of the procedure in the digestion trials was run in the regular way.

The second trial, whole and ground wild hay constituted the sole ration. Three of the four cows used on the corn stover trial were used; however, one of the cows aborted and so was taken off the trial. One of the other cows refused to eat her ration and showed symptoms of a light attack of pneumonia. Some time after the completion of the trial she died from pneumonia. Hence the data in this digestion trial must be interpreted with these facts in mind.

To obtain data on the digestibility of the whole ration when the roughage was fed whole and ground with grain a third ten day trial was run. Four dry cows were used. Whole wild hay was fed in the experimental manger, and a ground grain mixture of corn and oats were fed in the feed box. A three day preliminary period preceded the feeding of the ground roughage. The ground corn and oats were mixed thoroughly with the ground wild hay, and the ration fed in a two-bushel basket. The feces were collected, sampled and analyzed in the regular way.

Table 2 shows the results of all trials. It is noted that there is no consistent increase in the coefficients of digestion in any of the nutrients when ground roughages were fed. Workers from other stations have reported an increase in the digestibility except in crude fiber when ground roughages were fed alone and with a grain mixture. The data here presented do not indicate an increase in any nutrient. The data rather justify the conclusion that the coefficients of digestion are not increased by feeding ground roughages. Neither is the digestibility of the entire ration increased. However, the coefficients for the ground and unground roughages seem to be in closer agreement when the roughages were fed with concentrates than when the roughages constitute the sole feed. There is no reason to believe that the grinding of the roughage

*The work on two of these trials was supervised by E. C. Sheidenhelm as a research problem.

increases the coefficients of digestibility of the concentrates. It seems more probable that the coefficients of digestibility of the concentrates remain the same regardless of the condition of the roughage.

Forbes (6) explains the difference in digestibility of whole and ground alfalfa on the basis that the ground roughage is not subjected to the same degree of soaking and fermentation in the rumen that whole roughage is. The course of the food is determined largely by its fineness of grinding, hence the ground roughage passes by the paunch and consequently escapes the prolonged soaking and fermentation and the subsequent regurgitation and remastication.

Armsby (15) implies that finely comminuted portions probably pass on directly to the omasum or manifolds and the abomasum. This view is not borne out by Nevens' work (4) who found that there was little difference between the animals fed whole hay and those fed ground hay with respect to amount of dry matter of the rumen content or other parts of alimentary canal.

The course of the ground and whole roughage seems to be the important fact in explaining the difference in digestibility. If, as is held by some, the ground roughage passes the rumen directly to the honey comb abomasum, thus escaping the bacterial fermentation and enzymic action within the rumen, the lower digestibility of ground roughages can be explained on that basis.

The work at this station did not investigate the course of the roughage, however, a record kept during three ten day digestion trials on 12 cows, indicated that considerably more time was spent in eating the whole roughage. An average time of 224 minutes per day per cow was spent in eating the whole roughage as compared to 106 minutes for the ground roughage.

The longer time in chewing the whole roughage undoubtedly resulted in macerating and breaking down of the fibrous covering of the roughage, thus allowing for more rapid and thorough action in the paunch. The ground roughages were probably conveyed to the paunch heavily coated with saliva and mucous, thus deterring the digestive action of the rumen.

Further observations during the digestion trials indicated that fewer champs were made on each bolus in the chewing of the cud, for whole roughage than for ground roughage. The count on 800 boli showed an average of 51.5 champs for each bolus on ground roughage and 47.5 champs per bolus when whole roughage was fed.

Digestibility of Refused Corn Stover

It was previously pointed out that about one-third of the corn stover was refused. The refused stover was saved until sufficient had been obtained to conduct a digestion trial. The refused stover was cut into about one-eighth inch lengths. It was very dry when cut. A ten day digestion trial was planned in the regular way. Three dry cows were used. The cows had been receiving, previous to the trial, the herd ration, consisting of corn silage, alfalfa and a grain mixture composed of corn, oat, oil meal and bran.

The cows were weighed morning and evening each day while on the digestion trial. They had water and salt before them at all times. The cut refuse was fed in a tight manger, and a fresh supply fed morning and evening.

It was planned to continue the trial for ten days, but when the cows refused to eat, and lost greatly in weight, as table 3 will show, the trial was discontinued at the end of the sixth day. The cows ate more salt than normal and kept chewing at the wooden mangers.

Table 3 indicates a negative balance in all nutrients with all three cows. The weighings also show that the cows were losing in weight every day.

These results would seem to indicate that cows cannot utilize the nutrients in the refused corn stover even though the chemical analysis shows that nutrients are there in appreciable amounts. Perhaps if the refused stover had been made more palatable, the cows would have eaten it. At the conclusion of the trial an attempt was made to induce the cows to eat the cut refuse, by pouring a molasses solution over the cut stover, but without success. The cows refused it in any form.

It should be stated that the cut stover was very dry and several weeks old, as it took about that time to accumulate what we thought would be sufficient for a ten day digestion trial. However, the stover was not moldy nor did it have any undesirable odors. Perhaps if the stover had been cut as refused and fed, greater success in getting the cows to eat the stover might have resulted. It is also worthy of note that the cows which were used on the trials were dry, and fat, hence had considerable reserve and perhaps were more particular about what they would eat, than cows in thin condition and lacking the reserve fat.

CONCLUSIONS

The work at this station would seem to justify the following conclusions:

1. The feeding of ground or cut roughage to dairy cows increases slightly the production of milk and fat.

2. The increase in production is not sufficient to pay for the cost of grinding.

3. The cows increased slightly in weight during the feeding of the ground or cut roughages, but a somewhat greater amount of concentrates was eaten.

4. Dairy cows will eat coarse roughages in greater amounts when these roughages are cut and mixed with the concentrates.

5. When such coarse roughage as corn stover was fed, about 36 per cent by weight of the roughage was refused. The refused part of the corn stover was the lower two to two and one-half feet of the stalk. All the leaves and finer parts were eaten.

6. The digestibility of the roughage is not increased by grinding or cutting.

7. The digestibility of the entire ration is not increased by mixing the concentrates with the ground or chopped roughages; however, a closer agreement obtains in the coefficients of digestibility when concentrates are fed with cut roughages, than when the roughages are fed alone.

8. About twice the time was required by the cows to eat the whole roughage ration as the same number of pounds of the cut roughage ration.

9. In chewing the cud more champs per bolus were made on the cut roughage than the whole roughage.

10. No particular difference could be noted in the physical condition of the cows when fed cut roughage or whole roughage. A slight increase in weight in favor of the cut roughages was noted.

11. The cut corn stover was nicer to handle and feed to cows in stanchions.

12. Aside from the fact that the corn stover was not eaten up clean, no difference in palatibility was noted in whole and cut roughages.

13. The cutting or grinding of a good grade of roughage is not advisable. The cutting of a poor grade of roughage, or coarse roughage can be recommended only when the cost of grinding is low.

14. The saving of labor and the facility with which ground or cut roughage can be fed and stored, make cutting or grinding advisable under some conditions.

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Table No. II

COEFFICIENTS OF DIGESTIBILITY

	Length of trial days	No. of cows	Protein	Ash	Cr. Fiber	Ether Ex.	N. F. E.
Whole alfalfa	5	4	73.96	57.72	82.95	59.50	74.36
*Whole corn fodder	10	4	56.75	44.20	76.20	64.65	73.22
*Whole wild hay	10	4	32.86	8.99	50.18	38.48	58.68
Average			54.52	36.97	69.78	54.21	68.75
Ground alfalfa	5	4	69.53	43.02	78.90	53.98	73.14
*Ground corn fodder	10	4	40.56	20.48	66.71	51.96	62.75
*Ground wild hay	10	4	36.11	10.48	48.44	35.21	52.89
Average			48.73	24 66	64.68	47.05	62.93
Whole alfalfa, corn fodder, grain mixture	5	7	83.70	55.93	71.64	69.34	86.77
Whole sweet clover, silage, grain mixture	5	7	72.14	53.78	71.82	81.49	89.96
Whole wild hay, grain mixture	10	4	58.57	7.71	57.54	56.59	68.08
Average			71.47	39 14	67.00	69.14	81.60
Ground alfalfa, corn fodder, grain mixture	5	7	84.02	64.34	77.92	75.44	86.83
Ground sweet clover, silage, grain mixture	5	7	64.19	42.89	70.96	82.98	90.87
Ground wild hay, grain mixture	10	4	59.33	13 97	55.30	60.22	67.67
Average			69.18	40.40	68.06	72.88	81.79
†Whole alfalfa	5	4	73.96	57.72	82.95	59.50	74.36
†Ground alfalfa	5	4	69.53	43 02	78.90	53.98	73.14
†Ground alfalfa and ground barley	5	4	65.63	39.03	60.28	48.57	87.38

*These trials were supervised by E. C. Scheidenhelm.
†These trials were supervised by E. O. Herried.

Table No. I

FEED COST OF MILK AND FAT PRODUCTION

	Dry roughage	Per cwt.	Value	Silage	Per ton	Value	Concentrates	Per cwt.	Value	Total	Cost of grinding	Pounds of milk	Feed cost per 100 lbs. milk	Pounds of fat	Feed cost per 1 lb. fat	Number of cows
Ground alfalfa ...	1430	$ .60	$ 8.58	2700	$ 5.00	$ 6.75	752	$ 1.62	$ 12.18	$ 27.51	$ 1.02	1966	$ 1.45	85.59	$ .333	3
Whole alfalfa	1480	$ .60	$ 8.88	2700	$ 5.00	$ 6.75	725	$ 1.62	$ 11.75	$ 27.38		2025	$ 1.35	89.00	$ .308	3
Ground sweet clover. ...	1798	$ .50	$ 8.99	3600	$ 5.00	$ 9.00	1284	$ 1.62	$ 20.80	$ 38.79	$ 1.38	3601	$ 1.11	153.05	$ .262	4
Whole sweet clover.....	1860	$ .50	$ 9.30	3600	$ 5.00	$ 9 00	1255	$ 1.62	$ 20 33	$ 38.63		3546	$ 1.09	144.47	$ .267	4
				Corn fodder												
Ground roughage .	2601	$ .60	$ 15.61	2601	$ 8.00	$ 10.40	1417	$ 1.62	$ 22.96	$ 48.97	$ 4.00	3559	$ 1.49	153.25	$ .345	7
Whole roughage .	2750	$ .60	$ 16.50	2750	$ 8.00	$ 11.00	1265	$ 1.62	$ 20.49	$ 47.99		3313	$ 1.45	140.22	$ .342	7
Ground roughage .	2220	$ .60	$ 13.32	2250	$ 8.00	$ 9.00	1615	$ 1.62	$ 26 16	$ 48.48	$ 3 92	2924	$ 1.79	123.47	$ .424	7
Whole roughage .	2220	$ .60	$ 13.32	2260	$ 8.00	$ 9.04	1540	$ 1.62	$ 24.95	$ 47.31		2708	$ 1.75	113.95	$ .415	7
				Corn silage	Corn fodder											
Total for ground roughage.	8049		$ 46.50	6300	4851	$ 35.15	5068		$ 82.10	$ 163.75	$ 10.32	12050	$ 1.44	515.36	$ .337	21
Total for whole roughage..	8310		$ 48.00	6300	5010	$ 35.79	4785		$ 77 52	$ 161.31		11592	$ 1.39	487 64	$ .330	21

Table III

Cow 256 ate 1.386 pounds on dry basis, of cut corn stover in the six days, which according to the chemical analysis there was .097 plus, pounds of crude protein. During the same period of time the cow voided 18.978 pounds on dry basis, of feces in which there was .478 plus, pounds of crude protein. In other words, she voided in the feces approximately five times as much crude protein as was taken in in the feed. During this time the cow lost approximately 80 pounds in live weight.

In studying the other nutrients for Cow No. 256 as well as the other two cows we note a negative balance in every nutrient with all three cows.

Table No. III

CUT CORN STOVER REFUSE

	Lbs.feed Dry basis	Dry basis Nutrients	Lbs. feces Dry basis	Dry basis Nutrients	Weight of cows Lbs. P. M.	Lbs. A. M.
Cow 256	1.386 Analysis		18.978 Analysis		1472	1440
Protein	6.50	.090090	2.52	.4782456	1430	1420
Ash	4.92	.0681912	15.23	2.8903494	1413	1390
Crude fiber	39.39	.5459454	25.24	4.7900472	1385	1385
Ether Ext.	2.09	.0289674	2.72	.5162016	1393	1385
N. F. E.....	47.11	.6529446	54.29	10.3031562	1392	1398

	Lbs.feed Dry basis	Dry basis Nutrients	Lbs. feces Dry basis	Dry basis Nutrients	Weight of cows Lbs. P. M.	Lbs. A. M.
Cow 336	2.310 Analysis		22.323 Analysis		1805	1740
Protein	6.50	.1501500	4.02	.8973846	1780	1700
Ash	4.92	.1136520	14.87	3.3194301	1693	1690
Crude fiber	39.39	.9099090	28.30	6.3174090	1660	1645
Ether Ext.	2.09	.0482790	3.41	.7612143	1657	1630
N. F. E.....	47.11	1.0882410	49.40	11.0275620	1650	1645

	Lbs.feed Dry basis	Dry basis Nutrients	Lbs. feces Dry basis	Dry basis Nutrients	Weight of cows Lbs. P. M.	Lbs. A. M.
Cow 323	4.620 Analysis		23.229 Analysis		1620 1525	1550 1508
Protein	6.50	.3003000	2.12	.4924548	1520	1495
Ash	4.92	.2273040	15.77	3.6632133	1490	1500
Crude fiber	39.39	1.8198180	28.01	6.5064429	1515	1500
Ether Ext.	2.09	.0965580	2.69	.6248601	1520	1480
N. F. E.....	47.11	2.1764820	51.41	11.9420289	1485	