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I. B. Johnson

L. E. Johnson

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March, 1944

Fattening Range Lambs

On South Dakota Feeds

Bulletin 373

Sixteen Years of Experimental Feeding
At the Belle Fourche Field Station
Newell, South Dakota

Animal Husbandry Department, Agricultural Experiment Station
South Dakota State College, the Bureau of Animal Industry
and Bureau of Plant Industry, United States Department
of Agriculture Cooperating

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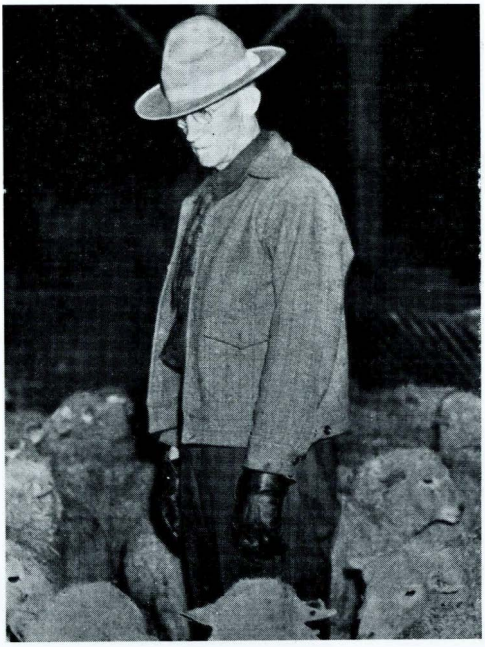

BEYER AUNE, Superintendent
BELLE FOURCHE FIELD STATION
(1909-1942)

The experimental lamb feeding results presented here are a tribute to Beyer Aune, who for 33 years directed the work of the U. S. Belle Fourche Field Station at Newell, South Dakota. When he came to Newell, the Field Station was in a pioneer stage of development. Through the succeeding years the experimental work expanded soundly to solve the problems of irrigation farming.

Experimental work in livestock production was started in 1922, and 5 years later the lamb feeding trials were begun. Since then a Lamb Feeder's Day has been held annually at the Field Station. On this day Mr. Aune presented results of the season's trials to farmers and stockmen of the surrounding territory.

Beyer Aune's interest in livestock improvement was not confined merely to his duties at the Field Station. He helped to organize the first 4-H lamb feeding work started in this country and supervised the work of the local club throughout his years of service. He was also director and later secretary of the Butte County Fair, taking a responsible part in developing a general interest in livestock of better type and quality.

Mr. Aune looked forward to the time when these data on feeding lambs could be printed for the farmers and stockmen on the irrigation project as well as those throughout the State and region. A fatal illness denied him the opportunity to assist in completing this publication.

Fattening Range Lambs on South Dakota Feeds

By I. B. Johnson and Leslie E. Johnson[1]

Lambs are important consumers of South Dakota farm grains, roughages, and beet byproducts. These feeds usually bring more profit when they are fed to lambs than when they are sold on the open market. The ability of the lamb to utilize South Dakota feeds and to fit into the general agriculture of the State is attested by the steady increase in lamb feeding during recent years. Government reports show that there were 366,000 sheep and lambs on feed in January, 1943,[2] four times as many as in 1925.

Still further expansion in lamb feeding in South Dakota seems likely for the following reasons: (1) Feeding practices fit readily into the farm-management system. (2) There is an ample supply of range feeder lambs within the State. (3) In this climate sheep thrive well in the feed lot. (4) Lambs are ideal as a means of marketing the large amount of roughage and moderate amount of grain that exist in many areas. (5) Good livestock marketing facilities are readily available.

Many problems regarding the use of suitable combinations of different feeds in fattening rations have arisen with the expansion of lamb feeding. To answer such questions the South Dakota Agricultural Experiment Station and the United States Department of Agriculture have cooperated in lamb feeding experiments at the U. S. Belle Fourche Field Station, Newell, South Dakota. During the 16 years of these experiments, 10,880 head of range feeder lambs were fed on 50 different test rations. This bulletin reports the results of these experiments.

Feeds Studied

All of the feeds studied were clean, sound, and of good quality. The shelled corn (yellow) graded mostly No. 2 and No. 3. The wheat, barley, and oats averaged 58 pounds, 48 pounds, and 35 pounds per bushel, respectively. The alfalfa hay was of No. 1 and No. 2 grades; the sudan grass hay, western wheat grass hay, and amber cane fodder were all bright and well cured.

The cottonseed cake and linseed oil meal carried a guarantee of not less than 43 percent and 34 percent protein, respectively. The molasses, pressed beet pulp, and dried beet pulp were of commercial grade, the former two being produced by the sugar company at Belle Fourche, South Dakota.

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[1] I. B. Johnson, Director of the South Dakota Agricultural Experiment Station and Animal Husbandman; and Leslie E. Johnson, Associate Animal Husbandman. Acknowledgement is due Director Emeritus J. W. Wilson of the South Dakota Station for his supervision and participtaion in the work and to Carl Larson, Superintendent of the U. S. Belle Fourche Field Station, for his supervision of the feeding trials during the 1942-43 feeding season.

[2] *South Dakota Agricultural Statistics, 1942*. South Dakota Crop and Livestock Reporting Service, Sioux Falls, South Dakota. 1943.

TABLE 1. CHEMICAL ANALYSES OF DIFFERENT PREPARATIONS OF BEET TOPS

	Water	Ash	Crude protein	Crude fiber	N-free extract	Ether extract	Carotene micrograms per gram
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	
Dry beet tops (field cured)	28.45	32.98	10.09	8.14	19.58	.76	7.55
Wilted beet-top silage	50.66	23.58	4.82	4.88	15.23	.83	10.35
Green beet-top silage	73.64	5.03	3.13	2.92	14.57	.71	11.94

Corn silage was made from corn yielding about 35 bushels of ear corn per acre. Dry beet tops were cured in piles in the field and fed as needed. Green beet-top silage was made by stacking the tops above ground immediately following harvest; wilted beet-top silage was made by stacking the tops above ground after they had wilted in the fields for 2 weeks.

The beet-top silages in all feeding trials were highly palatable and spoilage was not excessive. An average of 68 pounds of green beet tops was produced for each 100 pounds of beets. After deduction of spoilage, 100 pounds of green beet tops yielded 48 pounds of dry beet tops, 44 pounds of wilted beet-top silage, and 62 pounds of green beet-top silage.

The chemical analyses of the five different beet-top feeds are given in Table 1. The high ash content resulted largely from soil adhering to the tops during harvest. Thus the analyses represent the beet tops as fed and are somewhat different than analyses reported by those who have studied clean samples only.

How The Feeding Tests Were Conducted

Range feeder lambs from western South Dakota were fed in all of the feeding trials. Most of them were the white-face, close-wooled type, chiefly of Rambouillet breeding. They were bought directly from the range. Some culling was done each year to make the groups reasonably uniform in weight, type, and conformation.

Grouping of lambs for the different rations was made by taking gate cuts from the entire band. Because of the previous culling and the large numbers of lambs, fairly uniform groups resulted. One-day initial and final weights were used throughout the experiment. Weights were also taken at 28-day intervals during the feeding trials.

With the exception of the first few trials, 100 lambs were fed per lot. This number was used to approach actual farm feeding conditions as nearly as possible. In general, the selected feeder lambs were started on the tests at weights ranging from 60 to 70 pounds. The average starting weight was 66 pounds. The average finished feed lot weight was 97 pounds.

The feeding was done in the fenced enclosure shown on the cover page of this bulletin. In the holding pens there were 2,640 square feet per 100 lambs. In the grain-feeding pens, there were 1,650 square feet per 100 lambs. No shelter was furnished other than a tight board fence.

Feeds fed. Upon arrival at the Field Station, the lambs usually were held for 10 to 12 days on native pasture plus some dry roughage. When they were started on feed, the amounts fed were increased gradually.

PRESSED BEET PULP was unloaded and stored in a silo pit at the feed yard.

Grain was fed at the start at the rate of ¼ pound per head daily. Later it was increased to as much as the lambs would consume without going off feed—usually between 1¼ pounds and 1¾ pounds per head daily. However, in a few trials it was impossible to get the consumption above 1.1 pounds without the lambs having digestive disorders.

Beet molasses was started at ¼ pound per head daily and then gradually increased to 1 pound per head.

Grains, dried beet pulp, protein supplements, and beet molasses were fed twice daily. Pressed beet pulp, field-cured beet tops, and beet-top silage were fed once daily.

When dry beet tops, beet-top silages, and corn silage were fed, they replaced the evening feed of hay. Otherwise the hays were fed twice daily. The lambs were allowed all the alfalfa hay they would clean up after eating the other feeds. It was fed in panel mangers in the holding pens as illustrated on page 9.

Salt and water were kept in the lots at all times.

Length of feeding period. The length of the feeding periods ranged from 97 to 160 days, the average being 119. During the last 3 years the lambs were "topped out" (lambs of proper market finish were sorted out) and marketed as they finished. This method of marketing necessitated two to three shipments each year, but it prevented dockage in price because of overweight lambs. Also it lengthened the feeding period as the slower gaining lambs were fed until finished.

Costs and returns. The costs of production in these experiments included (1) initial lamb cost, (2) feed costs, (3) interest, (4) death loss, (5) freight and

marketing costs. No charges were made for labor and such overhead expenses as depreciation of equipment and risk. The returns for labor are included in the profit or loss on the season's feeding operations. No credit was allowed for the value of the manure.

With this method of figuring costs, the rations containing beet pulp, dry beet tops, beet top silage, and molasses have a slight financial advantage. The reason for this is that there was proportionately more labor needed to feed them than for the rations containing only grain and hay. Thus, the larger returns from the complex rations (Tables 3 and 4) would in part be offset by a greater labor cost.

The initial lamb cost was the cost of the feeder lambs delivered at the Field Station.

Feed lot death loss and shrinkage to market were prorated equally to all lots in figuring the returns per lamb. This prorating was done because the differences in death losses and shrinkage over the 16-year period were much more closely associated with years and lambs than with feeds.

Final values were determined by the sale of the lambs at the Sioux City central public market. Feed cost and returns per lamb were calculated by using average prices for the cost of feeder lambs, feeds, interest, and market expenses, and an adjusted average selling price for the finished lambs. For the corn and alfalfa ration, the adjusted selling price was the 16-year average. For all other rations it was that price which kept the price difference the same as it was during the years when the corn and alfalfa ration and the other rations were directly compared. The actual selling price could not be used since all rations were not fed each year.

Experimental Feeding Results

For convenience in reporting the experimental results, the rations fed have been divided into two groups: (1) Farm grains and roughages with or without protein supplements (Table 2). (2) Farm grains, roughages, and beet byproducts with or without protein supplements (Tables 3 and 4).

Farm Feeds With or Without Protein Supplements

The farm grown feed grains and roughages in South Dakota that have been among the most plentiful for fattening lambs are corn, barley, oats, alfalfa hay, sorghum fodder, wheat grass hay, and sudan grass hay. Each of these feeds was fed in different combinations with or without protein supplements, minerals, and a succulent feed in an attempt to find efficient feeds for finishing lambs (Table 2).

Corn and alfalfa hay were fed as the standard check ration during each of the 16 years of the experiment. As in tests at other stations this simple, easily fed ration proved very satisfactory in both rate of gain and returns per lamb. This was true in spite of the relatively high price paid for corn at Newell.

Cottonseed cake added to corn and alfalfa hay consistently increased the daily rate of gain and the returns per lamb.

Linseed oil meal, monocalcium phosphate, and corn silage (Rations 3, 4, and 5) were not very profitable under existing prices. The low daily gain occurring

TABLE 2. COMPARISON OF SOUTH DAKOTA GRAINS AND ROUGHAGES WITH OR WITHOUT PROTEIN FEEDS

Ration	Feed needed for 100 lb. gain	Daily gain	Years of feeding	Number of lambs	Death loss	Feeder lamb wt.	Finished lamb wt.	Shrink to market	Dressing percent	Selling price per cwt.	Return per lamb	Feed* cost per 100 lb. gain
	lb.	*lb.*			*percent.*	*lb.*	*lb.*	*lb.*				
1. Corn (shelled)	355											
Alfalfa hay	794	.28	16	1,346	2.2	65.6	99.1	5.8	51.2	$10.35	$.45	$8.35
2. Corn (shelled)	266											
Alfalfa hay	699											
Cottonseed cake	58	.33	5	252	2.0	58.9	98.6	7.1	49.9	10.40	.61	8.05
3. Corn (shelled)	326											
Alfalfa hay	731											
Linseed oil meal	65	.31	3	101	2.9	62.8	101.1	9.2	50.3	10.40	.07	9.59
4. Corn (shelled)	355											
Alfalfa hay	853											
Monocalcium phosphate	7	.27	3	292	7.0	67.4	100.1	5.2	51.3	10.35	.31	8.85
5. Corn (shelled)	356											
Alfalfa hay	783											
Corn silage	767	.21	3	300	5.7	70.8	95.2	4.7	51.0	10.35	.07	9.65
6. Corn (shelled)	536											
Sudan grass hay	1,320	.15	2	125	4.8	72.0	90.3	4.5	49.6	9.90	–.65	11.36
7. Corn (shelled)	409											
Sudan grass hay	1,175											
Cottonseed cake	102	.17	2	125	2.4	72.6	92.7	4.0	49.5	10.05	–.54	11.36
8. Corn (shelled)	591											
Western wheat grass hay	1,234	.14	2	125	8.8	72.9	89.8	3.4	49.5	10.05	–.86	13.50
9. Corn (shelled)	455											
Western wheat grass hay	1,095											
Cottonseed cake	112	.15	2	125	8.0	72.0	90.5	4.7	49.9	10.05	–.95	13.62
10. Corn (shelled)	438											
Amber cane fodder	1,310	.18	2	125	7.2	72.4	94.5	5.0	50.7	10.15	–.15	9.81
11. Barley	423											
Alfalfa hay	888	.25	6	400	2.7	66.3	98.0	6.1	50.5	10.40	.43	8.50
12. Barley	325											
Alfalfa hay	768											
Cottonseed cake	65	.30	4	153	0.6	62.3	96.7	8.0	49.7	10.50	.53	8.41
13. Oats	482											
Alfalfa hay	831	.26	3	103	1.0	62.7	94.3	7.6	47.4	10.50	.30	8.97

* Feed prices are shown below Table 4.

LAMBS WERE GRADED individually at the beginning and end of the feeding period. Men who were experienced in judging livestock acted as graders.

from the addition of corn silage gave a high feed requirement per 100 pounds of gain. Apparently the use of both alfalfa hay and corn silage in fairly large amounts gives the lambs too much bulk for rapid gain.

Amber cane fodder, sudan grass hay, or western wheat grass hay with or without protein supplements were very poor in all tests as substitutes for alfalfa hay.

Barley made a satisfactory substitute for corn in these tests but did not equal corn in feeding value. It took 119 pounds of the barley plus 26 pounds of alfalfa hay to equal 100 pounds of corn. The addition of cottonseed cake to the barley and alfalfa hay ration increased the daily gains and returns per lamb.

Oats and alfalfa hay gave fairly high daily gains but reduced the returns to about two thirds of the returns from either corn with alfalfa hay or barley with alfalfa hay. The reduced returns occurred in spite of the fact that the oats fed averaged 35 pounds per bushel, which is considerably better than much of the oats grown within the State.

Farm Feeds and Beet Byproducts With or Without Protein Supplements

Within the Belle Fourche irrigation area, beet byproducts are usually available for livestock feeders. In these experiments comparisons of rations were made in which lambs were fed pressed beet pulp, dried beet pulp, beet tops, and beet molasses, together with local farm feeds, protein supplements, and minerals (Tables 3 and 4).

Pressed beet pulp added to grain and alfalfa hay increased daily gains and added to returns per lamb (Table 3).

Molasses or cottonseed cake added to the rations containing grain, pressed pulp, and alfalfa hay did not pay. When dry beet tops were added together with molasses, returns per lamb were increased.

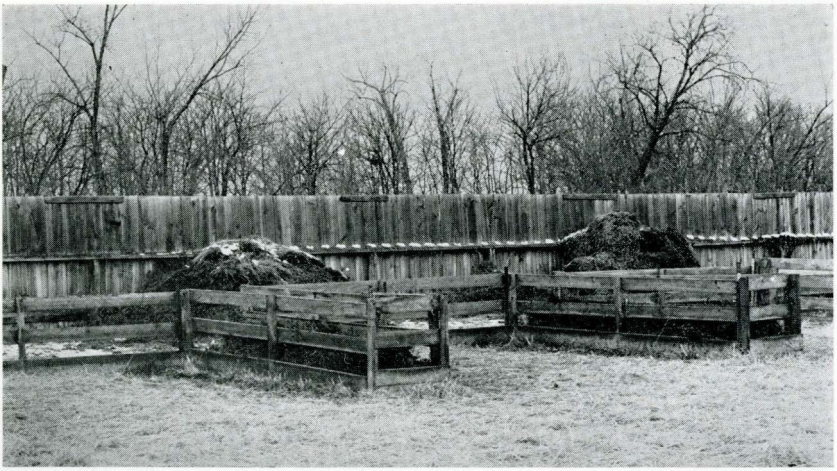
Wheat fed with alfalfa hay and pressed beet pulp resulted in satisfactory gains but was more expensive than other grains.

Alfalfa hay and pressed pulp fed without a grain, or the substitution of beet molasses for the grain, resulted in very small returns or financial losses. Such rations appeared to be too bulky to allow satisfactory daily gains. The use of cottonseed cake with alfalfa hay and pressed beet pulp made a better fattening ration but this combination was still inferior to corn and alfalfa hay.

Dried pulp was fed during 3 years of the experiment with results as shown in Rations 23, 24, 25, and 26 (Table 3). Good gains and fair returns resulted when the dried pulp was fed with alfalfa hay and a grain or with alfalfa hay and a protein concentrate. Dried beet pulp fed in such combinations was worth about the same as barley on a weight basis.

Beet tops added to grain, alfalfa hay, and pressed pulp further increased returns per lamb (Table 4). Feeding the beet tops as green or wilted silage gave less profit than feeding them as field-cured dry tops.

Minerals were not helpful. No benefits were evident from the use of bonemeal in the ration containing barley, alfalfa hay, pressed pulp, dry beet tops, and molasses.



ROUGHAGE FEED BUNKS were of simple construction. They were placed at regular intervals along one side of each feed lot. These are typical bunks.

TABLE 3. COMPARISON OF SOUTH DAKOTA GRAINS AND ROUGHAGES AND BEET PULP WITH OR WITHOUT PROTEIN SUPPLEMENTS AND MOLASSES

Ration	Feed needed for 100 lb. gain	Daily gain	Years of feeding	Number of lambs	Death loss	Feeder lamb wt.	Finished lamb wt.	Shrink to market	Dressing percent	Selling price per cwt.	Return per lamb	Feed* cost per 100 lb. gain
	lb.	*lb.*			*perct.*	*lb.*	*lb.*	*lb.*				
14. Corn (shelled)	317											
Alfalfa hay	573											
Pressed beet pulp	830	.30	6	600	3.0	63.7	99.6	5.3	51.6	$10.35	$.72	$7.65
15. Barley	405											
Alfalfa hay	625											
Pressed beet pulp	841	.28	6	598	2.2	64.4	98.6	6.2	51.1	10.25	.49	7.95
16. Barley	248											
Alfalfa hay	938											
Pressed beet pulp	971											
Cottonseed cake	68	.25	3	102	1.9	63.6	94.8	7.1	48.1	10.55	.22	9.36
17. Barley	319											
Molasses (beet)	51											
Alfalfa hay	801											
Pressed beet pulp	1,086	.25	3	300	2.3	70.6	99.0	5.0	50.8	10.35	.21	9.23
18. Oats	469											
Alfalfa hay	449											
Pressed beet pulp	906	.28	3	300	1.3	61.0	94.9	5.5	49.4	10.15	.32	8.00
19. Wheat	427											
Alfalfa hay	413											
Pressed beet pulp	851	.30	3	300	3.7	61.3	97.3	6.2	50.6	10.30	.22	8.74
20. Molasses (beet)	205											
Alfalfa hay	1,080											
Pressed beet pulp	2,734	.21	4	154	0.0	61.8	86.3	7.2	47.8	10.35	.04	9.04
21. Alfalfa hay	1,154											
Pressed beet pulp	2,908	.22	4	152	1.3	62.4	87.5	7.8	46.4	9.80	–.13	8.00
22. Alfalfa hay	979											
Pressed beet pulp	2,315											
Cottonseed cake	84	.24	3	103	1.0	62.6	92.4	8.4	49.3	10.50	.39	8.57
23. Barley	174											
Dried beet pulp	174											
Alfalfa hay	755											
Cottonseed cake	70	.29	3	104	0.0	63.5	99.5	8.6	47.5	10.50	.50	8.59
24. Dried beet Pulp	345											
Alfalfa hay	758											
Cottonseed cake	69	.29	3	101	3.8	62.9	98.4	9.3	47.8	10.45	.51	8.43
25. Dried beet pulp	339											
Alfalfa hay	778											
Linseed oil meal	68	.28	3	103	1.0	62.6	97.8	8.6	47.8	10.45	.32	8.88
26. Dried beet pulp	518											
Alfalfa hay	1,030	.21	3	99	4.8	63.0	89.0	7.8	48.0	10.30	–.17	9.79

* Feed prices are shown below Table 4.

TABLE 4. COMPARISON OF SOUTH DAKOTA GRAINS AND ROUGHAGES WITH PRESSED BEET PULP, BEET TOPS, AND MOLASSES

Ration	Feed needed for 100 lb. gain	Daily gain	Years of feeding	Number of lambs	Death loss	Feeder lamb wt.	Finished lamb wt.	Shrink to market	Dressing percent	Selling price per cwt.	Return per lamb	Feed* cost per 100 lb. gain
	lb.	*lb.*			*perct.*	*lb.*	*lb.*	*lb.*				
27. Corn (shelled)	279											
Alfalfa hay	396											
Pressed beet pulp	967											
Dry beet tops	577	.27	3	300	2.7	70.2	101.7	5.4	52.3	$10.35	$.80	$7.43
28. Barley	382											
Alfalfa hay	446											
Pressed beet pulp	791											
Dry beet tops	589	.27	3	296	1.7	68.2	102.1	5.8	52.4	10.35	.69	7.82
29. Barley	380											
Alfalfa hay	569											
Pressed beet pulp	784											
Green beet-top silage	854	.25	3	498	1.2	67.7	99.2	5.6	53.0	10.35	.30	8.81
30. Barley	384											
Alfalfa hay	522											
Pressed beet pulp	880											
Wilted beet-top silage	665	.25	3	399	0.8	69.9	100.7	5.3	52.1	10.35	.37	8.69
31. Barley	294											
Molasses (beet)	47											
Alfalfa hay	403											
Pressed beet pulp	994											
Dry beet tops	607	.27	3	300	3.0	70.1	100.8	5.2	51.8	10.35	.82	7.27
32. Barley	302											
Molasses (beet)	49											
Alfalfa hay	407											
Pressed beet pulp	1,040											
Dry beet tops	602											
Bonemeal	7	.26	3	300	2.3	69.4	98.8	4.6	51.7	10.35	.65	7.68
33. Wheat	207											
Oats	207											
Alfalfa hay	232											
Pressed beet pulp	828											
Dry beet tops	612	.31	3	300	3.7	60.5	97.5	6.2	50.5	10.30	.49	8.05

* Feed prices: Shelled corn, $1.35 per cwt. (76 cents per bu.); barley, $1.07 per cwt. (51 cents per bu.); wheat, $1.42 per cwt. (85 cents per bu.); oats, $1.09 per cwt. (35 cents per bu.); dried beet pulp, $1.00 per cwt.; molasses, 75 cents per cwt.; cottonseed cake, $2.30 per cwt.; linseed oil meal, $2.95 per cwt.; alfalfa hay, $8.95 per ton; western wheat grass hay, $8.95 per ton; sudan grass hay, $5.95 per ton; amber cane fodder, $5.95 per ton; corn silage, $3.50 per ton; pressed beet pulp, $1.95 per ton; dry beet tops, $3.29 per ton; green beet-top silage, $3.37 per ton; wilted beet-top silage, $4.18 per ton; monocalcium phosphate $3.45 per cwt.; and bonemeal, $3.65 per cwt.

Other Facts of Interest to Lamb Feeders

During the 16 years of lamb feeding work at the U. S. Belle Fourche Field Station, many facts were recorded that are not contained in the preceding report. They are given in the following pages, together with other information helpful to the lamb feeder.

Buying Feeder Lambs

Feeder lambs may be obtained (1) direct from the producer, (2) through stock buyers, (3) through livestock auction agencies, or (4) through central public markets. The method for a feeder to use depends largely upon his location and other circumstances.

The lambs purchased for the feeding trials reported here were obtained direct from the range producers every year except one, when they were bought from the local stock buyer. Purchasing direct proved very satisfactory on account of the location of the Station, and it allowed for greater uniformity in breeding and assured more similarity in care before the feeding tests.

It is desirable to obtain feeder lambs that are strong, healthy, vigorous, and blocky and have fleeces free from needle grass "stickers" and burrs. While careful selection will not eliminate death losses and slow gaining individuals, it certainly tends to keep both to a minimum. The thrifty lamb is able to get its share of the feed and thus responds more quickly to concentrated feeds. The market quality of the average feeder lamb increased approximately one grade between the time it entered the feed lot and the time it was marketed and slaughtered. "Good" feeder lambs graded "choice" when fat and dressed out "choice" carcasses.

All lambs did not increase in grade uniformly. In general, lambs that were two grades above average at the beginning of the feeding period were one grade above average when fat. Their carcasses were two thirds of a grade above average when on the hook. Lambs that were two grades below average at the beginning of the feeding period graded about one grade below average when fat. Their carcasses were only two thirds of a grade below average.

There was little tendency for lambs of the higher grades to outgain those of lower grades. Feeder lambs one grade above average produced fat lambs that weighed only one-half pound more than average lambs at the end of the feeding period. Apparently any premium paid for the superior feeder lambs will have to be repaid by an increase in the selling price of the finished lambs.

The weight of lambs for a feeder to buy depends largely upon the supply on the market, the kind and amount of feeds available, and the condition of the market regarding weight of finished lambs. In this experiment the average initial weights varied over the 16 years from 59 pounds to 73 pounds. The heavier lambs within the lots made slightly faster gains than the lighter ones. They also graded slightly higher when finished and dressed. These differences were not great enough to have any important effect on profits.

Most feeders prefer the mediumweight lambs, 55 to 65 pounds. Lambs of all weights can be developed into choice fat lambs if they are of good quality and are properly fed and managed.

The lightweight lambs ought to be brought on feed more slowly than the heavy lambs. They require 120 or more days to finish. They can utilize more roughage and cheaper roughage than the heavy lambs and still have proper finish at market weight.

Mediumweight lambs finish in 85 to 100 days. They should be fed moderate amounts of both grain and good quality roughage to become finished at 90 to 95 pounds live weight.

Heavy lambs should be finished rapidly. They need more concentrates throughout the fattening period. They are best adapted for lamb feeders who have a good supply of grain and a limited amount of roughage or for lambing-off corn or sorghum.

The purchase price must be in line with the quality of the lambs and with the expected selling price. On the average, the lamb feeder cannot afford to feed on less than a $2 per hundredweight margin; that is, the selling price of the lambs when fat must be as much as $2 per hundredweight more than the purchase price of the feeder lambs. This margin is necessary because the cost of 100 pounds gain usually exceeds the price received for 100 pounds of fat lambs.

The yearly margins and returns for lambs fed corn and alfalfa hay in the Field Station experiments are shown in Table 5. During 6 of these years there were financial losses. Five of these losses were due chiefly to low margins between purchase price of feeder lambs and selling price of fat lambs. The sixth loss (1934-35) was due to a very high death rate. The average margin for the period was $2.16, resulting in a return of 48 cents per lamb. During the 7 years in which the margin was less than $2, the feeding operations resulted in an average loss of 73 cents per lamb. During the 9 years when the margin was more than $2, the average return was $1.43 per lamb.

TABLE 5. EFFECT OF MARGINS ON RETURNS FROM LAMBS FED SHELLED CORN AND ALFALFA HAY (1927-42)

Year of feeding	Feeder-lamb price, cwt.	Fat-lamb price, cwt.	Margin	Returns per lamb*
1927-28	$12.00	$13.75	$1.75	$ .97
1928-29	12.00	16.40	4.40	2.58
1929-30	12.00	10.00	–2.00	–3.05
1930-31	6.50	8.25	1.75	–.22
1931-32	4.65	6.45	1.80	–.48
1932-33	4.25	5.65	1.40	.52
1933-34	5.50	9.35	3.85	2.81
1934-35	5.25	9.25	4.00	–.09
1935-36	7.50	10.60	3.10	1.81
1936-37	7.00	11.00	4.00	.39
1937-38	10.00	8.50	–1.50	–2.66
1938-39	6.75	8.85	2.10	.14
1939-40	8.00	9.25	1.25	–.19
1940-41	8.00	10.67	2.67	1.13
1941-42	10.00	12.05	2.05	1.37
1942-43	11.90	15.85	3.95	2.69
Average	8.21	10.37	2.16	.48

* Since this ration was fed each of the 16 years, actual death losses and shrinkage to market were used in calculating these values. This accounts for the 3 cents difference between the average returns per lamb in this table and the returns per lamb shown in Ration 1, Table 2.

In figuring the purchase price, the feeder should include all costs up to the time the lambs arrive at the feed lot—the cost of the lambs at source, transportation to feed yard, and loss due to shrinkage and death. Only once during the 16 years of this experiment were the lambs purchased on other than Field Station weights. On a haul of less than 50 miles, 68-pound lambs shrank an average of 5.2 percent or 3.5 pounds per head.

Feed Lots and Equipment

The feed lots and equipment need not be elaborate and expensive, but they should be serviceable. Well drained lots with good winter protection are necessary. In the less humid areas of South Dakota, a high board fence surrounding the feed lot furnishes all the protection needed. In the areas having more rainfall, an open shed allowing 4 square feet of floor space per lamb is desirable.

The holding pens where the lambs are fed hay and other roughages should contain about 20 square feet of area per lamb. Where the lambs are fed grain in a separate lot like that shown below, this lot should contain about 16 square feet per lamb. One linear foot of hay and grain trough space per lamb is advisable. Plans now available at state experiment stations for construction of feeding shelters, lots, bunks, and water systems, will greatly aid a feeder in solving equipment problems.

Feeding Practices

The largest single cost in lamb feeding other than the purchase price of the lambs is the feed cost. The selection of the feeds, therefore, needs to be given very careful consideration by every feeder. Feeds should be carefully selected each season because the relative prices of feeds are continually changing.

Local prices determine lamb fattening ration. The selection of a lamb fattening ration cannot be made on the basis of the feed costs per 100 pounds of gain or

REVERSIBLE GRAIN TROUGHS were used to feed grain, other concentrates, beet pulp, and silage. These troughs were in pens which adjoined each feed lot.

the returns per lamb as shown in Tables 2, 3, and 4. Variability in feed prices necessitates that each feeder select his own ration after considering local prices. In general, the ration that puts on the cheapest gains and finishes the lambs at

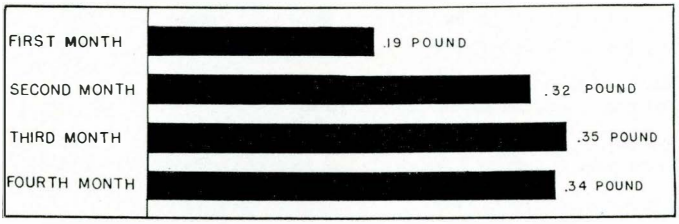


FIG. 1.—DAILY RATE OF GAIN OF LAMBS DURING SUCCESSIVE MONTHS OF FEEDING PERIOD.

desired market weights returns the greatest profits. Most lambs attain proper finish at desirable market weights if their daily gain is ¼ pound or more. In selecting a ration, a feeder should estimate feed costs per 100 pounds of gain on the basis of local prices for the feeds available and use the feeds that will finish his lambs at the lowest cost.

To calculate the cost of 100 pounds of gain at local prices, multiply the amount of each feed required for 100 pounds of gain by the price per pound and add the costs of all the feeds included in the ration. For example, with shelled corn at $0.66 per bushel ($0.0118 per pound), barley at $0.56 per bushel ($0.0117 per pound) and alfalfa hay at $8 per ton ($0.004 per pound), the cost of 100 pounds of gain on the corn and alfalfa hay ration would be [335 x .0118] plus [794 x .004] or $7.37. The cost of 100 pounds of gain on the barley and alfalfa hay ration would be [423 x .0117] plus [888 x .004] or $8.50. Thus it would be more profitable to feed corn and alfalfa hay at the prices indicated. With somewhat higher corn prices and lower barley prices, barley and alfalfa hay would be the more economical. In order to plan economical rations, a feeder should determine feed cost per 100 pounds of gain each feeding season.

Enough feed important. The importance of having enough feed available to finish the lambs cannot be overemphasized. Thin, unfinished lambs bring less on the market. Overhead costs, shrinkage, and marketing expense are greater per pound of gain with unfinished lambs than with lambs that have been properly fattened. Furthermore, the slowest gains are made during the first part of the feeding period. Fig. 1 shows the daily gain for each month of the feeding period for lambs fed the nine rations that proved very good. The daily gain during the first month is only slightly more than half the daily gain during each of the following months.

The amount of feed needed per lamb or group of lambs can be estimated from Tables 2, 3, and 4 (pages 7, 10, and 11). For example, to find the amount needed to put an average of 30 pounds of gain on 100 lambs with corn and alfalfa hay (Table 2, Ration 1), multiply 355 pounds of corn and 794 pounds of alfalfa hay by

TABLE 6. FEED REQUIRED TO FATTEN 100 HEAD OF LAMBS ON DIFFERENT RATIONS

Ration	Grain	Cottonseed cake or molasses	Alfalfa hay	Pressed beet pulp	Dry beet tops
	bu.	*lb.*	*tons*	*tons*	*tons*
Corn, alfalfa hay	190		11.9		
Corn, alfalfa hay, cottonseed cake	142	1,740	10.5		
Corn, alfalfa hay, pressed beet pulp	170		8.6	12.4	
Corn, alfalfa hay, pressed beet pulp, dry beet tops	149		5.9	14.5	8.7
Barley, alfalfa hay	264		13.3		
Barley, alfalfa hay, cottonseed cake	203	1,950	11.5		
Barley, alfalfa hay, pressed beet pulp	253		9.4	12.6	
Barley, alfalfa hay, pressed beet pulp, dry beet tops	239		6.7	11.9	8.8
Barley, beet molasses, alfalfa hay, pressed beet pulp, dry beet tops	184	1,410	6.0	14.9	9.1

30. The answers show that 10,650 pounds of shelled corn and 23,820 pounds of alfalfa hay would be needed. Table 6 shows the approximate amount of feed required to put an average of 30 pounds of gain on 100 head of lambs with the nine rations that did exceptionally well in the tests.

Marketing Lambs

In 13 of the 16 years of experimental feeding, the slaughter lambs were all marketed at the same time. During the last 3 years the lambs were marketed as they attained a finished condition. This practice is recommended when there are enough lambs finished at one time for a full carload or truckload. By such "topping out" the feeder can market the finished lambs at more desirable market weights, since the thriftier lambs will finish in a shorter feeding period. Fig. 2 shows the average monthly prices paid for the good to choice feeder lambs and a similar grade of slaughter lambs at the Sioux City livestock market during the 16-year period covered by the experimental feeding trials.

Shrinkage. This is one of the large costs of marketing lambs. The average shrink of the lambs while they were being shipped from the experimental feed lots to the Sioux City market was 5.9 pounds per lamb. The average shrinkage for the lots of 100 lambs varied from 1.2 pounds per lamb to 10.9 pounds per lamb.

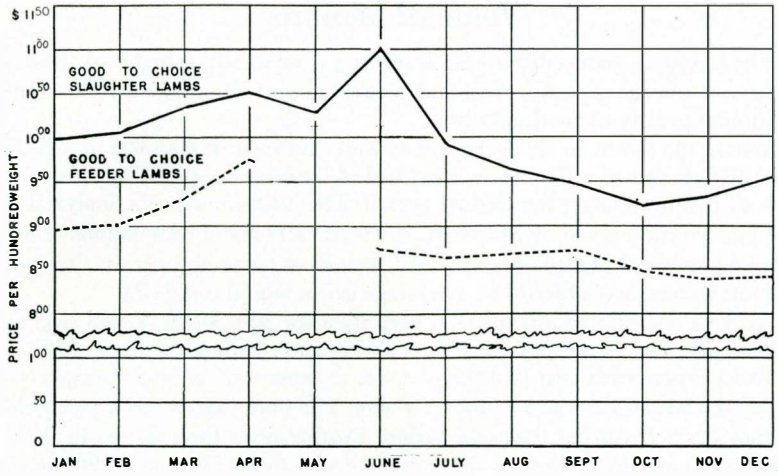


FIG. 2.—AVERAGE MONTHLY PRICES OF GOOD TO CHOICE FEEDER AND SLAUGHTER LAMBS AT SIOUX CITY MARKET (1927-43). THERE WERE NOT ENOUGH MAY FEEDER PRICES AVAILABLE TO ESTABLISH A DEPENDABLE AVERAGE.

Only one of the five series of tests indicated that the ration affected the shrinkage. Even with this test the difference was small and could not be explained on the basis of the kind of feeds.

The amounts of shrinkage in some years differed greatly from the shrinkage in other years. This difference was statistically significant in all series in which all of the lambs were shipped at one time. During the last 3 years, in which two to three shipments were made per feeding period, this difference was small between years but was large between shipments. Evidently weather and length of time and handling enroute are chiefly responsible for shrinkage differences experienced in marketing well finished lambs. The average shrinkage of 5.9 pounds represents 19 percent of the total feed lot gain.

Death losses during shipment. These losses were small for the lambs in this experiment—7 lambs during the 16-year period. There are times when feeders experience much heavier losses. The following suggestions are offered for keeping such losses to a minimum:

1. Do not overfeed fat lambs before shipping. Reduce the feed about 25 percent 12 hours before shipment.
2. Avoid overcrowding in the car or truck. Large trucks may well be partitioned.
3. Use fine sand for bedding in railroad cars and trucks.
4. In extremely cold weather, line the car with paper or cover the front and top of the truck with canvas.
5. Inspect the load at regular intervals while on the way to market.
6. Partition mixed loads to prevent bruising.
7. During stopovers on long shipments, feed the lambs hay before watering them.

Value of Manure

The manure produced from lamb feeding is especially valuable as fertilizer. It contains nitrogen, phosphorus, and potassium and its organic matter content contributes greatly to good soil tilth.

Where the lambs in this experiment were confined in feed lots and bedded liberally with straw, a double-deck carload of lambs produced 70 to 80 spreader loads of manure during the feeding period. This manure was not analyzed. According to figures given by Morrison[3] it would carry about 28.8 pounds of nitrogen, 4.4 pounds of phosphorus, and 20.2 pounds of potassium per ton. The same amounts in commercial fertilizer at average prices would cost $4.88.

At the Field Station, manure has been used for 30 years in certain crop rotation experiments. In a 2-year sugar beet and potato rotation, the use of 12 tons of manure per acre each year that the plot was in beets resulted in an average yield during the last 10 years of 14.3 tons per acre. The unmanured check plot yielded 7.8 tons per acre during the same period. Furthermore, the potatoes in the manured plot outyielded those in the untreated plot by an average of 50.9 bushels per acre annually. On the basis of $5.50 per ton for beets (value of beet tops included) and $0.60 per bushel for potatoes, the manure was worth $5.52 per ton in increased yields. Similar results occurred when sheep manure was used in the other rotations at the Station.

Additional Problems

In determining profits in lamb feeding, the price trend during the fattening period is important. If the lamb market is steadily declining, it is practically impossible to make a profit from the feeding operations. On such a market the feeder may have to take less per pound for the finished lambs than he paid for them as feeder lambs. A thorough study of the market outlook will, to some extent, indicate what future prices may be, thus preventing feeders expanding just because prices were high the previous year.

Lack of uniformity of gains during the feeding period should also be considered. The average total gain of all lambs fed during this experiment was 31 pounds. It was not uncommon to have the best lamb outgain the poorest lamb by 40 or more pounds when fed on the same ration the same length of time. In one trial one lamb gained 77 pounds while another lamb in the same lot gained only 9 pounds; both lambs appeared healthy. The average gain of the poorest 50 percent of the lambs was 24 pounds. The other half had an average gain of 38 pounds.

At present it is probably impossible to reduce the variation in gains below that found in these trials. All sick and unthrifty lambs had been culled, and all lambs had been treated for internal parasites. A few unthrifty or parasite-infested lambs would naturally increase the variation.

More breeding and management research work needs to be done to determine the causes of the large variations in gains and to develop methods of lowering them as much as possible. With the present large variation in gains it is well to market the lambs as they become finshed. Marketing in two or three shipments

[3] F. B. Morrison, *Feeds and Feeding*, 20th ed., 1936.

CARCASSES WERE GRADED in the cooler by federal and packer graders.

allows the slow gaining lambs time to become finished and prevents the fast gaining lambs from becoming too heavy for top market demand.

The careful feeder will continually guard against death losses in the feed lot. During the 16 years of feeding at the Field Station, death losses for all rations average 3 percent. The losses varied considerably from year to year, ranging from 1 to 30 lambs per carload (320 lambs). These losses were associated more closely with years or with lambs fed than with feeds.

How to Keep Down Death Losses

1. Buy strong, thrifty lambs.
2. Treat lambs for internal parasites.
3. Start lambs on feed slowly. Make any necessary changes in the feed gradually.
4. Allow enough feed bunk or trough space. Clean each regularly before feeding.
5. Feed regularly and systematically. Feed what the lambs will clean up readily at each feeding. It is advisable not to feed more than 2 pounds of grain per head daily.
6. Permit access to clean fresh water at all times.
7. Have salt available.
8. Sort out any sick or scouring lambs. Feed them separately on reduced amounts of feed.
9. Provide dry quarters and protection from severe weather.
10. Handle the lambs quietly at all times.

The importance of keeping the death loss as low as possible is shown in this experiment. The 3-percent death loss reduced the returns on the remaining lambs 19 cents per head.

Summary

The following statements summarize the findings of the lamb-feeding trials carried on by the South Dakota Agricultural Experiment Station and the U. S. Department of Agriculture at the Belle Fourche Field Station during 1927-43.

The feeding of lambs under irrigation agriculture is a profitable farm activity.

Corn fed with alfalfa hay returned a greater profit than barley fed with alfalfa hay.

Pressed beet pulp and beet tops added to a concentrate and alfalfa hay ration increased the returns per lamb.

Cottonseed cake increased profits when it was included in rations consisting of a concentrate and alfalfa hay. It reduced profits in a ration having a concentrate, alfalfa hay, and pressed beet pulp.

Beet molasses was profitable in some combinations but reduced profits in others. Feeding it regularly cannot be recommended.

Minerals were not beneficial in rations containing alfalfa hay.

Lambs that were one grade above average as feeders were one-half grade above average when fat and their carcasses were one-third grade above average. Lambs that were one grade below average as feeders were only one-half grade below average when fat and their carcasses were only one-third grade below average.

An average margin of at least $2 per hundredweight was necessary for profitable lamb feeding during the 16-year period.

"Topping out" and marketing lambs in two or three shipments as they became fat proved a worth while practice.

The shrinkage enroute to market was 5.9 pounds or 19 percent of total feedlot gains.

The death loss in the feed lot averaged 3 percent. This loss reduced returns 19 cents per lamb.

Sheep manure was worth $5.52 per ton in increased yields when it was applied on irrigated land growing sugar beets and potatoes.

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