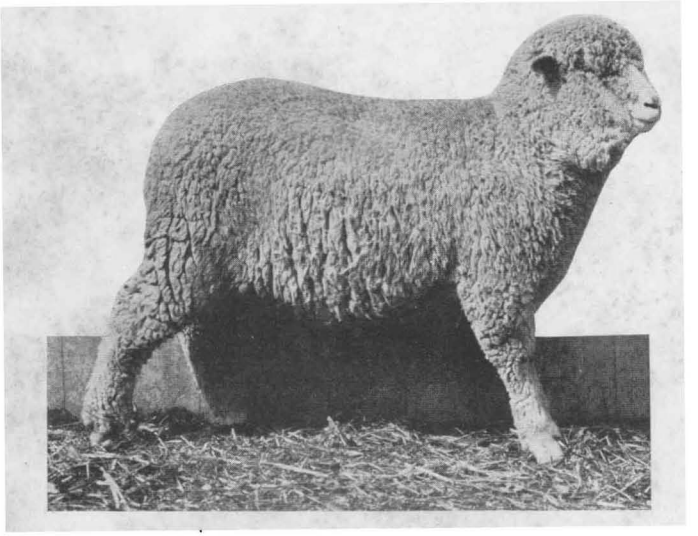
March, 1923 Bulletin No. 210

Corn Substitutes for Fattening Lambs



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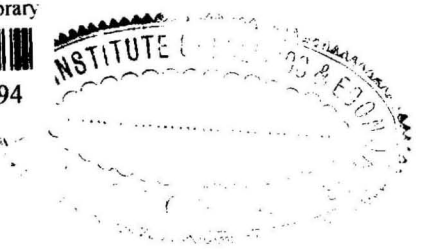

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CORN SUBSTITUTES FOR FATTENING LAMBS---Parts I and II *

By John M. Evvard, Russell Dunn and C. C. Culbertson

Shelled corn is a superior basal grain for fattening lambs in dry lot, in the cornbelt and under the conditions of the experiments reported in this bulletin. This fact stands out clearly in the results of the two years' work at the Iowa Agricultural Experiment Station in the winters of 1918-19 and 1919-20.

Shelled corn proved to be more efficient than either oats or barley when fed alone, this being the case when all factors, such as feed required per hundred pounds gain, feed costs, cost of shipping and margin of profit or loss per lamb, are considered.

Mixtures of shelled corn and whole oats and shelled corn and whole barley were less efficient than shelled corn alone. The substitution of corn gluten feed and hominy feed for shelled corn likewise proved financially and physiologically unsatisfactory relative to corn feeding under the then existing conditions.

As in practically all of our other tests, corn is shown to be a superior grain, superior in financial returns to substitutes that are imported, or which must be brought onto the farm. Of course, there may be times when some specific substitutes can be employed to advantage, but much depends on the relative prices charged for the feeds. There are times when it is possible in Iowa to buy substitutes for corn advantageously, but most often, in truth, practically always under existing economic conditions this is not the case. We would emphasize that livestock men in the good corn country of Iowa will do well to stick by corn as the basal grain and we repeat what we have said so often:

In the cornbelt farmers must realize that if they would make the most profit, on the average, year in and year out, they must stick closely to Iowa's favorite grain, corn, in their feeding operations. They must further realize that it is only under rare and exceptional circumstances or conditions that substitutes for corn can, in Iowa, the heart of the cornbelt, be economically made, either in swine or sheep or cattle feeding. If one grows his own oats, barley and similar grains, he can feed them to greater advantage than if they must be purchased elsewhere and transported to his farm. Nevertheless, it should be borne in mind that for fattening range grown lambs, corn grain is, pound for pound, worth more than oats or barley.

However, everything depends upon the relative prices; watch that. Know relative values and then, when opportunity offers, be in a position to buy corn substitutes when they are offered low enough in price relative to corn to be profitable.

*Part I contains the results of the work carried on during the winter of 1918-19. Part II gives the results secured in the winter of 1919-20. The two experiments reportaed in Parts I and II of this bulletin are specific units of a series of experiments on lamb feeding being conducted at the Iowa Agricultural Experiment Station to determine the best methods of feeding fattening lambs.

SUMMARY OF PART I--1918-19

The first year's work was conducted to determine the adaptability and relative efficiency of the three home-grown grains, shelled corn, whole oats and whole barley, for fattening lambs, when fed under similar practical conditions and in commonly used rations in connection with a basal ration of linseed oilmeal, corn silage, clover hay, and block salt; and to determine the value of the corn by-products, hominy feed and corn gluten feed, when entirely substituted for the homegrown grains.

1. Shelled corn proved to be the most satisfactory grain from the standpoint of the finished product, in that the lambs fed corn shrank the least in going to market; sold for the highest price, or $20.40 per hundred; dressed 48.46, the greatest percent; and returned $3.22, the greatest margin per lamb.

2. Whole oats in this test produced slightly greater gains and at less cost per pound than did the shelled corn, but the oat-fed lambs shrank more going to market, sold for $19.75 per hundred, or 65 cents less than the corn-fed lambs. They dressed only 44.39 percent, and returned a margin of $3.14 per lamb, which was 18 cents less than the margin for the corn-fed lambs.

3. Whole barley was similar to whole oats in production of gains and amounts of feed required to produce gains. The barley-fed lambs shrank more than the corn or oat-fed lambs in going to market, sold for $20 per hundred, which was 25 cents more than the oat and 40 cents less than the corn-fed lambs. The barley-fed lambs dressed 47.02 percent, which was 2.63 percent greater than the oat-fed lambs, and possessed more desirable dressed carcasses than the oat-fed lambs, but dressed 1.44 percent less and had less desirable carcasses than the corn-fed lambs. The margin per lamb was $3.16 as compared to $3.32 for the corn-fed lambs, and $3.14 for the oat-fed lambs.

4. Hominy feed—a corn by-product—made the poorest production showing. In shipping shrinkage and dressing percent they were about equal to the barley-fed Lot III. They sold for $19.85, outselling the oat lambs, but underselling the corn and barley lambs. The margin per lamb was $2.16, or $1.16 less than the corn-fed lot.

The lambs did not relish the hominy feed as they did the whole grains, namely: corn, oats, and barley, after the first thirty days, and the hominy feed fed lambs were kept on feed with difficulty.

5. Corn gluten feed produced gains equal to the corn Lot I, but a greater amount of concentrates was required to produce gains. The gains cost $14.86, and the lambs sold for $20.25 per hundred, or 15 cents less than the corn Lot I. In dressing percent, the corn gluten feed fed lot was practically equal to the corn-fed lot. The corn gluten feed fed lot shrank 10.51 percent, or 1.75 percent more than the corn-fed lot. The margin per lamb was $2.56 or 75 cents less than the corn-fed lambs.

6. To have made the same margin per lamb as in Check Lot I with corn at $1.45 a bushel, oats must have been bought for 57.4 cents, barley for 90.4 cents, hominy feed for $15.16 a ton, and corn gluten feed for $38.98 a ton.

On the above "margin per lamb" basis with corn figured at its actual cost of $1.45 per bushel, being considered as 100 percent efficient, oats in this test proved to be (in round numbers) only 69 percent as efficient per unit weight as corn, barley 73 percent, hominy feed 29 percent, and corn gluten feed 75 percent.

PART I. COMPARING CORN GRAIN WITH OTHER GRAINS OR CONCENTRATES, ALL FED STRAIGHT

By Russell Dunn, John M. Evvard, and C. C. Culbertson

The objects of the test herein reported were to determine the relative values of corn, oats, and barley for lamb feeding when each of these grains was fed in conjunction with corn silage. clover hay and linseed oilmeal; also to test out and compare two corn by-products, hominy feed and corn gluten feed with the whole corn grain and with the other home-grown grains, oats and barley.

ANIMALS USED IN TEST

The lambs used were fairly uniform, lowset and blocky, medium in condition and would grade as good feeder lambs. Their fleeces were medium in length and quite compact.

They were April and May lambs from South Dakota, out of Rombouillet and Shropshire ewes and by a Cotswold ram. They were purchased on the Omaha market, December 18, 1918. and averaged 49.2 pounds per lamb and cost $14.50 per hundred weight. Their total cost was $7.41 per lamb laid down at Ames, this including the initial cost, commission and freight from Oma ha to Ames.

The lambs arrived at the experiment station feed yards, December 20, P. M., where they were kept in dry lots until the experimental feeding began January 2, P. M. During this period, the lambs were given a small allowance of a grain mixture made up of equal parts of shelled corn, whole oats, whole barley, hominy feed and corn gluten feed, in addition to what corn silage and clover hay they would eat. Linseed oilmeal was allowed to the extent of about one-tenth of a pound per lamb per day.

The total cost per lamb, January 2, was $7.82, or based on weights, January 2, $14.45 per hundred weight, which figure is used in computing final results.

METHODS OF EXPERIMENTATION AND CARE OF ANIMALS

In dividing the lambs into experimental lots, special attention was paid to uniformity in weights and condition. The average initial weight and average condition for each lot was practically identical.

One hundred and fifty lambs were divided into five lots of 30 lambs each. Three individual weights were taken at the begin ning and three at the close of the test. At the end of the 30-day

periods one individual and two group weights were taken. The average of the three consecutive weights was used as the correct weight for each respective lot.

The lambs were housed in a long shed open to the south. The inside pens were 20x16 feet, while the outside run was 20x80 feet. All of the feeding was done in combination grain and hay bunks which were placed inside of the shed.

Fresh water in galvanized iron tubs was kept before the lambs at all times.

RATIONS FED

The rations fed to the five lots of 30 lambs each were as follows:

Lot I.—Shelled corn hand full-fed twice daily, plus linseed oilmeal O. P., .15 pound per lamb daily allowed on silage once daily at A. M. feed, plus corn silage hand full-fed twice daily, plus clover hay full-fed once daily, plus block salt self-fed.

Lot II.—Whole oats hand full-fed twice daily, plus linseed oilmeal O. P., .15 pound per lamb daily allowed on silage once daily at A. M. feed, plus corn silage hand full-fed twice daily, plus clover hay full-fed once daily, plus block salt self-fed.

Lot III.—Whole barley hand full-fed twice daily, plus linseed oilmeal O. P., .15 pound per lamb daily allowed on silage once daily at A. M. feed, plus corn silage hand full-fed twice daily, plus clover hay full-fed once daily, plus block salt self-fed.

Lot IV.—Hominy feed hand full-fed twice daily, plus linseed oilmeal O. P., .15 pound per lamb daily allowed on silage once daily at A. M. feed, plus corn silage hand full-fed twice daily, plus clover hay full-fed once daily, plus block salt self-fed.

Lot V.—Corn gluten feed hand full-fed twice daily, plus linseed oilmeal O. P., .15 pound per lamb daily allowed on silage once daily at A. M. feed, plus corn silage hand full-fed twice daily, plus clover hay full-fed once daily, plus block salt self-fed.

FEEDS DESCRIBED

Shelled Corn. All the corn grain fed in this test was of the locally grown 1918 crop, and ran about 17.5 percent moisture. It was bright, and free from foreign material.

All figures presented show the corn reduced to a 14 percent moisture basis.

Whole Oats. The oats fed were of the 1918 crop. They were bright, plump, and weighed 32.5 pounds per bushel.

Whole Barley. This barley was a good feeding barley of the 1918 crop, fairly bright and free from foreign material, and weighed 46 pounds per bushel.

Hominy Feed. This hominy feed was purchased from the Beaver Valley Milling Company, of Des Moines, Iowa, and was made from white corn.

Corn Gluten Feed. This corn gluten feed fed in this trial came from the Douglas Starch Company, of Cedar Rapids, Iowa, and is known on the market as "Douglas Corn Gluten Feed."

Linseed Oilmeal. This meal came from the Midland Linseed Mills, Minneapolis, Minnesota, and was finely ground.

Corn Silage. All of the corn silage fed in this test was made from the 1918 corn crop.

The silage fed from January 2 to February 18 was made from corn of late planting and was frosted before ensiling consequently a goodly proportion of the blades had dropped from the stalks. The grain yield was 83 bushels of 14 percent moisture corn per acre, and the silage yield was 4.55 tons per acre.

The corn silage fed from February 18 to close of the test, March 25, was made from early planting, and was very ripe when put into the silo, and the leaves had shattered badly. The grain yield was 32 bushels of 14 percent moisture corn per acre, and the silage yield was 3.81 tons per acre.

Water was added to all the silage thru the blower at filling time.

Clover Hay. This was Iowa grown hay of the first cutting; it was rather coarse and would not grade better than No. 2 hay.

Block Salt. Pressed block salt was used to facilitate the keeping of accurate records. This salt came from the Morton Salt Company, Chicago, Illinois.

CHEMICAL COMPOSITION OF FEEDS

The chemical composition of the feeds used in the tests as reported by Professor W. G. Gaessler, of the Chemistry Section of the Iowa Agricultural Experiment Station, are shown in the following table:

TABLE I. CHEMICAL COMPOSITION OF FEEDS
(In Percents)

	Dry matter	Crude protein	Carbohydrates: Nitrogen free extract	Carbohydrates: Crude fibre	Fat	Ash
Shelled corn*	86.00	8.88	71.00	2.55	2.24	1.32
Whole oats	91.72	12.02	61.19	10.65	4.41	3.45
Whole barley	89.79	12.33	67.42	5.05	2.10	2.89
Hominy feed	91.29	10.93	62.61	6.63	8.30	2.82
Corn gluten feed	91.77	25.90	48.84	8.63	4.40	4.00
Corn silage (Jan. 2-Feb. 18)	33.84	3.11	20.72	7.36	.95	1.69
Corn silage (Feb. 19-March 25)	46.06	3.71	30.21	8.72	1.66	1.75
Clover hay	95.66	8.94	41.51	36.80	2.27	6.14
Linseed oilmeal	91.71	36.21	33.89	8.71	7.34	5.56

*All figures in this Bulletin are for corn carrying 14 percent moisture. However, the average moisture content of the shelled corn for the entire test ranged from 17.5 to 18.3 percent, with an average of approximately 17.8 percent.

METHODS OF FEEDING

The lambs were fed twice daily thruout the trial between 7:00 and 8:00 A. M., and 3:00 and 4:00 P. M. The order of feeding was as follows: Grain was always fed first and followed by the corn silage in both the morning and afternoon feeding.

The linseed oilmeal fed in constant amount of .15 pound per lamb per day thruout the trial was fed sprinkled over the silage at the morning feed.

The clover hay was fed but once a day, in the evening after the lambs had eaten up the grain and silage.

Block salt was kept before the lambs at all times during the test.

The only instance in which the above feeding schedule was not followed was in the case of Lot IV, where hominy feed was fed. In this lot considerable difficulty was experienced in getting some of the lambs to eat the hominy feed, especially after the daily hominy feed allowance had reached three-fourths of a pound per lamb per day. To overcome this difficulty, the hominy feed was fed on the silage, after the first 30 days of the feeding trial.

Aside from the linseed oilmeal, which was fed in constant amounts of .15 pound per lamb per day to all lots thruout the trial, no effort was made to regulate the amounts of feed fed and each group of lambs was fed according to their appetites for the various feeds.

GAINS MADE BY LAMBS

The gains made by the lambs in the five lots were quite uniform. The range of average daily gain was only .06 pound per lamb. The lambs receiving the whole oats and whole barley took the lead with an average daily gain of .36 pound per lamb; the shelled corn and corn gluten feed fed lambs followed with .33 pound per lamb; while the hominy feed fed group ranked last with an average daily gain of .30 pound per lamb.

AVERAGE DAILY FEED EATEN

The greatest average daily grain consumption is noted in the whole oats and whole barley lots, which in turn are closely followed by the lambs which received corn gluten feed.

The shelled corn group showed a comparative decrease of 10 percent, while the hominy feed was only about three-fourths of the average daily whole oats, whole barley and corn gluten feed consumption.

The average daily roughage consumption was very close for all lots, however, the lots with the greatest grain consumption showed the least amounts of roughage eaten.

TABLE II. FIGURES COVERING LAMB FEEDING TRIALS

Five lots of thirty lambs each. All figures in pounds unless otherwise designated.

Ration Fed	Lot I: Shelled Corn, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot II: Whole oats, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot III: Whole barley, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot IV: Hominy feed, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot V: Corn gluten feed, Linseed oil-meal, Clover hay, Block salt.
Av. initial weight	56.2	55.9	55.4	55.6	55.5
Av. final weight	83.4	85.7	85.0	80.0	83.0
Gain per lamb	27.2	29.8	29.6	24.4	27.5
Av. daily gain	.33	.36	.36	.30	.33
Av. daily feed					
Grain	.93	1.06	1.02	.76	1.01
Linseed oilmeal	.15	.15	.15	.15	.15
Corn silage	2.08	1.99	2.07	2.14	2.05
Clover hay	.24	.22	.24	.25	.24
Block salt	.01	.01	.01	.01	.01
Feed for 100 lbs. gain					
Grain	281.4	294.2	284.2	257.4	301.63
Linseed oilmeal	45.2	41.4	41.6	50.4	44.8
Corn silage	630.3	553.5	576.1	723.1	614.2
Clover hay	73.5	60.5	67.2	85.2	73.1
Block salt	3.1	3.6	3.0	4.2	3.7
Cost of 100 lbs. gain	$13.60	$11.45	$11.70	$13.90	$14.86
Initial cost per cwt.	$14.45	$14.45	$14.45	$14.45	$14.45
Necessary selling price per cwt. to break even at Ames	$14.17	$13.41	$13.49	$14.28	$14.59
Actual Ames selling value per cwt. based on net receipts	$18.16	$17.08	$17.21	$16.99	$17.67
Selling price per cwt. Chicago.	$20.40	$19.75	$20.00	$19.85	$20.25
Margin per lamb over feed cost	$ 3.32	$ 3.14	$ 3.16	$ 2.16	$ 2.56

PRICES OF FEEDS FED

Shelled corn	$ 1.45 per bu. or $51.79 per ton
Whole oats	$ .64 per bu. or $40.00 per ton
Whole barley	$ 1.00 per bu. or $41.66 per ton
Hominy feed	$52.00 per ton
Corn gluten feed	$57.40 per ton
Linseed oilmeal	$70.00 per ton
Corn silage	$12.00 per ton
Clover hay	$25.00 per ton
Block salt	$ 1.00 per cwt. or $20.00 per ton

TABLE III. RECORD OF WATER CONSUMPTION, WITH CORRELATIONS

Period, ten days, February 11, P. M.-February 21, A. M., inclusive (all figures in pounds), 1919

Group No. and basal feed	Water consumed by all lambs: Drunk	Partaken in feed	Total Drunk and in feed	Percent Water drunk of total consumed	Water drunk daily per Lamb	Water Consumed (Drunk and in Feed): Daily per Lamb	Per 100 lbs. Gain	Per 100 lbs. Dry matter Ingested
I. Corn (Check)	504	458	962	52.4	1.68	3.21	939	159
II. Oats	640	405	1045	61.2	2.13	3.48	1014	164
III. Barley	682	429	1111	61.4	2.27	3.70	1176	177
IV. Hominy feed	648	421	1069	60.6	2.16	3.56	1574	186
V. Corn gluten feed	788	406	1194	66.0	2.68	3.98	1869	184

WATER CONSUMPTION OF THE LAMBS

To secure facts as to the water consumption of these lambs when on full feed, a ten-day record was taken, February 11, P. M., to February 21, A. M., inclusive, on each group. It appears that:

1. These lambs in the winter and when on full feed drank from 1.68 to 2.63 pounds of water daily, and this was from 52 to 66 percent of the total water ingested, the remaining percentages being in the feeds eaten.

2. The greatest water consumption was in the corn gluten feed, Group V, with the barley and hominy groups closely following.

3. The water requirement for 100 pounds of grain exceeds greatly the total feed requirement, ranging in this test from 939 to 1369 pounds, the higher requirements being in the hominy feed and corn gluten feed groups.

4. The water intake is greater than the dry matter consumption, or from 59 to 86 percent more in this test, thus showing that, weight for weight, more water is taken than dry matter, by winter fed lambs under the conditions of this experiment.

5. These lambs drank enough water to equal their weight in a little more than a month's time.

FEED REQUIRED FOR 100 POUNDS GAIN

There was relatively little difference in the total concentrates required to produce 100 pounds of gain in the three whole grain lots, namely: Lots I, II, and III, where corn, oats and barley were fed. The least number of pounds of corn was required, or 281.4 pounds of corn as compared to 294.2 pounds of oats and 284.2 pounds of barley. Due to the slightly smaller daily gain in Lot I (corn group), the linseed oilmeal requirement was relatively increased as compared to Lot II (whole oats) and Lot III (whole barley).

The whole oat-fed Lot II and whole barley fed Lot III required less of both corn silage and clover hay for 100 pounds gain than did the shelled corn-fed Lot I. The advantage gained by the whole oats Lot II and the whole barley Lot III was due to a saving in amount of total roughages required rather than to saving in the concentrates or to an increase in the rate of gains.

Comparing corn and the corn by-products, hominy feed and corn gluten feed, shelled corn occupied an intermediate position. Lot IV required 257.4 pounds of hominy feed, Lot I, 281.4 pounds of shelled corn, and Lot V, 301.6 pounds of corn gluten

feed for 100 pounds of gain. In comparison of total concentrates (grain plus linseed oilmeal), the three lots rank in the same order; however, the hominy feed Lot IV shows up relatively less favorably, due to slower gains and a correspondingly higher linseed oilmeal requirement, which raises the total concentrates required.

The roughage requirements for 100 pounds of gain in Lot I, fed shelled corn, and Lot IV, fed hominy feed, and Lot V, fed corn gluten feed, are in reverse order from the concentrates, with Lot IV, fed hominy feed, requiring 808.3 pounds of silage and hay for 100 pounds of gain, as against 703.8 pounds for Lot I, fed shelled corn, and 687.3 pounds for Lot V, fed corn gluten feed.

SHRINKAGE AND DRESSING PERCENTAGE OF LAMBS.

A comparison of the shipping data in table IV shows shelled corn to be superior to all the other grains fed, in that the corn fed lambs, Lot I, shrank least enroute to market, dressed the most and cost the least per lamb to market.

Lot II, fed whole oats, and Lot III, fed whole barley, which lots in some respects made a better showing in the feed yards than the corn-fed Lot I, did not ship so well in that the shrink was heavier, the dressing percentage was less and the total cost of marketing was greater.

The corn by-products lots, Lot IV, hominy feed, and Lot V, corn gluten feed, made a fair showing; however, not so good as the corn lot, but better in the main than the oats Lot II, and the barley Lot III.

TABLE IV. SHIPPING SHRINKAGE PER LAMB IN POUNDS AND PERCENTAGE, DRESSING PERCENT AND COST OF MARKETING PER LAMB.

	Lot I Shelled Corn	Lot II Whole Oats	Lot III Whole Barley	LOT IV Hominy Feed	Lot V Corn Gluten Feed
Shrinkage enroute to market (pounds per lamb)	7.31	9.66	9.98	9.70	8.73
Shrinkage enroute to market (percent)	8.76	11.28	11.75	12.13	10.51
Dressing percent based on cold weights and Chicago weights.	48.46	44.39	47.02	46.71	48.43
Cost of marketing per lamb (not including shrinkage)	$0.38	$0.38	$0.38	$0.36	$0.38
Cost of marketing per lamb (including shrinkage) at Chicago selling price*	$1.87	$2.30	$2.38	$2.29	$2.15
Internal fat per lamb (caul and gut fat in pounds)	2.76	2.40	2.70	2.32	2.24

*Just to cover the cost of shrinkage, the lambs were worth from $1.49 to $2.00 less per 100 pounds at home (price based on home weights) than in Chicago (price based on Chicago selling weights).

PACKER'S COMMENT ON CARCASSES

By A. I. Powers, of Swift and Company, March 28, 1919.

In order of merit, best first:

Lot I (Shelled corn)—Shape fair, best covered backs, legs and shoulders, most kidney fat, cut brightest and most firm. average carcass price 33 cents per pound.

Lot III (Whole barley)—Shape fair, not as well covered over backs, legs and shoulders, less kidney fat, cut darker and less firm, average carcass price 32 cents per pound.

Lot V (Corn gluten feed)—Shape fair, legs do not have enough covering, kidneys poorly covered, meat a trifle dark and not firm, average carcass price 31½ cents per pound.

Lot II (Whole oats)—Shape fair, lack covering over legs and shoulders, kidneys bare, meat dark and soft, average carcass price 30 cents per pound.

Lot IV (Hominy feed)—Shape fair, lacking in condition in general, meat dark and soft, average carcass price 30 cents per pound.

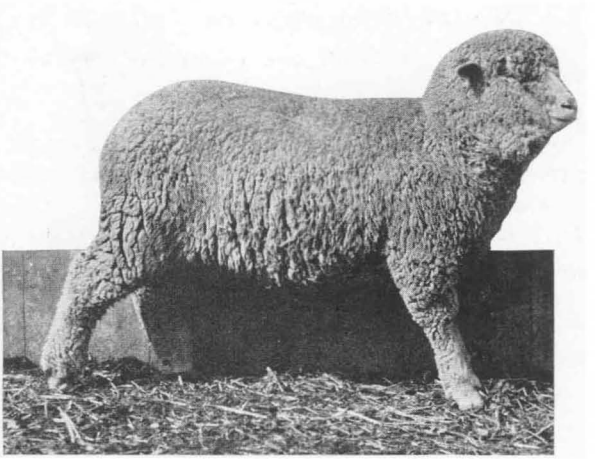

Fig. 1—Lot I.

Representative shelled corn lamb at close of feeding period. This lot tied with Lot V, ranking third in gains (average daily gain per lamb .33 pound); first in condition (average of good plus); first in selling price ($20.40 per cwt., Chicago); and first in margin per lamb over feed costs ($3.32 per lamb).

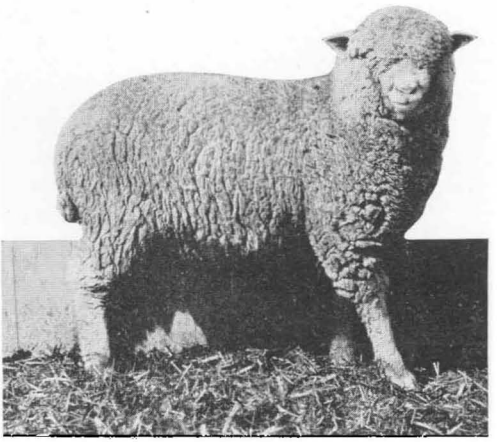

Fig. 2—Lot II.

Representative whole oats lamb at close of feeding period. This lot tied with Lot III, ranking first in gains (average daily gain per lamb .36 pounds); fifth in condition (average of good minus); fifth in selling price ($19.75 per cwt., Chicago); and third in margin per lamb over feed costs ($3.14 per lamb).

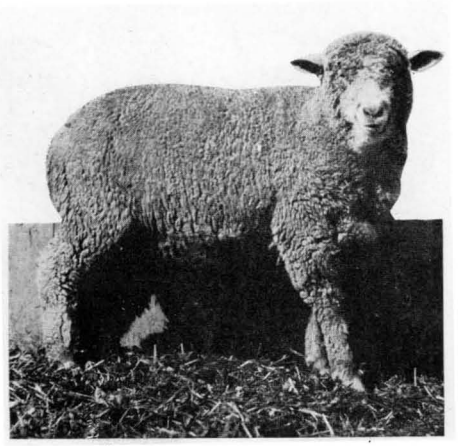

Fig. 3—Lot III.

Representative whole barley lamb at close of feeding period. This lot tied with Lot II, ranking first in gains (average daily gain per lamb .36 pound); third in condition (average of good); third in selling price ($20 per cwt., Chicago); and second in margin per lamb over feed costs ($3.16 per lamb).

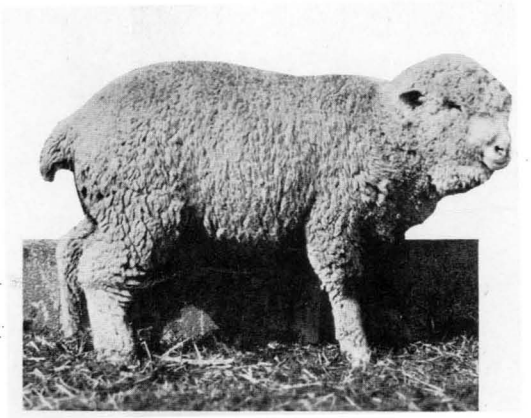

Fig. 4—Lot IV.

Representative hominy feed lamb at close of feeding period. This lot ranked fifth in gains (average daily gain per lamb .30 pound); fourth in condition (average of good minus); fourth in selling price ($19.85 per cwt., Chicago); and fifth in margin per lamb over feed costs ($2.16 per lamb).

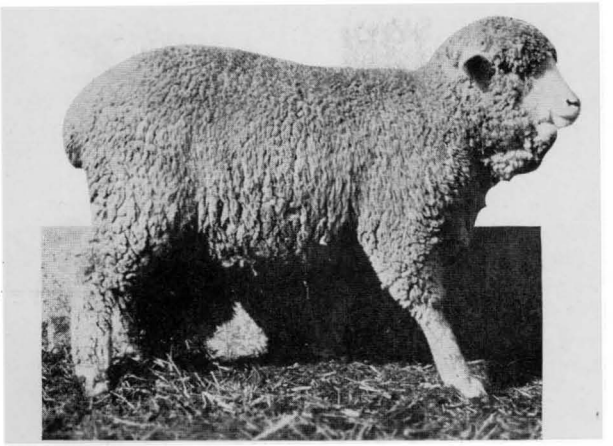

Fig. 5—Lot V.

Representative corn gluten feed lamb at close of feeding period. This lot tied with Lot I ranking third in gains (average daily gain per lamb .33 pound); second in condition (average of good plus); second in selling price ($20.25 per cwt., Chicago); and fourth in margin per lamb over feed costs ($2.56 per lamb).

SUMMARY OF PART II—1919-20

The second year's work was conducted to determine the relative value of whole oats and whole barley when used as entire or partial substitutes for shelled corn, with each substitute fed singly or in combination with corn as basal grains. The results may be summarized as follows:

1. Shelled corn proved to be the superior basal grain. The corn-fed lambs made the most rapid and economical gains. These lambs shrank the least, dressed the highest percent, produced the best finished and most desirable dressed carcasses and returned $5.04, the greatest margin per lamb by 41 cents.

2. Oats fed as the single grain made the poorest production showing. The lambs made a smaller daily gain at greater cost per 100 pounds gain than the corn-fed lambs. They shrank more than the corn-fed lambs, and dressed 47.59, the lowest percent. They returned a margin of $4.16 per lamb, which was 88 cents less than the corn-fed lot.

3. Whole barley made a better production showing than whole oats, but was not equal to corn. The barley-fed lambs made greater daily gains than the oat-fed lambs, but less than the corn-fed lambs. In cost of gains they rank in the same order, the cost being greatest in the case of the oat-fed lambs, and the least with the corn-fed lambs. The barley-fed lambs shrank more than either the corn or oat-fed lambs, but dressed 1.70 percent more than the oat-fed lambs, and .89 percent less than the corn-fed lambs. The margin per lamb was $4.24 for the barley-fed lambs as compared to $5.04 for the corn-fed lambs, and $4.16 for the oat-fed lambs.

4. The lambs receiving the corn and oats mixture were second to the corn-fed lambs in production showing. The daily gains were less and the cost of gains was higher than in the corn-fed lot. These lambs shrank .59 percent more and dressed 1.12 percent less than the corn-fed lambs, and had less desirable carcasses than the corn-fed lambs. The lambs fed the corn and oats mixture returned a margin per lamb of $4.63, or 41 cents less than the corn-fed lambs.

5. The corn and barley mixture gave better results than the barley alone, but not as good as the corn alone. The lambs made less gains and at greater cost per 100 pounds than was the case with the corn-fed lambs. They shrank more than the corn-fed lambs, but dressed a little higher. The margin returned by the lambs fed the corn-barley mixture was $4.38 as compared to $5.04 for the corn-fed lambs.

6. To have made the same margin per lamb as in Check Lot I with corn at $.02357 per pound or $1.32 per bushel, oats must have been bought for $.0153 per pound or $.49 per bushel; barley $.0189 per pound or $.91 per bushel; corn and oats mixture $.0196 per pound; and corn and barley mixture $.0181 per pound.

On the above "margin per lamb" basis with corn figured at its actual cost of $1.32 per bushel being considered as 100 percent, oats in this test proved to be in round numbers only 65 percent as efficient as corn per unit weight; barley 80 percent; oats and corn mixture 83 percent; and barley and corn mixture 77 percent.

PART II. COMPARING CORN WITH OATS AND BARLEY ALL FED STRAIGHT; ALSO WITH ADMIXTURES OF SAME

By John M. Evvard and C. C. Culbertson

This experiment was planned to determine the relative value of shelled corn as compared to whole oats and whole barley when fed with linseed oilmeal, corn silage, clover hay and block salt, for fattening lambs; and to note the advisability of using mixed grain rations of shelled corn and whole oats, or shelled corn and whole barley, in place of a single grain.

The comparison was made from the standpoint of gains, cost of gains, and character of finished product.

ANIMALS USED IN EXPERIMENT

The animals used in this experiment were fairly uniform, low-set and blocky, fair in condition, and would grade good feeder lambs. Their fleeces were longer and less dense than many of the western lambs possess. The lambs were all thrifty and healthy, and possessed good appetites. The lambs showed some of the characteristics of both Merino and Long Wool breeds.

The lambs were purchased on the Omaha market November 14, 1919, and averaged 50.6 pounds per head. They cost $12.00 per cwt. at Omaha, making the total cost at Ames $6.35 per lamb, the latter figure including initial cost, commission and freight from Omaha to Ames.

The lambs reached the experiment station feed yards November 15, where they were kept in dry lot until the experimental feeding began November 29, P. M. During this time their ration consisted of a mixture of corn, oats and barley, equal parts, linseed oilmeal, corn silage, clover hay and salt. The lambs gained almost 10 pounds per head at a cost of 30 cents per lamb, thus decreasing the initial cost per cwt. from $12.00 at Omaha to $11.65 at Ames at the beginning of the experimental feeding period.

METHODS OF EXPERIMENTATION AND CARE OF ANIMALS

For use in this experiment 216 lambs were purchased, 150 of the lambs being divided into five lots of 30 lambs each.

The methods of experimentation and care of animals were practically the same as noted in the experiment of the previous year reported in Part I of this bulletin.

RATIONS FED

Insofar as Lots I, II and III are concerned, this experiment represents a direct check on the work carried on in 1918-19 as reported in Part 1 of this bulletin.

Lot No. and Grain Ration Fed	Protein Supplement	Corn Silage	Clover Hay	Block Salt
I —Shelled corn II —Whole oats III —Whole barley IV* —Shelled corn and whole oats mixture V**—Shell corn and whole barley mixture	Linseed oil-meal .15 lb. per lamb per day, same for all lots.	Corn silage according to appetite twice daily, same for all lots.	Clover hay according to appetite once daily, at P. M. feed, same for all lots.	Block salt allowed at free-will to all lots.

*Lot IV received mixtures of shelled corn and whole oats as follows:
First 30 days—1 part shelled corn, 2 parts whole oats.
Second 30 days—1 part shelled corn, 1 part whole oats.
Third 30 days—2 parts shelled corn, 1 part whole oats.

**Lot V received mixtures of shelled corn and whole barley as follows:
First 30 days—1 part shelled corn, 2 parts whole barley.
Second 30 days—1 part shelled corn, 1 part whole barley.
Third 30 days—2 parts shelled corn, 1 part whole barley.

DESCRIPTION OF FEEDS

Shelled Corn. This corn was a good grade of corn, white and yellow mixed and well matured and bright. It contained about 20 percent moisture as fed. (All figures used in this bulletin give corn reduced to a 14 percent moisture basis.)

Whole Oats. These were a good quality of white oats, and weighed 31 pounds per bushel.

Whole Barley. This was a fairly good quality of feeding barley, quite plump but colored—weight 46 pounds per bushel.

Linseed Oilmeal. This meal came from the Midland Linseed Mills, Minneapolis, and was finely ground.

Corn Silage. The corn silage was made from well matured Reid's yellow dent corn, part of which was grown on the experiment station farm, and part from a farm northwest of the experiment station known as the Strausbaugh field. The yield of silage per acre from the Strausbaugh field, which was fed from November 29, 1919 to January 20, 1920, was 5.81 tons, with a yield of corn of 10.33 bushels per ton of silage. The silage yield from the station farm which was fed from January 20, to February 14, 1920, was 14.05 tons per acre, with a yield of corn per ton of silage of 4.64 bushels. The wide variation in yield of silage per acre was due to the first field being planted in check row, while the second field was drilled and not checked.

Clover Hay. The clover hay fed was fair in quality, rather coarse and somewhat colored. It contained about 10 percent timothy, and was purchased thru the Pease Hay Company, Des Moines, Iowa.

Block Salt. Pressed block salt was used to facilitate the keeping of accurate records. This salt came from the Morton Salt Company, Chicago, Illinois.

Water. Water was furnished from the college water system, and was kept before the lambs at all times.

CHEMICAL ANALYSIS OF FEEDS

The chemical composition of each feed used in the experiment, as reported by W. G. Gaessler of the Chemistry Section of the the Iowa Experiment Station, is shown in the following table:

TABLE I. CHEMICAL COMPOSITION OF FEEDS (in Percents)

	Dry Matter	Crude Protein	Nitrogen-Free Extract	Crude Fiber	Fat	Ash
Shelled corn*	86.00	9.32	69.62	2.30	3.37	1.38
Whole oats	87.44	14.32	52.77	11.96	4.36	4.03
Whole barley	91.42	13.13	66.65	5.78	2.79	3.07
Linseed oilmeal ..	91.71	36.31	33.89	8.71	7.34	5.56
Clover hay	83.79	9.77	35.72	30.96	2.32	5.02
Corn silage fed from Nov. 29, 1919, to Jan. 20, 1920	31.65	3.13	19.28	6.47	.66	2.11
From Jan. 20, 1920, to Feb. 14, 1920	29.75	2.40	17.28	6.83	1.12	2.11
Composite analysis for entire period.	31.17	2.94	18.77	6.56	.78	2.11

*All figures in this bulletin are for corn carrying 14 percent moisture.

METHODS OF FEEDING

The same methods of feeding were employed as the previous year reported in Part I of this bulletin.

Precautions were necessary at times to prevent the lambs in this trial from going-off feed, especially in Lots I, III and V, receiving shelled corn, whole barley, and shelled corn and whole barley respectively. This condition was not a result of unthriftiness, but was probably due to a slight tendency to overeat at times.

There were no signs of unthriftiness in any of the lots except for three lambs in Lot I, one in Lot III, two in Lot IV, and five in Lot V, all of which developed bladder stones, a condition similar to that of previous years at this station.

The lambs on the whole took readily to their feeds, possessed keen appetites thruout the feeding period, and were bright and generally thrifty.

GAINS MADE BY THE LAMBS

The gains made by the lambs in the five lots were quite uniform, the average daily range between the highest and lowest being .028 pound. The lambs receiving shelled corn made the greatest daily gain, with an average of .300 pound per lamb. The shelled corn and whole oats-fed lot was next with an average daily gain of .298 pound per lamb. This lot was closely

TABLE II. FIGURES COVERING LAMB FEEDING TRIAL

Five Lots of 30 Lambs Each.

(All figures in pounds unless otherwise designated).

Ration fed	Lot 1 Shelled corn, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot II Whole oats, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot III Whole barley, Linseed oil-meal, Corn silage, Clover hay, Block salt.	Lot IV Shelled corn, Whole oats, Linseed oilmeal Corn silage, Clover hay, Block salt.	Lot V Shelled corn, Whole barley, Linseed oilmeal Corn silage, Clover hay, Block salt.
Av. initial weight	58.33	58.61	58.63	58.04	58.49
Av. final weight	81.59	79.70	81.46	81.13	79.57
Gain per lamb	23.26	21.09	22.83	23.09	21.08
Av. daily gain	.300	.272	.295	.298	.272
Av. daily feed					
Grain	1.06	1.20	1.17	*1.15	*1.11
Linseed oilmeal	.15	.15	.15	.15	.15
Corn silage	1.92	1.75	1.75	1.80	1.75
Clover hay	.19	.18	.18	.18	.17
Block salt	.009	.010	.010	.014	.009
Feed per 100 lbs. gain					
Grain	353.46	442.52	396.60	*384.73	*407.28
Linseed oilmeal	49.67	54.77	50.60	50.03	54.75
Corn silage	641.37	641.70	594.12	590.53	642.94
Clover hay	62.20	64.17	60.44	60.21	65.55
Block salt	3.29	3.75	3.28	4.65	3.25
Cost of 100 lbs. gain	$15.10	$17.95	$17.49	$15.77	$17.54
Initial cost per cwt.	$11.65	$11.65	$11.65	$11.65	$11.65
Necessary selling price per cwt. to break even at Ames	$12.63	$13.32	$13.29	$12.82	$13.21
Actual selling price at Ames per cwt.	$18.81	$18.54	$18.50	$18.53	$18.71
Selling price per cwt. Chicago	$20.90	$20.84	$20.93	$20.73	$20.94
Margin per lot	$151.12	$124.79	$127.31	$138.94	$131.36
Margin per lamb over feed costs	$5.04	$4.16	$4.24	$4.63	$4.38

*See rations fed for the proportion of each grain fed.

PRICE OF FEEDS

Shelled corn—$1.32 per bu. or $47.20 per ton.
Whole oats—$ .79 per bu. or $49.40 per ton.
Whole barley—$1.33 per bu. or $55.40 per ton.
Linseed oilmeal—$85.00 per ton.
Corn silage—$12.00 per ton.
Clover hay—$25.00 per ton.
Block salt—$20.00 per ton.

TABLE III. WATER CONSUMPTION, WITH CORRELATIONS, RECORD

Average of Two 10-Day Periods

Lot No. and Basal feed	Water consumed by all lambs					Water consumed (Drunk and in feed)		
	Drunk	Partaken in feed	Total drunk and in feed	Percent water drunk of total consumed	Water drunk daily per lamb	Daily per lamb	Per 100 lbs. gain	Per 100 lbs. dry matter ingested
I—Corn (Check)	233	473	706	33.0	.78	2.35	726	130
II—Oats	432	418	850	50.8	1.44	2.83	911	152
III—Barley	339	406	745	45.5	1.13	2.48	845	133
IV—Corn and oats	428	431	859	49.8	1.43	2.86	893	156
V—Corn and barley	317	423	740	42.9	1.06	2.47	804	138

followed by the whole barley-fed lot, with an average daily gain of .295 pound. The whole oats-fed lot and the shelled corn and whole barley-fed lot made the smallest gains, with an average daily gain of .272 pound per lamb.

WATER CONSUMPTION

In order to get an idea as regards the water consumption of these lambs when on full feed, two 10-day records were taken, December 9 to 19, 1919, and January 8 to 18, 1920, inclusive, on each group.

Table III, entitled "Water Consumption, With Correlations, Record," shows by groups, total water drunk; total water partaken in feeds; total water consumed; percent drunk of total water consumed; water drunk daily per lamb; total water consumed per 100 pounds gain; and water consumed per 100 pounds of dry matter ingested.

It appears that:

1. These lambs, in the winter and when on full feed, drank from .78 to 1.44 pounds of water daily, and this was from 33 to 51 percent of the total water ingested, the remaining percentages being in the feeds eaten.

2. The greatest water consumption was noted in the oat-fed Lot II, and the corn and oat-fed Lot IV. The corn-fed Lot I drank the least water, and the barley-fed Lot III and the corn and barley fed Lot V were intermediate.

3. The water requirement for 100 pounds gain was less than the total feed requirement, roughly in this test, 726 to 911 pounds, the higher requirements being in the oats and the corn and oat-fed groups.

4. The water intake is greater than the dry matter consumption, or from 30 to 56 percent more in this test, thus showing that weight for weight, more water is taken than dry matter by winter-fed lambs, under the conditions of this experiment.

5. These lambs drank enough water to equal their weight in a little more than a month's time.

AVERAGE DAILY FEED EATEN

The greatest daily grain consumption was noted in the whole-oat-fed lot, which in turn was closely followed by the lots receiving whole barley, shelled corn and whole oats and shelled corn and whole barley. The lot receiving shelled corn alone consumed the least grain per day, with an average of 1.06 pounds.

The corn-fed lambs, Lot I, consumed about 12 percent less grain than the oat-fed lambs, Lot II, while the other lots consumed from 3 percent to 8 percent less grain per day than the oat-fed lot.

The average daily roughage consumption for all lots was very close, being greatest in the corn-fed lot, the lot consuming the least grain.

FEED REQUIRED FOR 100 POUNDS GAIN

In grain required per one hundred pounds of gain, shelled corn proved to be superior to all other grains or combinations of grains used in this trial. Lot I required 89 pounds less grain than Lot II, and 43 pounds less than Lot III. Lot I required 353.5 pounds of corn as compared to 442.5 pounds of oats, and 396.6 pounds of barley. The corn and oat-fed Lot IV required 384.7 pounds of grain per 100 pounds of gain, which was 31.3 pounds more than the corn-fed Lot I and 57.8 pounds less than the whole oats Lot II. The corn and barley-fed lot had the second largest grain requirement, or 407.28 pounds.

In linseed oilmeal requirements, Lot I consumed the least amount per one hundred pounds gain, with 49.67 pounds as compared to 54.77 pounds in Lot II; 50.60 pounds in Lot III; 50.03 pounds in Lot IV; and, 54.75 pounds in Lot V.

The roughage requirements of the corn-fed lot and the oat-fed lot were very similar, Lot I requiring 703.5 pounds of roughage, and Lot II requiring 705.8 pounds, while the barley-fed Lot III required only 654.5 pounds. The corn and oat-fed Lot IV required slightly less roughage than either the corn or oat-fed lots, with 650.74 pounds, while the corn and barley-fed lot had the greatest roughage requirement of all, with 708.49 pounds.

A comparison of these figures shows shelled corn to be more efficient than whole oats, whole barley, or combinations of shelled corn with oats or barley. Whole barley proved more efficient than whole oats as a complete substitute for shelled corn.

Shelled corn seemed to enhance the value of whole oats when fed as a mixture, the mixture being more efficient than oats or barley alone, but not as efficient as corn alone.

From the standpoint of feed per 100 pounds of gain, the mixture of shelled corn and whole barley was not as efficient as whole barley alone, but was more efficient than whole oats alone.

SHIPPING AND SLAUGHTER DATA

Table IV gives the shipping and slaughter data covering this experiment.

TABLE IV. SHIPP ING SHRINKAGE PER LAMB IN POUNDS AND PERCENTAGE, DRESSING PERCENT AND COST OF MARKETING PER LAMB

Basal feed	Lot I Shelled corn	Lot II Whole oats	Lot III Whole barley	Lot IV Corn and oats	Lot V Corn and barley
Shrinkage enroute to market (pounds per lamb)	6.35	7.03	7.68	6.80	6.94
Shrinkage enroute to market (percent)	7.79	8.82	9.42	8.38	8.69
Dressing percent based on cold weights and Chicago weights	50.18	47.59	49.29	49.06	50.22
Weight of pelt per lamb (pounds)	10.04	9.87	9.66	9.97	9.86
Weight of internal fat per lamb (caul and gut fat pounds)	3.14	2.60	2.97	2.47	3.11
Cost of marketing per lamb (not including shrink)	$0.389	$0.379	$0.389	$0.389	$0.379
Cost of marketing per lamb (including shrink)	$1.72	$1.84	$2.00	$1.80	$1.83

A comparison of the shrinkage of the several lots shows a particularly heavy shrink for several lots. This was probably due to the delay in shipping.

It will be noted that the lambs fed shelled corn in Lot I had the lightest shrinkage in transit of any lot, and those fed whole barley the heaviest shrinkage. Lot I lost 6.35 pounds or 7.79 percent of their weight, based on the final weight at Ames. Lot III, fed barley, shrank 7.68 pounds or 9.42 percent, the greatest shrink of all lots.

Corn seemed to have a beneficial effect in decreasing the shrinkage per lamb when fed in combination with both oats and barley as compared with the latter feeds as the lone grains. Corn fed with oats decreased the shrinkage per lamb, .23 pound, and as fed with barley .74 pound, as compared with oats alone as the basal grain and barley alone in Lots II and III, respectively.

The cost of marketing each lamb varied within narrow limits, due to the variation in total weight of each lot. The average cost per lamb from Ames to Chicago was 38.85 cents, not including shrinkage. Including shrinkage, the cost of marketing varied from $1.72 in the case of Lot I, to $2.00 in Lot III.

In dressing percent Lot I, shelled corn and Lot V. shelled corn and whole barley were practically equal. Lot II, whole oats, dressed the least, while Lots III and IV were intermediate.

A comparison of these data shows shelled corn to be the superior basal grain when considered from the standpoint of shipping shrink and dressing percentage.

PACKER'S COMMENT ON CARCASSES

By Swift and Company's head retail butcher

"Lot I was a very uniform lot of lambs. In condition, they were well covered over the back and loin, and full in the leg of mutton. The kidneys were well covered. The flanks were firm, showing good finish, but the meat was quite highly colored, rather too dark.

"Lot I easily ranked first.

"Lot V lambs were well covered over the back, loin and kidneys. Their flanks were quite firm, but a few soft ones were found. They were not as good as Lot I in the latter respect. The meat was dark in color.

"This lot ranked second.

"Lot IV lambs were fairly well covered over the back, but lacked condition. They were not well covered over the kidneys. Their flanks were not firm, and as in other lots, the meat was dark in color.

"This lot ranked third.

"Lot III lambs were fairly well covered over the back and kidneys. Their flanks lacked the desirable firmness, and the meat was quite highly colored.

"This lot ranked fourth.

Lot II lambs were not as uniformly finished as Lot I, and only carried a fair covering of fat over the back and loin. The kidneys were not as heavily covered as in Lot I. There were a

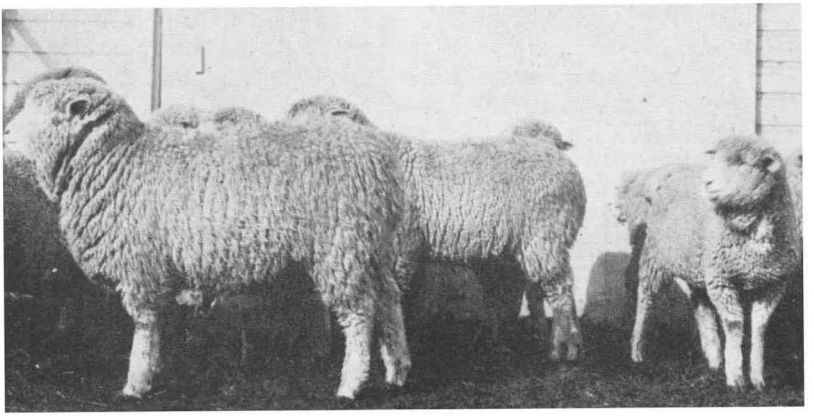

Fig. 6— Group I.

Shelled corn-fed lambs. General side view of all lambs at close of experiment. This group ranked first in gains (average daily gain per lamb .30 pound); first in condition (average of good plus); third in selling price ($20.90 per cwt., Chicago); and first in margin per lamb over feed costs ($5.04 per lamb).

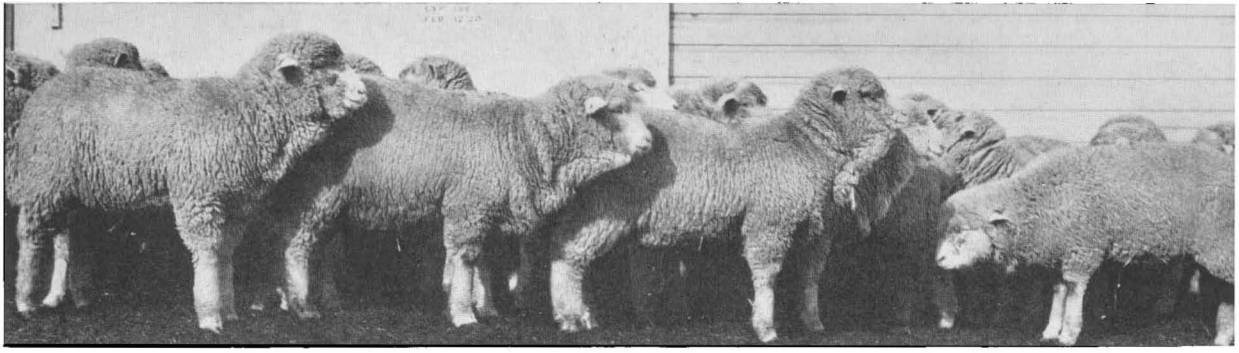

Fig.7—Group II.

Whole oat-fed lambs. General side view of all lambs at close of experiment. This group tied with Group V in gains, ranking fourth (average daily gain per lamb .272 pound); fifth in condition (average of good); fourth in selling price ($20.84 per cwt., Chicago); and fifth in margin per lamb over feed costs ($4.16 per lamb).

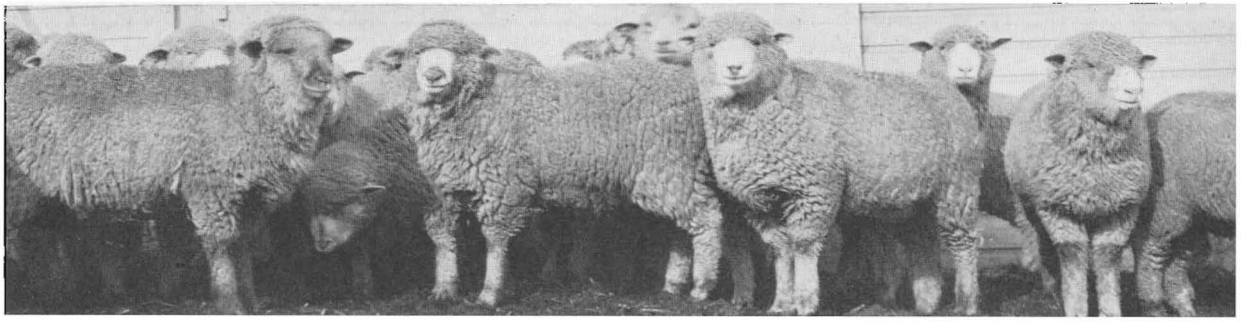

Fig. 8—Group III.

Whole barley-fed lambs. General side view of all lambs at close of experiment. This group ranked third in gains (average daily gain per lamb .295 pound); second in condition (average of good); second in selling price ($20.93 per cwt., Chicago); and fourth in margin per lamb over feed costs ($4.24 per lamb).

few good lambs in Lot II, but most of them were 'flabby' and not firm in the flank. As in Lot I, the meat was dark colored.

"This lot easily ranked last and was least desirable."

RENAL CALCULI FINDINGS

The formation of bladder stones, so called renal calculi, is a source of much loss in fattening range lambs in the Corn Belt. Western lambs, fed under local conditions, do not seem to be affected, but considerable difficulty is often encountered when they are shipped and finished in the middle west.

The results of this trial show that lots fed corn alone, or as a mixture with barley, had more lambs affected than when oats formed a part or all of the grain ration. It would seem that the shorter the feeding period, the less difficulty with bladder stones.

After 60 days, the chronic cases become more acute and two lambs died before they could be slaughtered. It would seem, then, that lambs can be fed for 60 days with reasonable safety, after which they become more affected as the feeding period is extended.

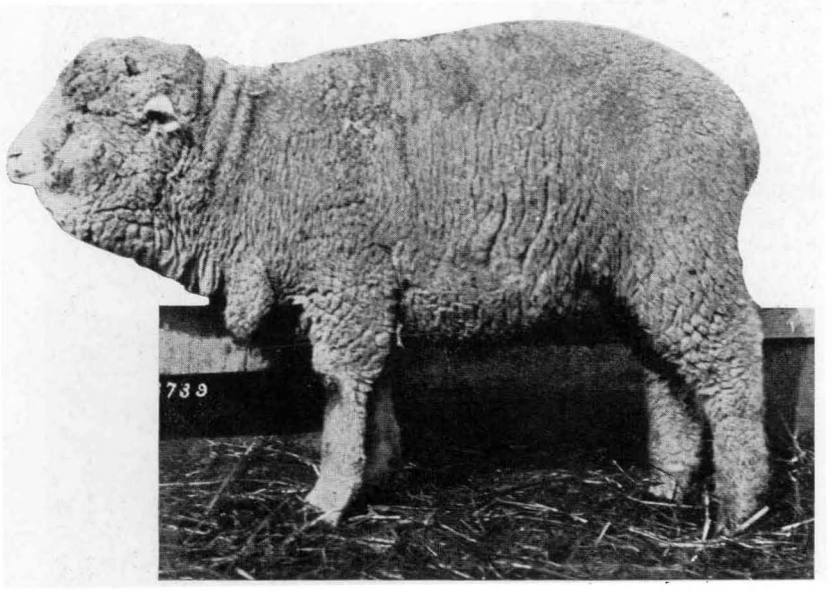

Fig. 11. Typical pose of a lamb suffering with renal calculi.