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CANE AND BEET MOLASSES FOR FATTENING LAMBS

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SUMMARY

EXPERIMENTAL RESULTS WITH DEDUCTIONS

1. **Shelled corn of mixed color was more economically satisfactory when fed straight in the ration without any molasses, either cane or beet.** However, when molasses was allowed, either cane or beet, the gains were greater, thus indicating the high value of molasses from the physiological standpoint. All of the molasses groups out-gained the Check Corn Group I. The Check Corn Group I, receiving no molasses was excelled in cost of gain by only one group, Group VI, receiving one-half pound of beet molasses per lamb daily, the relative costs being $7.70 and $7.33 per hundred pounds. All of the other groups cost $7.85 or more, the highest being $8.92 per hundred pounds of gain. However, the straight Corn Fed Group I sold for enough more than Group VI per hundred pounds, these netting at Ames $8.92 and $8.41 respectively, to offset the advantage of cheaper gains in this group. The "Margin per Lamb over Feed Costs" was greatest in the straight Corn Group I, or namely 11c per lamb.

2. **The cane-molasses-fed groups were excelled in every instance by the corresponding beet molasses groups in gains, feed required for a hundred pounds of gain, cost of gains, net selling values at Ames, Chicago selling values, and margins per lamb over feed costs.**

3. **Among the cane-molasses-fed groups it appeared that the one-half pound allowance of molasses on the silage was the most favorable allowance.** The lambs seemed to tire of the cane molasses when it was heavily fed, as when the allowance exceeded .7 pound; it was our experience that two-thirds to three-fourths pound of molasses was about as much as we could get the lambs to consistently take on the silage.

4. **The more beet molasses allowed, up to the maximum, the better the showing, everything considered.** The added allowance of beet molasses, over one-fourth pound daily, enhanced the selling value materially, so that the highest selling group of all groups in the experiment was Group VII receiving .72 pound of beet molasses daily per lamb. Whether more than one-half pound of beet molasses should be fed per lamb daily depends greatly upon the relative cheapness of the molasses and upon the particular basal ration to which added.

5. **The figures showing what one could have afforded to pay for the molasses and still return the same margin per lamb over feed costs, as in the Corn Check Group I, demonstrates that the molasses was priced too high in all groups.** With corn at 52c per bushel, or $18.56 per ton, both cane and beet molasses at $30.00 per ton were priced out of line; they cost too much. In only one group, namely Group VII receiving a full-fed allowance of beet molasses or .716 pound per lamb daily, did the beet molasses show up to be worth pound for pound more than corn, or 139.01 percent as much. In all of the other groups, molasses, cane and beet, was worth less per pound than corn.

6. **The evidence indicates that cane or beet molasses should be purchasable for at least 10 to 15 percent less than the price of No. 2 corn, ton for ton, if it is to compete favorably with the corn grain.** Lamb feeders that know the corn feeding game had best be cautious in venturing into the molasses feeding of lambs, sweet tho it may appear, and sticky as it is, the "Use Home Products for Livestock Feeding" slogan applies well here in the Iowa corn fields and feed lots.

CANE AND BEET MOLASSES FOR FATTENING LAMBS
PART I—HISTORICAL

BY JOHN M. EVVARD, C. C. CULBERTSON AND QUINTIN W. WALLACE*

The feeding of cane and beet molasses to livestock presents to the practical corn belt feeder a problem of comparatively recent origin.

The rapid growth of the sugar manufacturing industry within the last two or three decades has resulted in the production of large amounts of both beet and cane molasses, by-products which in the earlier days were utilized only to a limited extent.

In the United States experiments have been conducted by the various experiment stations to determine the feeding value of molasses. A survey of the available literature on this subject indicates that most of the research work has been done with cattle and horses. The investigational work covering molasses feeding with sheep is very meagre. This bulletin, covering the feeding of both cane and beet molasses to fattening lambs, therefore adds evidence as to the value of these thick liquid feeds.

USE OF MOLASSES FEED BEGAN 100 YEARS AGO

The history of molasses as a feed for livestock dates back to the beginning of the nineteenth century. With reference to this point Patterson and Outwater (1) say:

The first suggestion of the use of molasses as a stock feed was made by Hermstadt in 1811. The first recorded ration was used in 1830 and consisted of chopped straw and 220 pounds of molasses per day for 2000 sheep, 80 head cattle and 20 horses. In 1850, rations mentioned by Stockhardt, Kenneburg and Stohman consisted of molasses, oat-straw and hay. They limited the amount of molasses to 8 pounds per 1000 pounds live weight of the animal fed. By 1860 the use of molasses became quite general in Germany, France and Russia and by 1870 its use had spread to England. Owing to the cost of molasses and the variability of the product, the demand for it did not increase rapidly until about 1890 when the increased production caused a marked decrease in price. It is estimated that now about one-third of the molasses produced in Europe is used as forage for stock.

During the years following 1890, considerable experimental work was carried on with molasses in Europe. However, the feeds used were principally mixtures, made by mixing the molasses with some absorbent material, which in too many cases had but little, if any feeding value.

In America the use of molasses as a stock feed did not commence until about 1900. In 1898, Shutt (2) reported the feeding of beet molasses to cattle, good results being obtained by individual farmers.

*With the collaboration of S. S. Ivins, graduate student, 1920-21.

In 1902, Linfield (3) conducted an experiment to determine the value of beet molasses for fattening lambs. The same year, Dr. G. H. Berns (4) reported successful molasses feeding by the Arbuckle Bros. Sugar Refining Company, this to one hundred draft horses doing heavy draft work in New York. The allowance was a quart per horse daily, diluted with water and mixed with the grain and cut hay. In 1904 and 1905 investigations were reported from the Florida (5) and Louisiana (6) stations on the use of cane molasses as a feed for draft animals.

Following the above initial work researches have been carried on at the experiment stations in the United States and Canada to determine the practical dollars and cents value of molasses as a feed for horses, dairy cattle, fattening cattle, swine and sheep. The most important results are covered in later pages.

The manufacture of commercial molasses feeds in the United States probably began about 1900. In 1902, in a Louisiana publication (7), there is described a feed called "molassecuit" made by mixing cane molasses with bagasse, the residue of cane after the juice is pressed out. In 1903 the Canadian Experimental Farms (8) reported a feed made by adding beet molasses to the pulp residue.

In recent years the molasses feed industry has grown rapidly. The 1906 report of analyses of commercial feeds, made by the Louisiana Station (9), contains analyses of eight molasses feeds, manufactured by three companies and the same report for 1917-1918 (10) contains analyses of 149 molasses feeds put on the market by 41 manufacturers. Other states show similar increases in the number of mixed molasses feeds on the market.

The sale of molasses feeds is quite large in some sections of the country and, as a result of inspection laws, the feeds have in general become more uniform and dependable in make-up and composition. The following is the average percentage composition of the 149 molasses feeds analyzed at the Louisiana station: Water, 11.7; protein, 10.6; carbohydrates other than fiber, 52.3; fiber, 15.5; fat, 2.9; and ash, 7.0. These figures show that the molasses feeds, as then offered, were very similar in composition to oats or bran. Generally speaking, the molasses feeds made up with roughages with and without concentrated grain, vary in general average percentage composition about as follows: Water, 9 to 17; protein, 8 to 14; carbohydrates other than fiber, 45 to 54; crude fiber, 6 to 20; fat or ether extract, 1 to 6; and ash, 6 to 10. The ordinary grains do not absorb molasses very well, hence the reason why fibrous feeds are often incorporated in the mixture; they permit the inclusion of much molasses, up to approximately a half of the total weight.

KINDS OF MOLASSES AND THEIR SOURCE AND MANUFACTURE

The molasses available for stock feeding purposes is of three kinds: cane molasses, beet molasses and corn molasses, obtained as by-products from the manufacture of cane, beet and corn sugar. The first two mentioned have been used extensively for a number of years, while the corn product, because of its high cost and appetizing qualities in the human dietary, has been little used as a feed for livestock. The sugar cane and the sugar beet, therefore, supply the molasses used for animal feeding.

There are four general steps in the manufacture of sugar from either sugar cane or sugar beets. The first step consists of the extraction of the juice by means of a pressing mill or by the diffusion process which consists of the digestion of the sliced beets with water at a temperature of about 60°C.

In the second step the juice is clarified, by straining and by chemical treatment, to remove the invert sugar, organic acids, gummy material, etc. The clarified juice is next evaporated down to a point at which the sugar begins to crystallize, and in the fourth step the crystallized sugar is separated from the syrup by means of centrifugal machines. The remaining syrup is called "first molasses" and is usually again clarified and boiled to extract more of the sugar. The syrup remaining after the second extraction is called "second molasses," and contains approximately 40 to 60 percent of sugar. This is the molasses which ordinarily goes on the market for feeding purposes unless the Steffen method is used for further sugar extraction.

The Steffen method, because of its economic advantages, is now used in many of the beet sugar factories. It consists of the addition of lime, under proper conditions, to the molasses residue, which results in the precipitation of much more of the sugar in combination with the lime. This "lime sugar" or "milk sugar" is mixed with the unclarified juice, and as a result of the regular treatment of the juice, the sugar is freed from the lime. Theoretically, this process could be repeated many times with the result that there would be practically no molasses by-product, but in practice a part of the molasses is necessarily discarded periodically to get rid of certain impurities that are returned to the syrup in the process of Steffenization. The beet molasses coming from factories where the Steffen method is used is not necessarily of lower feeding value than that resulting where the method is not in use, but comparative experiments are lacking in regard to this point.

THE AMOUNT OF MOLASSES AVAILABLE

The amount of molasses available for stock feeding purposes has increased with the growth of the sugar manufacturing in-

dustry of the world. Altho it is difficult to estimate closely the amount available annually in the United States, we can obtain an approximate idea. Harris (11) places the sugar beet crop in this country for 1916 at 7,000,000 tons, and says that from each ton of beets sliced, 40 to 60 pounds of molasses is obtained as a by-product. This would mean the production of 280,000,000 to 420,000,000 pounds, or 40,000,000 to 70,000,000 gallons of beet molasses in 1916, assuming that all beets grown were sent to the sugar factories. According to government statistical reports (12), the cane molasses produced in Louisiana, in the fairly typical year of 1915, amounted to 12,743,000 gallons. The same reports show that the imports of molasses during the year 1916-1917 were 143,000,000 gallons, while the exports for the same year were 3,000,000 gallons. From these and other statistics, it may be roughly estimated that the amount of beet molasses available annually in the United States is probably in excess of 50,000,000 gallons, and of the cane product, about 150,000,000 gallons. This totals around 200,000,000 gallons. This is not all available for feeding purposes, some of it being used in the manufacture of alcohol, potash, betain and other chemical substances. While these figures are only approximate, they show that molasses offers a rather substantial feed source for the American farmer. How much can profitably be shipped into corn-belt Iowa, where corn is supreme as an effective economic competitor, is another matter. Ordinarily the Iowa corn feeder cannot afford to feed molasses to the fattening stock of the feed lot. The molasses would have to be purchased at a much less cost per ton than corn to permit of a profit equal to corn feeding. The molasses requires more work in the handling which is quite an important item in determining profits.

COMPOSITION OF MOLASSES

Cane molasses or "blackstrap," is a thick, dark-colored molasses, with a sweet taste, and pleasant odor. The beet product has the same general appearance, but a rather disagreeable odor and somewhat bitter, lingering taste, probably due to the nitrogen compounds and mineral salts it contains. The human taste, however, is not a reliable guide as to the domestic animals' palatability requirements.

Chemically, cane molasses contains from 20 to 30 percent moisture, 60 to 65 percent carbohydrates, practically all in the form of sugar, 5 to 10 percent ash, from 2.5 to 5 percent protein, no fat, and no crude fiber. Henry and Morrison (18), in the eighteenth edition of "Feeds and Feeding," 1922, give the average percentage composition of cane or blackstrap molasses as follows: Water, 25.7; crude protein, 3.2; carbohydrates, no fiber

being found, 65; fat, none; and ash, 6.1. This average represents 21 analyses.

Beet molasses has the same general chemical composition containing, however, a larger percent of ash, especially salts of potassium, and more nitrogenous material. Henry and Morrison give the average percentage composition of beet molasses as follows: Water, 22; crude protein, 9; carbohydrates, no fiber being found, 62; fat, none; and ash, 7. This approximate analysis compares favorably with shelled corn of *No. 5 Grade.* Most of the nitrogen of the beet molasses is usually stated as being in the form of amides, which used to be thought to have practically no nutritive value but our newer knowledge of protein nutrition now teaches us differently. These amides are said to be partially responsible for the somewhat unpleasant odor and taste (to the human) of the beet molasses. The sugar of the beet molasses is practically all sucrose, while a large proportion, in some cases nearly one-half of the sugar of the cane molasses, is "invert sugar," a mixture of glucose and fructose.

FEEDING VALUE OF MOLASSES

Judging from the chemical composition, it is appreciated that molasses owes its feeding value to its large percentage of sugar, which is of course highly and easily digestible, and therefore must be considered as a strictly carbohydrate feed. The palatability of molasses, more especially the cane, adds to its feeding qualities and reputation. Mixed with other feeds, molasses increases their palatability as is shown in the feeding of show stock, and in the opinion of some investigators, their digestibility. Patterson and Outwater (1) concluded, altho perhaps not correctly, as a result of experiments with steers, that molasses fed with hay and with a mixed grain ration, increased the digestibility of these feeds, and that its presence in commercial feeds gave greater value to the other ingredients, aside from the increased consumption due to palatability. Kellner (13) maintains that mixing molasses with other materials does not increase their general digestibility, excepting that the fiber is found to be less digestible in this event. The evidence is contradictory therefore, in these respects.

It is believed, however, that the readily soluble sugars of the molasses, especially in the case of the cane, tends to prevent to some degree the beneficial preliminary digestive action of alimentary bacteria on the fiber of other feeds with which mixed. The bacteria find plenty of soluble food in the molasses, and hence are not forced to attack the more unavailable fiber, hence the food materials, the fats, the proteins, the carbohydrates held within the fibrous cell walls are not so fully released, and hence

not so fully acted upon as in the case where the soluble sugars were not present. Some practical observations and feeding trials tend to substantiate this view especially where large amounts of cane molasses are fed to either steers or sheep. In the case of the former the senior author has noted that large allowances of cane molasses caused excessive fermentation, as evidenced in bloating and belching, this indicating that the gases of bacterial fermentation were being formed from the molasses.

It is generally assumed that cane molasses has a higher feeding value than beet molasses but incontrovertible experimental data to support the assumption are lacking. There has been very little work done directly comparing the two materials. In an experiment of 120 days run at the Iowa Agricultural Experiment Station (14) in 1919-20, by Evvard, Culbertson and associates, to compare cane and beet molasses for fattening two-year-old steers, the addition of one, three, and five pounds of either cane or beet molasses, respectively, to a basal standard corn belt full-fed ration, shelled corn, linseed oil meal, corn silage, clover hay, and block salt, (the molasses being placed on the silage-oil meal allowance), showed that the steers relished all amounts and gained well, there being no noticeable untoward or bad physiological effects of any kind. The shelled corn was charged at $1.29 the bushel, or $46.08 the ton. The molasses in comparison, so as to return the same margins per steer as the standard corn ration check lot, appeared to be worth per ton as follows:

In the 1-pound cane molasses lot	$103.26
In the 3-pound cane molasses lot	48.69
In the 5-pound cane molasses lot	56.77
In the 1-pound beet molasses lot	105.64
In the 3-pound beet molasses lot	34.25
In the 5-pound beet molasses lot	28.19

The molasses in this unusual year cost $40.00 the ton. In all instances the cane molasses appeared more valuable than corn when used as a partial substitute, whereas the beet excelled in but the one pound allowance lot, but the results of the second test in 1920-21 by the same authors (14) must be considered alongside. In this 120-day test with two-year-old steers the molasses at rate of two and five pounds (fullest allowance possible when put on hay or silage as was the case) per steer daily, superimposed upon standard corn belt feeds, shelled corn, linseed oil meal, mixed clover-timothy hay (alfalfa substituted after 41 days of feeding) made a good showing, altho in no instance did any of the four molasses lots out-gain the check group. The molasses cost $30.00 a ton as compared to corn at 51 cents the

bushel, $18.22 the ton, which was a great deal too much. In no case was the molasses feeding profitable. Actually in every instance the molasses, even tho presented to the steers free, did not equal the financial showing of the check lot. However, the beet molasses made a better showing than the cane. In commenting on the experiments Evvard and Culbertson have this to say:

Generally speaking, we figure that cane molasses for cattle feeding is of about the same value as beet molasses, but that one should go rather slowly in purchasing either cane or beet molasses if the price is higher than corn, pound for pound, unless, of course, the feeder wishes to use the molasses in very limited amounts, say a pound or so per 1000-pound steer daily, when he apparently can pay relatively more for the molasses than when larger amounts are offered.

We suspect that molasses would make a better showing if added to a rough basal ration consisting of low-grade hay and poor dry feeds. Generally there is need for more experimental figures bearing on this problem of "Molasses Worth".

It is considered that beet molasses, fed in considerable amounts, is more likely than the cane product to cause scouring in the animals. This is usually thought to be due to its high percentage of potassium and other alkaline salts, but Kellner (13) says that it is caused by the feeding of so much sugar in a dissolved form. Armsby (15) suggests that it is due to a combination of both causes. In our experience at the Iowa station we have experienced no particular trouble from scouring when either cane or beet molasses was used for cattle or sheep.

AMOUNT OF MOLASSES TO FEED

Opinions differ somewhat concerning the amount of molasses that can be safely fed to farm animals. Kellner (13), who is in practical agreement with Maercker, Morgen and other German investigators, advocated approximately the following amounts of beet molasses daily per 1,000 pounds live weight: horses, two to three pounds; steers, two to four pounds; sheep, four to eight pounds; and swine, four to five pounds.

Garland (16) reported that when sheep were fed more than four and one-half pounds of beet molasses per 1,000 pounds live weight, bad results were noticed, while Ram (17) says that sheep can take close to eight pounds daily per 1,000 pounds weight without injury.

Henry and Morrison (18) set the following maximum amounts of beet molasses daily per 1,000 pounds live weight: driving horses, two and one-half pounds; draft horses, four pounds or even more; dairy cows, two and one-half to three pounds; fattening cattle, four to eight pounds; fattening sheep, three to five pounds; and fattening swine, five to ten pounds.

At the Utah Agricultural Experiment Station (19, 20) lambs

were fed from one-fourth to one-half pound of beet molasses per day, and steers four pounds without any ill effects. Maynard (28) of the Colorado Agricultural Experiment Station, recently fed three pounds of beet molasses per lamb daily along with corn and alfalfa hay to good advantage.

The Texas Agricultural Experiment Station (21) reports no unfavorable results from feeding as high as twelve pounds of cane molasses to yearling steers, but when more was fed, scouring resulted.

Dalrymple (22) reports the results of investigations among a large number of planters feeding cane molasses to horses and mules, showing that as much as 21 pounds daily was fed with good results, the average amount fed being practically ten pounds. He emphasizes the harmless effects of cane or blackstrap molasses, from the laxative standpoint, and calls attention to the "sugar estates in Fiji, where a large number of valuable work horses were fed, along with some grain, as high as 30 pounds per head per day without any untoward effects." Later the allowance was made 15 pounds regularly. The effect of so much molasses was constipating rather than laxative. He also advocated the feeding of as much as ten pounds daily to milch cows and fattening steers.

The limiting factor in feeding molasses may in general not be considered as the amount that can be fed without injury to the animals, but that which can be fed with profit to the feeder. This will depend on what he must pay for molasses as compared to other fattening feeds of similar composition and use, feeds such as corn grain, barley, wheat, rye, the sorghum grains and others.

MOLASSES FOR SHEEP

The use of molasses for fattening sheep has been rather limited, particularly so in the corn belt states where corn is relatively quite cheap. Hence comparatively little experimental work has been done to test its value for this purpose.

In 1896, Ram (17) fed three lots of two lambs each, for six months on beet molasses, peat, molasses cake and barley meal, respectively, in addition to a basal ration of hay and bean meal. The lambs fed molasses gained only 83 percent as much as those receiving barley meal. If the molasses is purchased cheaply enough as compared to barley, under conditions better than under which Ram worked, the profits may well be in favor of the molasses feeding. For relative values, American experiments are of greater value to American sheep feeders.

In an experiment conducted by Albert (24) in 1898 to determine the value of different forms of beet molasses for fattening

lambs, results were obtained indicating that the straight molasses had slightly less feeding value than when mixed with other materials in commercial feeds. This work suggests, therefore, the mixing of the molasses with some one or more of the other feeds used in feeding. This practice is very generally accepted as sound from the feed lot standpoint, being convenient to do, and also offering less opportunity for the sheep to smear the free molasses on their wool, and thus detract from their sale value. To feed the molasses straight, unmixed with other feeds as silage or hay, is sticky, "smeary" business.

Linfield (19) fed six lots of 16 56-pound lambs for 78 days on rations made up of different combinations of wheat screenings, bran, beet molasses and sugar beet pulp plus lucern ad libitum. The results showed that the molasses fed lambs made poorer gains than any other lambs except those receiving only alfalfa and beet pulp but were third in cheapness of gains. Here again the relative values of the feeds used determines the financial outcome. The question arises as to the comparative value of the molasses and other basal feeds for sheep. In one comparison alfalfa and grain (wheat) screenings were compared to alfalfa, bran, and beet molasses. The unsweetened ration made close to 10 percent better daily gains, and the molasses was not equal to grain pound for pound. It took 100 pounds of beet molasses in addition to 124 pounds of alfalfa hay to equal 84 pounds of grain. The beet molasses thus showed up rather poorly.

Fortunately some American experiments, in addition to the one covered in this bulletin, bear on this point of relative values of molasses and other feeds.

Merril and Clark (20) in 1902 added beet molasses to a basal ration of alfalfa and mixed grain (wheat bran one-half, wheat shorts one-half) fed to wether lambs, 16 in a lot, for 107 days. The molasses was mixed with the grain and allowed at the rate of .34 pound per wether lamb daily. The gains made were quite similar, the check lot having .01 pound daily per lamb advantage. Molasses to the extent of 100 pounds saved 14 pounds of grain but lost 34 pounds alfalfa; or stated otherwise, it took 100 pounds of molasses plus 34 pounds of alfalfa hay to save 14 pounds of grain. Naturally the molasses feeding in this experiment was unprofitable. In a steer feeding trial carried on at the same time by the same authors (22), it took 100 pounds of beet molasses plus 55 pounds of alfalfa hay to replace 30 pounds of grain.

Skinner and King (23) fed cane molasses to fattening lambs at the rate of practically one-seventh of a pound (.15) per head daily along with shelled corn, cottonseed meal, corn silage, and

clover hay, and found it worth no more than an equal weight of the corn grain.

Shaw (25) compared dried beet pulp and dried molasses-beet-pulp with corn for lambs. The lambs receiving molasses-beet-pulp, which is the dried pulp plus beet molasses, made greater and cheaper gains than those receiving corn, in addition to a basal ration of bran and linseed meal. The feed charges were per ton: corn grain, $15.00; dried pulp, $11.60; and dried molasses-beet-pulp, $13.70. The molasses-beet-pulp also showed a little greater gains than the dried beet pulp, but at slightly greater cost. The advantage in the feeding value of the dried molasses-beet-pulp over dried beet pulp was not quite enough to offset the difference in price. The dried molasses beet pulp was thus shown in this test, to be a little better than 10 percent more valuable than the straight dried beet pulp. This test, along with results of Maynard (26) of the Colorado station and Humphrey and Kleinheinz (20) of the Wisconsin station, shows that the beet pulp is a good feed, and that the dried beet pulp is practically equal to corn grain under some conditions of sheep feeding.

These and other tests indicate that the beet molasses has in producing gains, a feeding value similar to the other beet by-products, the dried beet pulp, or molasses-beet-pulp; all three products being carbohydrate in nature with the straight beet molasses running much higher in water and of course having the great advantage in production, in that it has no fiber as compared to about 19 percent in the dried beet pulp, or as compared to the 16 percent in the molasses-beet-pulp. The beet molasses may be considered slightly superior to the dried pulp or the molasses-beet-pulp for gain production.

Hackedorn (18) of the Washington Agricultural Experiment Station, in a test with beet molasses for fattening lambs, is quoted by Henry and Morrison to have found the liquid sweet feed to be worth slightly less than Washington grain, pound for pound.

Taylor (27) compared molasses and corn meal, when fed to fattening ewes, in addition to a basal ration of clover hay, middlings and oats. When molasses replaced corn meal in the daily ration, the gains of the molasses fed lot were 1.4 times that of the lot receiving corn meal and were made cheaper for each 100 pounds gain. The molasses was purchased cheap enough to permit of this good showing. The molasses in this test with ewes was therefore, more valuable than the corn grain ton for ton.

In a recent test by Maynard, at the Colorado Station (28), to determine the feeding value of sugar beet by-products, eight lots of 32 lambs each, were fed for 93 days. The results of this experiment showed that the beet molasses fed in limited quanti-

ties was more than equal to corn pound for pound, in putting on gain, but not so in producing final profits. One hundred pounds of beet molasses replaced 104.7 pounds of corn grain and 26.2 pounds of alfalfa in the production of a unit gain. The lambs fed molasses, however, sold for a little less and lost only 4 cents less per lamb than those in the check lot. The corn was charged at $1.35 the hundred-weight and the molasses at $15.00 the ton. The lambs receiving dried molasses-beet-pulp and grain, sold for more and lost less than the lambs in the check lot. The molasses, in this experiment decreased the cost of feed per hundred pounds gain, but increased the labor cost and the shrink in shipping, as well as decreasing the selling price. The beet molasses may be considered in Maynard's tests to be practically equal to corn grain, ton for ton, in putting on the gains, but considering the whole profit on the transaction based on profits per lamb the beet molasses was worth much less per ton than the corn, actually about two-thirds as much. The corn lambs outsold the corn and molasses lambs 10 cents the hundred pounds and slightly outdressed them too.

Henry and Morrison (18) may well be quoted in regard to the values of both cane and beet molasses. Concerning the former they say, "When fed in moderate amounts, cane molasses is about equal, pound for pound, to dent corn for fattening steers, horses, dairy cows, and sheep, and has also been fed with success to pigs.....By thinning it, and pouring it over or mixing it with roughage, animals may be induced to eat more roughage and waste less than otherwise. This is especially important when feeding unpalatable, low grade roughage." Concerning beet molasses this is to the point—"In the beet sugar districts the molasses is usually a cheap source of carbohydrates, being valued at three-fourths as much per ton as corn, or more."

The authors of this bulletin are of the opinion that, taking all the economic and other factors into consideration, the Iowa lamb feeder cannot afford to feed either cane or beet molasses to his fattening lambs (in place of the corn or any part of it) unless he can get the molasses, beet preferred, for at least 10 to 15 percent less than good sound No. 2 corn, ton for ton. Even on the basis of these percentage differentials the authors are favorable to *corn feeding.*

PART II—EXPERIMENTAL RESULTS IN FEEDING CANE AND BEET MOLASSES TO FATTENING LAMBS

The objects of the experiment reported in the following paper were to determine the relative efficiency and value of cane and beet molasses when fed in limited versus full-fed amounts to fattening lambs, this when superimposed on standard corn belt feeds such as shelled corn, linseed oil meal, O. P., mixed hay, corn silage and block salt; and to note the effect of molasses on feed consumption, gains, water consumed, feed requirement, market finish, market value, shrinkage in shipping and character of pelts and carcasses.

ANIMALS USED IN EXPERIMENT

The lambs used in this experiment were western lambs of fairly uniform appearance. They were lowset and blocky, fair in condition and would grade good feeder lambs. The lambs were all healthy and thrifty and showed a preponderance of mutton breeding.

The lambs were purchased on the Omaha market, November 23, 1920, and averaged 59 pounds per head. They cost $9.00 per hundred-weight at Omaha making the total cost laid down at Ames $5.56 per lamb. (The latter figure including initial cost, commission and freight from Omaha to Ames.)

The lambs reached the Experiment station feed yards November 24, P. M., where they were kept in dry lots until the experimental feeding began on December 2, 1920. During this time the lambs all received the same preliminary feeds as follows: Shelled corn, corn silage, mixed hay and block salt. During the last three days they were given a small allowance of a mixture of equal parts of cane and beet molasses.

The total cost per hundred pounds at the beginning of the experiment was $9.21. This figure was used in computing final results.

METHODS OF EXPERIMENTATION AND CARE OF ANIMALS

In making allotments special attention was given to uniformity in weights and condition. The average initial weight and average condition of each lot were as nearly identical as it was possible to get them.

Of the 308 lambs purchased, 210 were selected for this experiment. These lambs were divided into seven lots of 30 lambs each. Three individual weights were taken at the beginning and three at the close of the experiment. The average of the three consecutive daily weights was taken as the correct initial and final wights. One individual and two group weights were taken at the end of thirty day periods.

The lambs were housed in the east end of the cattle feeding shed. The inside pens were 20x16 feet, while the outside runs on the south side of the shed were 20x80 feet. All of the feeding was done in combination grain and hay bunks which were inside the sheds. Fresh water was kept before the lambs at all times.

RATIONS FED

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

LOT I—Standard Corn Belt Ration Full-Fed (Check): Shelled corn handful fed twice daily; plus linseed oil meal, Old Process, .15 pound per head fed once daily sprinkled on the corn silage at the A. M. feed; plus corn silage handful fed twice daily; plus mixed "red clover 90 percent—timothy 10 percent" hay (alfalfa was substituted the last 30 days) hand-fed, limited according to appetite of the least eating lot, P. M. feed only; plus block salt self-fed.

Lot II—Limited, Small Allowance, Cane Molasses: Same as Check Lot I plus cane molasses one-fourth pound per head daily, allowed in the two feeds, A. M. and P. M. on the corn silage.

Lot III—Limited, Medium Allowance, Cane Molasses: Same as Lot I plus cane molasses one-half pound per head daily, allowed in the two feeds, A. M. and P. M. on the corn silage.

Lot IV—Full-Fed Allowance Cane Molasses: Same as Check Lot I plus cane molasses, all the lambs would take the two daily feeds on the corn silage.

Lot V—Limited, Small Allowance Beet Molasses: Same as Check Lot I plus beet molasses one-fourth pound per head daily, allowed in the two daily feeds on the corn silage.

Lot VI—Limited, Medium Allowance, Beet Molasses: Same as Check Lot I plus beet molasses one-half pound per head daily, allowed in the two daily feeds on the corn silage.

Lot VII—Full-Fed Allowance Beet Molasses: Same as Check Lot I plus beet molasses, all the lambs would take in the two daily feeds on the corn silage.

TIME OF FEEDING AND ORDER

The lambs were fed twice daily, about 7.30 a. m. and 4.00 p. m. The order of feeding was as follows: A. M. feed—shelled corn; corn silage with oilmeal placed on top and molasses poured over both the oilmeal and the silage, and P. M. feed—shelled corn; corn silage with molasses poured over same; hay.

PREPARATION OF FEEDS

There was no special preparation of the feeds, except that the molasses was slightly diluted with hot water to make handling easier in cold weather.

FEEDS DESCRIBED

Shelled Corn: This corn was a good grade of mixed corn, well matured and bright. As fed, it contained about 20 percent moisture. All figures presented, however, show the corn reduced to a 14 percent moisture basis, hence the weights given may be considered as equivalent to No. 2 grade of corn both in quality and moisture.

Linseed Oil Meal: The linseed oil meal was Old Process meal obtained from the Midland Linseed Mills, Minneapolis, Minnesota.

Cane Molasses: The cane molasses used was secured from the American Sugar Refining Company of New York, having been imported from Cuba. It was the ordinary "blackstrap" molasses produced as a by-product from the manufacture of cane sugar. The standard set for this molasses specifies that it should weigh 11.7 pounds per gallon at a temperature of 17.5 degrees centigrade. At this temperature and at this weight one gallon should carry approximately 22 percent water, and test about 42 degrees Baume.

Beet Molasses: Two kinds of beet molasses were fed in this experiment.

a. Peters' Beet Molasses.

This molasses was fed only for the first 13 days. It was a regular commercial beet molasses such as the M. C. Peters' Mill Company uses in its mixed feeds. It was a by-product of the manufacture of beet sugar.

b. Northern Sugar Corporation Beet Molasses.

This molasses was fed after December 15, A. M. feed, 1920. It was obtained from the Northern Sugar Corporation, Mason City, Iowa. It had been Steffenized. This molasses had a somewhat more bitter taste than that obtained from the M. C. Peters Mill Company.

Corn Silage: The corn silage was made from corn grown on the Animal Husbandry Farm. The corn was of the Reid's Yellow Dent variety.

Hay: The hay fed was of two kinds. The mixed hay, "red clover 90 percent—timothy 10 percent" fed during the first fifty days, was baled from the 1919 Iowa crop, being only fair in quality, many of the bales being dusty and discolored.

The alfalfa hay fed during the last 30 days was Iowa grown, baled from the first and second cuttings. It was rather fine, of excellent color and free from dust.

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 Professor W. G. Gaessler of the Chemistry Section of the Iowa Agricultural Experiment Station, is shown in the following table:

TABLE I. CHEMICAL COMPOSITION OF FEEDS. (In percents)

	Water	Dry matter	Crude protein	Nitrogen free extract	Crude fiber	Fat	Ash
Shelled corn*	11.93	89.07	10.28	70.68	2.31	4.57	1.23
Linseed oilmeal	8.29	91.71	36.21	33.89	8.71	7.34	5.56
Corn silage	70.44	29.56	2.64	16.61	7.47	.86	1.97
Mixed hay	16.21	83.79	9.77	35.72	30.96	2.32	5.02
Alfalfa hay	9.54	90.46	11.69	36.56	37.96	1.92	5.33
Cane molasses	8.15	71.85	4.72	60.84	1.01	.72	4.56
Beet molasses	10.58	79.42	9.06	63.43	.04	.23	6.66

*All figures in this bulletin are for corn carrying 14 percent moisture. This sample was dried out somewhat in the laboratory before being analyzed.

SPECIAL METHODS OF FEEDING EXPLAINED

The hay was fed but once daily, in the evening after the lambs had eaten the grain and silage.

The amount of hay fed was kept the same in all lots and was regulated by what the least consuming lot would clean up before morning.

The molasses was placed on the oil meal and silage of the A. M. feed and over the silage of the P. M. feed.

PRICES CHARGED FOR THE FEEDS USED

Shelled corn—$0.52 per bushel or $18.56 per ton.
Linseed oilmeal—$50.00 per ton.
Cane molasses—$30.00 per ton.
Beet molasses—$30.00 per ton.
Corn silage—$7.00 per ton.
Mixed hay —$25.00 per ton.
Alfalfa hay—$25.00 per ton.
Block salt—$30.00 per ton.

DISCUSSION OF EXPERIMENTAL RESULTS

HEALTH AND GENERAL BEHAVIOR

Observations made thruout the feeding period revealed no noticeable differences in the general behavior of the lambs in the various lots, or in the health and thriftiness of the lambs as a whole.

The lambs in all molasses lots showed a slightly more laxative condition than those in the check lot, but none of them showed any signs of scouring. The lambs receiving the heavy allowance of beet molasses appeared no different from the cane lots in this respect.

Apparently to the eye the addition of either cane or beet molasses to the ration had no outstanding detrimental effects upon the health and thriftiness of the lambs. However, slaughter tests revealed that the molasses feeding had some effect on the formation of renal or bladder calculi.

In previous years we have had at Ames some trouble with bladder calculi forming when the lambs are about two months along in the feeding test. Therefore this year we examined all the bladders of the slaughtered lambs for grit or gravel, or calculi with these results: The percentage of lambs showing calculi for the various lots was in round numbers as follows: Lot I, Check, 3 percent; Lot II, one-fourth pound cane molasses, 3 percent; Lot III, one-half pound cane molasses, 7 percent; Lot IV, seven-tenths pound cane molasses, 23 percent; Lot V, one-fourth pound beet molasses, 27 percent; Lot VI, one-half pound beet molasses, 30 percent; Lot VII, seven-tenths pound beet molasses, 48 percent.

Some of the calculi findings were very, very slight, but the presence of any grit, or gravel whatsoever was considered as a

"finding of calculi." These calculi findings are of practical significance inasmuch as they show quite unmistakably that the feed is a factor in their formation. "Water belly" is caused by the calculi lodging in the canal that leads outward from the bladder and the trouble is an outstanding one with wether lambs and rams. Only one lamb in the check lot, or 3.33 percent, showed indications of calculi, as compared with 20.86 percent for all the molasses lambs. Each beet lot showed more calculi than the corresponding cane lot, the average for all beet lots being 30.87 percent, and for all cane lots, 11.18 percent. In both the cane and beet lots, the indications of calculi increased with the amount of molasses fed. These results indicate that, under the conditions of this experiment, the feeding of molasses to fattening lambs apparently tends to cause the formation of renal calculi; this being especially true of the beet molasses.

GAINS MADE BY THE LAMBS

The addition of either cane or beet molasses to the standard corn belt ration proved advantageous as far as the daily gains were concerned (see Table II.) The lambs in all lots receiving molasses made somewhat greater daily gains than did the lambs in the check lot. The average daily gain in the check Lot I was .290 pound as compared to .313 pound in Lot II. receiving one-fourth pound of cane molasses per day and .391 pound in Lot IV, receiving one-half pound beet molasses, the molasses fed lots making respectively the least and greatest average daily gains.

In each case where molasses was fed, the lots receiving beet molasses made greater gains than the corresponding lots receiving cane molasses. In both the cane and the beet lots, the lambs receiving one-half pound of molasses per day made the best gains, while those receiving one-fourth pound molasses per day made the poorest gains. The lots receiving molasses full-fed were intermediate.

It appears that under the conditions of this experiment, the addition to the ration of one-half pound of either cane or beet molasses had greater effect in increasing gains than the addition of molasses in greater or less amounts.

WATER CONSUMPTION

In order to get an idea as regards the water consumption of these lambs on feed, three ten-day records were taken, one during the middle ten days of each 30 day period.

Table III, entitled "Water Consumption, with Correlations, Record", shows by groups the total water drunk; total water partaken in feeds; total water mixed with feeds; total water consumed; percent water drunk of total water consumed; water

TABLE II. FIGURES COVERING LAMB FEEDING TRIAL

Weights, Gains, Feed Consumption, Feed Requirements, Costs, Selling Values and Margin Period Seven Lots of Thirty Lambs Each

(All Figures on Average Single Lamb Basis)

(All Designations in Pounds unless otherwise designated)

Lot No. Ration	I Shelled corn, corn silage, oil meal, clover and alfalfa hay, block salt	II Same as Lot I plus one-fourth pound cane molasses	III Same as Lot I plus one-half pound cane molasses	IV Same as Lot I plus cane molasses, full-fed	V Same as Lot I plus one-fourth pound beet molasses	VI Same as Lot I plus one-half pound beet molasses	VII Same as Lot I plus beet molasses, full-fed
Average initial weight	60.03	60.14	60.56	60.32	60.14	59.98	59.54
Average final weight	83.22	85.15	89.87	88.74	86.02	91.24	90.26
Gain per lamb	23.18	25.01	29.31	28.42	25.87	31.27	30.72
Average daily gain	.290	.313	.366	.355	.323	.391	.384
Average daily feed:							
Shelled corn	1.182	1.120	1.050	1.033	1.116	1.048	1.042
Linseed oil meal	.150	.150	.150	.150	.150	.150	.150
Cane molasses	.....	.250	.504	.713	.....	.....	.....
Beet molasses	.....	.....	.....	.....	.250	.504	.716
Corn silage	1.504	1.537	1.539	1.533	1.537	1.531	1.537
Hay	.180	.179	.179	.178	.179	.180	.178
Block salt	.005	.005	.006	.003	.003	.002	.001
Feed required for 100-lbs. gain:							
Shelled corn	407.84	358.15	286.60	290.87	345.07	268.06	271.43
Linseed oil meal	51.76	47.99	40.93	42.22	46.38	38.38	39.07
Cane molasses	.....	79.98	137.61	200.80	.....	.....	.....
Beet molasses	.....	.....	.....	.....	77.30	129.00	186.51
Corn silage	518.82	491.66	420.13	431.44	475.19	391.62	400.19
Hay	62.05	57.32	48.80	50.19	55.27	45.95	46.45
Block salt	1.61	1.51	1.76	.80	.86	.53	.21
Cost of 100-lbs. gain	$7.70	$8.18	$7.85	$8.92	$7.89	$7.33	$8.28
Initial cost at Ames per cwt.	$9.21	$9.21	$9.21	$9.21	$9.21	$9.21	$9.21
Necessary Ames selling price per cwt. to break even	$8.79	$8.91	$8.77	$9.12	$8.81	$8.57	$8.89
Actual Ames realization price per cwt.	$8.92	$8.47	$8.39	$8.49	$8.53	$8.41	$8.88
Chicago selling price per cwt.	$10.15	$9.80	$10.00	$9.90	$9.85	$10.15	$10.30
Margin per lamb over feed costs	$0.11	—$0.38	—$0.34	—$0.56	—$0.24	—$0.14	—$0.01

TABLE III. WATER CONSUMPTION, WITH CORRELATIONS, RECORD PERIOD AVERAGE OF THREE TEN-DAY PERIODS

(All figures in pounds)

Lot No.	Molasses fed	Water consumed by all lambs in lots				Percent water drunk of total consumed	Water drunk daily per lamb	Water consumed (Drunk, mixed with and in feed)		
		Drunk	Mixed with molasses	Partaken in feed	Total			Daily per lamb	Per 100 pound gain	Per 100 lb. dry matter ingested
I	none	532	...	393	925	57.5	1.77	3.08	1124	164
II	.25 lb. cane	536	82	428	1046	59.1	1.79	3.49	1182	172
III	.50 lb. cane	599	87	446	1132	60.6	2.00	3.77	1040	176
IV	Full-fed (.713 lb.) cane	592	105	459	1156	60.3	1.97	3.85	1123	171
V	.25 lb. beet	559	70	422	1051	59.8	1.86	3.50	1136	172
VI	.50 lb. beet	708	73	432	1213	64.4	2.36	4.04	1052	186
VII	Full-fed (.716 lb.) beet	738	85	448	1271	64.8	2.46	4.24	1133	181

drunk daily per lamb; total water consumed daily per lamb; total water consumed per 100 pounds gain; and total water consumed per 100 pounds dry matter ingested.

It appears that:

1. These winter fed lambs when on full feed drank on the average from 1.77 to 2.46 pounds of water daily, this being from 57.5 to 64.8 percent of the total water ingested, the remaining percentages being the water naturally carried in the feeds eaten and the water mixed with feed, (the molasses).

2. The greatest water consumption was noted in the lot receiving beet molasses full-fed. The check lot receiving no molasses consumed the least water. Apparently the molasses increased the desire of the lambs for water inasmuch as all lots receiving molasses, either beet or cane, consumed more water than the check lot. In all cases where molasses was fed the lots receiving beet molasses consumed more water than the corresponding lots receiving cane molasses. It appears that as the amount of molasses fed is increased the water consumption is correspondingly increased. The heavy molasses feeding, from one-half pound up, stimulated the lambs to drink from 13 to almost 40 percent more water, quite a significant difference.

3. The total water intake for 100 pounds gain exceeds the total feed requirement in all instances. The total water requirement per 100 pounds gain, as compared to "no-molasses" feeding in this test ranged from 1040 to 1182 pounds, the highest requirement being in Lot II, fed one-fourth pound of cane molasses.

4. The water intake was greater than the dry matter con-

sumption, or from 64 to 86 percent more in this test. This clear ly shows that weight for weight more water was taken than dry matter by these winterfed lambs.

AVERAGE DAILY FEED EATEN PER LAMB

The average daily consumption of shelled corn was apparently affected to some extent at least by the amount of molasses fed. The greatest daily corn consumption is noted in the check lot receiving no molasses, the lambs in Lot 1 consuming 1.182 pounds of shelled corn per head daily as compared to 1.033 pounds of corn in the least consuming lot receiving molasses and 1.120 pounds in the greatest consuming lot receiving molasses. Molasses, being a corn substitute, should naturally be expected to inhibit corn consumption, particularly where relatively large quantities are fed. This holds true in steer as well as lamb feeding. The corn consumption in the molasses fed lots was somewhat less than that of the check lot, decreasing as the amount of molasses fed was increased.

It is noted that the corresponding lots receiving respectively cane or beet molasses consumed practically the same amount of corn.

In regard to the total concentrates consumed per head daily, the ranking of the various lots is reversed. The check lot consumed the least amount of total concentrates with 1.332 pounds per head. The consumption of total concentrates increased as the amount of molasses fed was increased, the full-fed beet molasses lot consuming 43 percent more than the check lot. The amount of total concentrates eaten by the corresponding beet and cane molasses-fed lots was approximately the same.

While the addition of molasses to the ration decreased the daily corn consumption, it also made it possible to get the lambs to consume considerably more total concentrates than when molasses was not fed.

The amount of silage consumed daily per head showed very little variation among lots altho all of the lots receiving molasses ate slightly more silage than did the check lot.

The salt consumption was decreased as the molasses increased, in all cases but one, this being particularly marked of the lots receiving beet molasses. Too, each cane molasses-fed lot consumed more salt than the corresponding beet molasses-fed lot.

These facts seem to indicate that the mineral content of the molasses, especially from the beet, was such as to lessen the need for salt or else to supply some of salt carried constituents, sodium or chlorine, or both to the lambs. The beet molasses apparently supplied a greater amount of salt or salt equivalent. This is to be expected inasmuch as beet molasses is somewhat higher in ash or mineral content than is the cane molasses.

FEED REQUIRED FOR ONE HUNDRED POUNDS GAIN

All lots receiving molasses required less shelled corn for 100 pounds gain than did the "no-molasses" check lot. Lot VI receiving one-half pound of beet molasses per head daily stands first in this respect requiring 268 pounds of shelled corn as compared to 408 pounds for the check lot. The lots receiving beet molasses required less corn than did the corresponding lots receiving cane molasses. The lots making the greatest daily gain required the least corn for 100 pounds gain.

In total concentrates required for 100 pounds gain the check lot excells all the molasses-fed lots with the exception of Lot VI. Lot VI required 24 pounds less of concentrates than did the check lot while the other molasses-fed lots required from 5.5 to 74 pounds more of concentrates than did the check lot.

On the average it appears that the addition of molasses to the ration increased the amount of concentrates required for 100 pounds gain.

All lots receiving molasses required somewhat less linseed oil meal than the check lot, due to the faster gains made by the molasses-fed lambs.

The check lot required the greatest amount of silage for 100 pounds gain or 519 pounds. The molasses-fed lots required 392 pounds of silage in Lot VI to 492 pounds in Lot II.

The hay requirement proved favorable to molasses feeding in that the hay required for one hundred pounds gain was somewhat less in the molasses-fed lots than in the check lot.

The addition of molasses to the ration reduced the salt requirement considerably, particularly in the lots receiving beet molasses, the full-fed beet molasses lot requiring only about one-eighth the amount of salt required by the check lot.

The facts discussed above indicate that while the addition of molasses increased the grain or grain equivalent required to make the same gains, the roughage and total feed requirements for 100 pounds gain decreased.

COST OF A HUNDRED POUNDS GAIN

In cost of feeds required for 100 pounds gain the lots ranked as follows, best first: Lot VI, one-half pound beet molasses, $7.33; Lot I, Check, $7.70; Lot III, one-half pound cane molasses, $7.85; Lot V, one-fourth pound beet molasses, $7.89; Lot II, one-fourth pound cane molasses, $8.18; Lot VII, full-fed beet molasses, $8.28; Lot IV, full-fed cane molasses, $8.92. **Only one lot, Lot VI, receiving one-half pound of beet molasses per lamb daily, excelled the "no molasses" check lot in cost of 100 pounds gain. The cost in all other molasses-fed lots was greater than the check lot by from $.15 to $1.12.**

From the standpoint of cost of 100 pounds gain with molasses selling for $30.00 per ton, it did not pay to add molasses to the ration in any case except where .50 pound of beet molasses was fed daily per lamb.

When molasses can be obtained for the same price as corn, the feed cost is altered considerably. If the molasses fed in this experiment had been obtained for the same price as corn or $18.56 per ton, the feed cost per hundred pounds gain would have been as follows: Lot VI, one-half pound beet molasses, $6.60; Lot III, one-half pound cane molasses, $7.07; Lot VII, full-fed beet molasses, $7.21; Lot V, one-fourth pound beet molasses, $7.44; Lot I, check, $7.70; Lot II, one-fourth pound cane molasses, $7.70; Lot IV, full-fed cane molasses, $7.77.

With molasses valued at the same price as corn, only one molasses-fed lot exceeded the check lot in cost of 100 pounds gain. Under the same conditions the beet molasses would have proven more valuable than did the cane molasses inasmuch as all lots receiving beet molasses would have put on gains at a less cost per 100 pounds gain than the check lot, while only one lot receiving cane molasses would have made gains at a less cost than the check lot. But cost of gains, highly important as they are, tell only a part of the real financial story. We must not forget that the shrinkage in shipment, the selling price of the lambs, the character of the wool and of the carcasses are most important as we shall see.

SHIPPING AND SLAUGHTER DATA

Table IV shows the shinkage in shipment, cost of shipping, dressing, percent and weight of internal fat of the lambs in this experiment.

A comparison of the data contained in table IV shows shelled corn to be superior to corn plus molasses insofar as the shipping is concerned. The corn fed lambs shrank the least of all and consequently cost the least of all lots to ship. The molasses-fed lambs shrank 1.38 pounds to 5.46 pounds per hundred weight more than the check lot and cost from $.11 to $.57 more per lamb to ship. In general the lots making the greatest gains shrank the most, altho there are some exceptions to this generality.

The pelts in the molasses-fed lots were uniformly heavier than where this sticky material was not fed. The lambs eating silage with molasses on it seem to have a fondness for smearing the molasses all over their wool. The molasses in the wool was plainly the cause of most of the one-half to one and one-half pound excess weight of pelts in the molasses lots.

The molasses-fed lots, all outdressed the check lot, the check lot, being the best shipper, shrinking the least enroute to mar-

TABLE IV. SHIPPING SHRINKAGE, DRESSING PERCENT, AND COST OF SHIPPING

(In pounds, percents, or dollars)

Lot No.	I	II	III	IV	V	VI	VII
Molasses allowance	None	One-fourth pound cane molasses	One-half pound cane molasses	Full-fed cane molasses (.713 pound)	One-fourth pound beet molasses	One-half pound beet molasses	Full-fed beet molasses (.716 pound)
Shrinkage enroute to market (pounds per lamb)	3.88	5.15	8.05	6.08	5.02	9.24	5.95
Shrinkage enroute to market (percent)	4.67	6.05	8.96	6.85	5.83	10.13	6.59
Dressing percent based on cold weights and Chicago weights	48.78	49.50	50.13	49.56	49.22	50.77	50.24
Shrinkage in cooler, warm to cold weights (percent)	2.44	3.02	2.21	2.69	2.21	2.04	2.53
Weight of pelt per lamb (pounds)	12.33	12.83	13.03	13.60	13.03	13.73	13.55
Weight of internal fat per lamb (caul and gut fat) (pounds)	3.13	3.40	3.59	3.53	3.37	3.67	3.55
Cost of shipping per lamb (not including shrink)	$0.63	$0.63	$0.65	$0.65	$0.64	$0.65	$0.67
Cost of shipping per lamb (including shrink)	$1.02	$1.13	$1.46	$1.25	$1.13	$1.59	$1.28

ket would naturally show a lighter dressing percentage than the heavy shrinking lambs. This is well illustrated in this example: Take two eighty-pound lambs; one shrinks to 75 pounds and the other to 70 pounds, or respectively 5 and 10 pounds each on the way to market. Both yield 35 pound carcasses, the light shrinker thus dresses only 46.67 percent and the heavy shrinker 50 percent, inasmuch as dressing percentages are based on market, not home weights.

The lots which received beet molasses dressed slightly more than the lots which received cane molasses. In general the lambs which made the best gains shrank the most in shipping and dressed out the highest..

The comparison of the warm and cold weights, as expressed in percentages shows: That the check lot showed practically the same shrink in the cooler as the average of all molasses lots; that the beet lots shrank a little less than the cane lots; that the medium beet lot, which showed the greatest shrink in shipping, and highest dressing percentage, shrank the least in the cooler; and that, in general, the shrinkage in the cooler was to a large degree inversely proportional to that in shipping.

CHICAGO SELLING VALUE PER CWT.

The actual Chicago selling price of the lambs, ranked according to selling price, best first, was as follows:

Lot No.	Chicago selling price per cwt.	Ames* realization or net value per cwt. (Given for comparison)
VII—Full-fed beet molasses.....	$10.30	$8.88
VI—One-half pound beet molasses...	10.15	8.41
I—Check no-molasses	10.15	8.92
III—One-half pound cane molasses...	10.00	8.39
IV—Full-fed cane molasses.....	9.90	8.49
V—One-fourth pound beet molasses..	9.85	8.53
II—One-fourth pound cane molasses..	9.80	8.47

*This is based on Ames weights. It is the net figure realized per cwt. after deducting all shipping expenses.

One molasses-fed lot (VII) brought a higher selling price than the check lot, while one other lot (VI) brought the same price as the check lot. Both of these lots received beet molasses.

Each beet-molasses-fed lot brought a higher price than the corresponding cane-molasses-fed lot, there being quite a difference in favor of beet molasses. The dressing percentages and the internal fat figures justify these differences in favor of the beet molasses-fed lambs, excepting in case of the light or one-fourth pound allowance. The internal fat figures show that on the whole beet molasses put a little better finish on the lambs than did the cane molasses. The lambs receiving the larger allowances of molasses were better finished than the light and "no-molasses" fed lots.

The lambs in the "no-molasses" check lot were not as fat as the molasses-fed lambs, but the absence of molasses from their

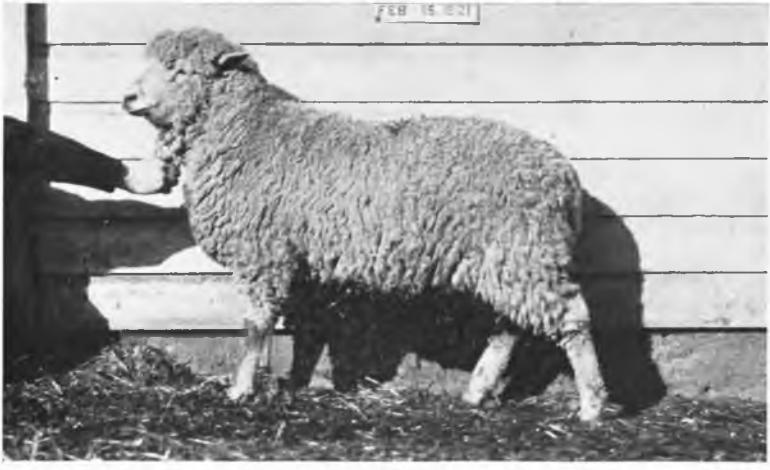

Fig. 1—A typical Corn-Fed Lamb of Check "No-Molasses" Group I. Note the clean wool, there being no molasses to "daub" and "smear" it up. These lambs at close of the experiment presented a neat, trim, tidy, and finished selling appearance; they shipped well with small shrinkage and therefore they sold well.

Fig. 2—A Typical "Cane-Molasses" Fed Finished Lamb of Group IV. Some of the seven-tenths of a pound daily molasses allowance got into this lamb's wool, thus producing an untidy "stuck-up" appearance and a heavy pelt, better than a pound and a quarter heavier than the straight corn fed lambs.

wool improved their appearance so that only one molasses-fed lot brought a higher price. The molasses on the wool was the cause of a slight dockage running up to twenty-five cents per hundred pounds of live lamb.

VALUE OF LAMBS ON FOOT TO PACKER

The following comparison shows what the packer figures he could have paid for the lambs per 100 pounds live weight, and still break even. It is based by the packer on the current selling value of the cold carcasses at 18 cents a pound, and all by-products, (pelts at $1.20 each; internal fats at $2.05 per hundred weight; plucks at 5 cents per lamb; and the others not included herein at the blanket range of 12 cents per hundred pounds of lamb live weight), and the costs of killing (53 cents per head plus 83 cents per 100 pounds live weight).

Lot VI	Medium allowance, beet molasses	$9.40
Lot III	Medium allowance, cane molasses	9.28
Lot VII	Full-fed allowance, beet molasses	9.27
Lot II	Small allowance, cane molasses	9.19
Lot IV	Full-fed allowance, cane molasses	9.16
Lot V	Small allowance, beet molasses	9.13
Lot I	Check, no molasses	9.06

This comparison shows a different ranking of the lots from the way they were actually evaluated by the buyers in the stock yards pens before killing, the main differences being that the full-fed beet lot which was evaluated at 5 cents higher than any other lot, was third in actual value to the packer, and that

the check lot shows a relatively lower actual value than its estimated value. However, the packer computer in figuring the actual by-products values, considered the pelt value the same for all lots, while as has been heretofore noted, the molasses on the pelts of the molasses-fed lambs was in the evaluations, discriminated against.

The actual values as figured by the packer show that the beet lots had a slightly higher value than the cane lots, and that the medium allowance of molasses, of both kinds, which produced greatest gains in the feedlot gave better results than the full-fed allowance, or the smaller molasses ration; while on the other hand all molasses lots were worth more than the check lot.

These actually figured values based on the actual killing of the lambs shows to the packer buyers how they are missing or hitting their purchases. The stock pen valuations, however, are the ones on which the sheep feeder must figure his livelihood. The figures just given are of much practical interest to the student, the theorist, and the packer buyer: but they are of academic interest when it comes to future price expectation on other lambs. The point is that if the lambs in this experiment could, under conditions similar to their first selling adventure, go to the yards for sale again the buyers would value them for what they appear to show, and not in accordance with the "check-up" figures.

Fig. 3—A Typical "Beet-Molasses" Fed Finished Lamb of Group VII. This lamb and mates have some "sweetness" in their wool, the pelts being heavy therefrom. These lambs sold exceptionally well, the highest of all, but even at that they did not "bring the bacon of profit home," they were lacking only a single cent of paying for their feed.

TABLE V. SEVEN LOTS OF THIRTY LAMBS EACH FED FROM DEC. 2, 1920, TO FEB. 20, 1921—80 DAYS.

Sub-Periods were 30, 30, and 20 Days Each.
Data: By periods and total for entire test.
(All figures in pounds)

	Total initial weight	Total final weight	Total gain	Av. daily gain per lamb	Total feed allowed (charged)						Feed allowed (charged) per 100 pounds gain					
					Shelled corn	Linseed oil meal	Molasses	Corn silage	Hay*	Block salt	Shelled corn	Linseed oil meal	Molasses	Corn silage	Hay*	Block salt
Lot I—Ration: Shelled corn—Linseed oil meal—Corn silage—Hay*—Block salt.																
Dec. 2-Jan. 1	1801.00	2104.30	303.30	.337	846.03	135.00	None	1600.00	204.00	3.00	278.94	44.51	None	527.53	67.26	.99
Jan. 1-Jan. 31	2104.30	2405.30	301.00	.334	1179.53	135.00	None	1240.00	147.50	4.40	391.87	44.85	None	411.96	49.01	1.46
Jan. 31-Feb. 20	2405.30	2496.50	91.20	.152	810.99	90.00	None	768.42	80.00	3.80	889.24	98.68	None	842.57	87.72	4.17
Dec. 2-Feb. 20	1801.00	2496.50	695.50	.290	2836.56	360.00	None	3608.42	431.50	11.20	407.84	51.76	None	518.82	62.05	1.61
Lot II—Ration: Shelled corn—Linseed oil meal—¼ lb. cane molasses—Corn silage—Hay*—Block salt.																
Dec. 2-Jan. 1	1804.30	2145.70	341.40	.379	714.67	135.00	225.00	1655.00	203.00	3.70	209.34	39.54	65.91	484.77	59.46	1.08
Jan. 1-Jan. 31	2145.70	2462.70	317.20	.352	1153.26	135.00	225.00	1265.00	147.00	4.90	363.80	42.59	70.98	339.05	46.37	1.55
Jan. 31-Feb. 20	2462.70	2554.50	91.80	.153	818.93	90.00	150.00	768.42	80.00	2.70	892.08	98.04	163.40	837.06	87.15	2.94
Dec. 2-Feb. 20	1804.30	2554.50	750.00	.313	2686.86	360.00	600.00	3688.42	430.00	11.30	358.15	47.99	79.98	491.66	57.32	1.51
Lot III—Ration: Shelled corn—Linseed oil meal—½ lb. cane molasses—Corn silage—Hay*—Block salt.																
Dec. 2-Jan. 1	1816.70	2165.30	348.60	.387	573.21	135.00	476.25	1650.00	202.00	4.95	164.43	38.73	136.62	473.32	57.95	1.42
Jan. 1-Jan. 31	2165.30	2493.30	328.00	.364	1122.29	135.00	433.75	1265.00	147.00	6.80	174.76	41.16	132.24	385.67	44.82	2.07
Jan. 31-Feb. 20	2493.30	2696.00	202.70	.338	824.60	89.92	300.00	779.16	80.10	3.75	406.81	44.36	148.00	384.39	39.52	1.85
Dec. 2-Feb. 20	1816.70	2696.00	879.30	.366	2520.10	359.92	1210.00	3694.16	429.10	15.50	286.60	40.93	137.61	420.13	48.80	1.76
Lot IV—Ration: Shelled corn—Linseed oil meal—Cane molasses, full-fed—Corn silage—Hay*—Block salt.																
Dec. 2-Jan. 1	1809.70	2158.70	349.00	.388	544.73	135.00	632.00	1655.00	201.00	3.00	156.08	38.68	181.09	474.21	57.59	.86
Jan. 1-Jan. 31	2158.70	2513.00	354.30	.394	1122.29	135.00	720.00	1255.00	147.00	2.20	316.76	38.10	203.22	354.22	41.49	.62
Jan. 31-Feb. 20	2513.00	2662.30	149.30	.249	812.98	90.00	360.00	768.42	80.00	1.60	544.53	60.28	241.13	514.68	53.58	1.07
Dec. 2-Feb. 20	1809.70	2662.30	852.60	.355	2480.00	360.00	1712.00	3678.42	428.00	6.80	290.87	42.22	200.80	431.44	50.19	.80

Lot V—Ration: Shelled corn—Linseed oil meal—¼ lb. beet molasses—Corn silage—Hay*—Block salt.

Dec. 2-Jan. 1	1804.30	2163.70	359.40	.399	714.22	135.00	225.00	1655.00	202.00	1.95	198.73	37.56	62.60	460.49	56.20	.54
Jan. 1-Jan. 31	2163.70	2468.00	304.30	.338	1153.26	135.00	225.00	1265.00	147.00	3.00	378.99	44.36	73.94	415.71	48.30	.99
Jan. 31-Feb. 20	2468.00	2580.50	112.50	.188	810.99	90.00	150.00	768.42	80.00	1.70	720.88	80.00	133.33	683.04	71.11	1.51
Dec. 2-Feb. 20	1804.30	2580.50	776.20	.323	2678.47	360.00	600.00	3688.42	429.00	6.65	345.07	46.38	77.30	475.19	55.27	.86

Lot VI—Ration: Shelled corn—Linseed oil meal—½ lb. beet molasses—Corn silage—Hay*—Block salt.

Dec. 2-Jan. 1	1799.30	2202.30	403.00	.448	573.21	135.00	476.25	1650.00	204.00	.15	142.24	33.60	118.18	409.43	50.62	.04
Jan. 1-Jan. 31	2202.30	2536.70	334.40	.372	1122.29	135.00	433.75	1255.00	147.00	2.50	335.61	40.37	129.71	375.30	43.96	.75
Jan. 31-Feb. 20	2536.70	2737.30	200.60	.334	818.93	90.90	300.00	768.42	80.00	2.30	408.24	44.87	149.55	383.06	39.88	1.15
Dec. 2-Feb. 20	1799.30	2737.30	938.00	.391	2514.43	360.00	1210.00	3673.42	431.00	4.95	268.06	38.38	129.00	391.62	45.95	.53

Lot VII—Ration: Shelled corn—Linseed oil meal—Beet molasses, full-fed—Corn silage—Hay*—Block salt.

Dec. 2-Jan. 1	1786.30	2173.70	387.40	.430	544.73	135.00	632.00	1650.00	201.00	.00	140.61	34.85	163.14	425.92	51.88	.00
Jan. 1-Jan. 31	2173.70	2530.70	357.00	.397	1122.29	135.00	720.00	1255.00	147.00	1.00	314.37	37.82	201.68	351.54	41.17	.28
Jan. 31-Feb. 20	2530.70	2707.80	177.10	.295	834.22	90.00	366.72	782.77	80.04	.92	471.04	50.82	207.07	441.99	45.17	.52
Dec. 2-Feb. 20	1786.30	2707.80	921.50	.384	2501.24	360.00	1718.72	3687.77	428.04	1.92	271.43	39.07	186.51	400.19	46.45	.21

*Mixed hay (clover approximately by weight 90 percent and timothy 10 percent) fed from December 2 to January 21; Alfalfa substituted from January 21 to February 20.

MARGIN PER LAMB OVER FEED COSTS BY LOTS

The margin over feed costs is based on the initial cost of lambs, cost of feeds, shipping and selling costs and the actual Chicago selling price. Labor, housing, equipmental charges and interest, as well as the value of the manure produced are not taken into consideration.

The ranking of lots as to the margin received per lamb over and above feed costs was as follows:

Lot No.	Molasses fed	Margin
I	Check, no molasses	$0.11 Surplus
VII	Full-fed allowance, beet molasses	0.01 Deficit
VI	Medium allowance, beet molasses	0.14 Deficit
V	Small allowance, beet molasses	0.24 Deficit
III	Medium allowance, cane molasses	0.34 Deficit
II	Small allowance, cane molasses	0.38 Deficit
IV	Full-fed allowance, cane molasses	0.56 Deficit

The check lot was the only one that paid for the cost of feeds, shipping and selling, altho the lot receiving beet molasses full-fed lost only one cent per lamb.

All the lots receiving beet molasses came nearer paying for their feed than any of the lots receiving cane molasses.

Under the conditions of this experiment and at the prevailing prices of feeds, it did not pay to add molasses to the standard corn belt ration of shelled corn, linseed oil meal, corn silage, hay and block salt. Beet molasses in this experiment proved to be more valuable than cane molasses and was more valuable when fed in large, rather than small amounts.

REALIZATION VALUE OF MOLASSES

The following comparison under the caption, "What the Molasses was Worth", shows what one could have afforded to pay per ton for the molasses fed to the different lots, with corn at $18.56 per ton, and still return the same margin over feed costs as was made by the check lot. This is the one outstanding figure in the comparative study of the kinds of molasses as well as of the relative economy of corn and corn partially supplemented or substituted, which depends on the viewpoint. These

"WHAT THE MOLASSES WAS WORTH"

Lot No.	Molasses fed	Comparative realization value per ton
I	Check, no molasses, shelled corn basis.	$18.56 (corn)
VII	Full-fed allowance, beet molasses	25.76
VI	Medium allowance, beet molasses	17.37
III	Medium allowance, cane molasses	7.36
IV	Full-fed allowance, cane molasses	6.48
V	Small allowance, beet molasses	−5.43 (negative)
II	Small allowance, cane molasses	−19.03 (negative)

relative figures in combination with the percentage figures showing comparative values as contrasted with corn grain are to be given high rank in making a decision as to the advisability of feeding molasses in the corn growing country.

These figures indicate that in no case was the molasses worth the price paid for it ($30.00 per ton).

In just one instance did the molasses prove as valuable as corn, that being in Lot VII, given a full feed of beet molasses. Figuring these results on a percentage basis with corn taken as 100 percent we find that beet molasses full-fed was 139 percent as valuable as corn. The molasses fed in other lots was not as valuable as corn. The percentage figures show the following comparative rankings:

Lot No.	Molasses fed	Percent of value of corn
VII	Full-fed allowance, beet molasses.	139.00
VI	Medium allowance, beet molasses.	93.75
III	Medium allowance, cane molasses.	39.88
IV	Full-fed allowance, cane molasses.	34.48
V	Small allowance, beet molasses..	−29.09 (negative)
II	Small allowance, cane molasses.	−102.00 (negative)

Unless the Iowa lamb feeder can purchase good standard, up to the grade feeding molasses at a cost less per ton than corn grain, which is seldom possible, molasses feeding is relatively speaking a questionable financial venture. Our suggestion is, based upon the experimental evidence herein given, to keep on sticking corn fat on the lambs' backs unless there are tempting price concessions on molasses tons comfortably below the ton corn price.

That both cane and beet molasses are good feeds for lambs is without question; the big question is "What can one afford to pay for the molasses as compared to other feeds?"—That price should as the evidence points, be at least 0 to 15 percent less than the corn price per unit weight.

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