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Methods of Storing Alfalfa for Fattening Cattle

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By

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This thesis is approved as a creditable independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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INTRODUCTION

Cattle feeders and ranchers of South Dakota winter and fatten a great number of cattle on harvested grasses and legumes. The forages are stored for winter feeding both as hay and as silage. Alfalfa is one of the important crops in both the eastern and western portions of the state. The use of alfalfa, particularily as silage, in cattle feeding is increasing. This has raised many quentions regarding the efficiency of alfalfa silage in relation to hay.

A number of experiments have been conducted at various stations in which the feeding value of grass and/or legume silage has been compared with hay from a similar crop. Most of these experiments have compared silage with hay on the basis of the weight of forage fed. Such experiments do not give an accurate value of the amount of feed obtained from a given acreage as silage or hay, since the amount of nutrients lost during harvesting and during storage is not considered. A considerable amount of nutrients may be lost during the harvesting of hay, and most farmers and ranchers seem well aware of this fact. Since silage is put up in the green state, little loss of nutrients occurs during harvesting. Little attention appears to have been given to the losses that may occur in silage during storage.

Silage is stored by various methods varying from an above ground pile, representing no structural cost, to the

expensive gas-tight silo. Many questions are received from farmers and ranchers concerning the relative value and cost of different methods of storing silage. The loss of nutrients under various methods of storage is an important consideration, as well as the cost of the silo. Little information is available from previous work from which to answer these questions.

The experiment reported herein was conducted to compare the relative feeding value of alfalfa hay and alfalfa silage when stored by different methods for fattening steers. Silage was stored in a conventional tower silo, a trench and an above-ground pile. The experiment was conducted so that the feeding value of a given acreage or tonnage of forage, stored by the various methods, could be determined.

REVIEW OF LITERATURE

Losses in Making Grass Silage:

Storing forage as silage is a means of preserving crops that are high in moisture at the time of harvest. Transformation of the crop into silage occurs after storage. There are numerous changes that take place in the process, which have been described by several workers. A brief description of the important changes will serve to point out where and why losses may occur when green forage is made into silage.

Shepherd *et al.* (1948) in a study of silage formation stated that the transformation of green crops into silage is brought about by the changes that take place when the green forage is stored in a silo in the absence of air. Plant respiration, enzymes present in plant cells, and bacteria, yeasts and molds present on the crop when it is ensiled, all take part in this change. This report also stated that after the crop is ensiled, plant respiration continues until the supply of oxygen is used up and replaced by carbon dioxide and nitrogen. There is a rise in the temperature of the forage, the extent of the rise depending upon the amount of oxygen present. Enzymes, which are also active during this time, break down sugars into alcohol, water, and acetic, carbonic, lactic and butyric acids. These enzymes also act on proteins to some extent, forming amino acids, peptides and some ammonia. As plant respiration and the activity of the plant enzymes slow

down, the activity of the bacteria, yeast and molds increases. Molds cease growing as soon as the air is exhausted, yeasts soon disappear, and only the bacteria remain active thereafter. Bacteria produce additional acid from soluble carbohydrates and from alcohol, and are responsible for further break-down products from the other constituents of silage, notably protein. They are responsible for most of the losses of dry matter and feeding constituents that occur during fermentation and storage. When the acidity of the silage increases beyond a certain point, bacterial action diminishes, and the silage-making process is completed.

Moisture content, exposure to air and the supply of available carbohydrates would be important factors affecting the above processes. This is the basis for recommending a proper moisture level, exclusion of air and an adequate supply of available carbohydrates in making silage.

The loss of nutrients results in four major ways according to workers at the Illinois station (1953). They list these as: (1) actual decomposition or rotting in the outside layers, (2) shrinkage in the weight of the preserved forage, (3) leaching of nutrients by drainage of excess moisture, and (4) spoilage inside the silo due to contamination from the outside.

Lasley et al. (1953) conducted experiments with grass silage to determine time of cutting, amount of moisture and amount of wilting needed. They found that as a general rule

the crops should be harvested at the same stage of maturity as they would normally be cut for the best quality hay. At this stage they are palatable, succulent, highly digestible, and high in protein, carotene and minerals. The authors stated that moisture content of the crop at the time of ensiling is the most important single factor affecting quality of the silage. Excessively high moisture content (70 percent or more) led to seepage losses and often resulted in foul odors. A low moisture content (60 percent or less) resulted in molding and spoiling. Best results were secured when the moisture content of the crop ran between 65 and 70 percent at the time the crop was put into the silo.

According to Lasley (1953), the average crop cut at the recommended stage will run from 74 to 80 percent moisture. Moisture content of such crops can be reduced by wilting. Wilting time will vary according to the level of moisture desired and with different weather conditions. On a sunny day, two to four hours between cutting and loading will reduce the moisture content sufficiently (65 to 70 percent).

Top and side spoilage of silage will be affected by the type of structure and how adequately air is excluded. Smith and Davis (1952) made a study of the tower, trench and different temporary silos. They made the following comments concerning the various types. The tower silo, with diameters varying from 7 to 20 feet and heights that should be at least

twice but not more than three and one-half times the diameter, is a permanent farm structure and as such should be constructed to stand long usage. Because the capacity of a silo is increased by depth, the pressure of the silage on the walls will vary directly with the diameter of the silo and the depth of the silage. Unpacked silage ranges in weight from about 16 to 20 pounds per cubic foot. In the bottom of a 40-foot silo, a cubic foot of silage will range in weight from about 65 to 70 pounds.. Therefore, one tall silo will hold considerably more feed than two short silos of the same cubic capacity.

Temporary silos can be constructed of poles, wooden staves or snow fences erected in circular form and lined with water-resistant tar paper. The height of this type of construction should not be more than twice the diameter because of its relatively weaker walls. Spoilage losses may be greater; but if air is properly excluded, these temporary silos can be just as efficient as a permanent structure.

Trench silos should be used only in areas of good drainage and where soil moisture from the outside is not a problem. The sides of the trench, which may or may not be lined, usually slope outward at the rate of 3, 4 or 5 inches per foot of depth. Where topography permits, the trench silo can be located on the side of a hill. This lessens the difficulty of filling, makes for easier packing and provides adequate

drainage of the silo and the approach. Size of the silo depends on the number of cattle to be fed, length of the feeding period and the amount of feed available. Since a trench silo is not as deep as other types of silos, the silage is not packed as tightly; therefore, artificial packing at the time of filling is important in order to avoid air pockets.

Table 1.

Estimate of minimum dry matter losses in forage stored as silage at different moisture levels.

Kind of silo and moisture content of forage as stored	Dry Matter Losses				
	Surface spoilage	Fermentation	Seepage	Field losses	From cutting of crop to feeding
	Percent	Percent	Percent	Percent	Percent
Conventional tower silos:					
85 percent	3	10	10	2	25
80 percent	3	9	7	2	21
75 percent	3	8	3	2	16
70 percent	4	7	1	2	14
Gas-tight tower silos:					
85 percent	0	10	10	2	22
80 percent	0	9	7	2	18
75 percent	0	8	3	2	13
70 percent	0	7	1	2	10
Trench silos;					
85 percent	6	11	10	2	29
80 percent	6	10	7	2	25
75 percent	8	9	3	2	20
70 percent	10	10	1	2	23
Stack silos:					
85 percent	12	12	10	2	36
80 percent	12	11	7	2	32
75 percent	16	11	3	2	32
70 percent	20	12	1	2	35

Shepherd *et al.* (1953) have conducted studies on dry-matter losses of grass silage stored in different types of silos. They made estimates on the extent of losses based upon their own work and the work of others. These estimates are given in Table 1.

According to the authors, these are conservative estimates for careful filling methods when no preservative is used. These data show the importance of the proper moisture content of the forage in reducing dry-matter losses. Losses are the highest in the stack and lowest in the gas-tight silo. Even under good silage making methods it would appear that nearly one-third of the dry matter may be lost in the stack silo.

Feeding Value of Legume Silage:

Considerable work has been done on the actual feeding of grass and/or legume silage to steers as a part of the fattening ration. When compared with hay, grass silage is generally considered to have several advantages. Harlan et al. (1952) reported that silage had two major advantages. First, its succulence provides an appetite stimulant when the rest of the ration is dry and coarse; and second, it contains a higher proportion of carotene, which is a valuable contribution to the ration during the winter and early spring months. Their work also showed that carotene is plentiful in green succulent forage, but much of it is destroyed when the forage is dried in the sun and air. Grass silage not only retained a large proportion of the original carotene, but also preserved it for a relatively long period of time. Silage also had a definite advantage over hay in preserving the forage from a weedy field, since many weeds were consumed when made into silage, but refused in hay.

Work on alfalfa hay and silage comparisons have been conducted by Garrigus (1951) to compare the feeding value of first-cutting alfalfa forage when cured as hay, and when made into silage, as the sole roughage for yearling steers fattened in dry lot. Blackstrap molasses was added to the silage at the rate of 51, 60, 83 and 72 pounds per ton of forage during four trials. Results of four tests showed that average

daily gains, average carcass yields and average carcass grades over the four-year period were practically identical for the two rations, even though silage in test one was of poor quality. None of the differences in gain were statistically significant at the 5 percent level. No objectionable off-color of fat was noted in the carcasses from steers fed the silage. The average feed replacement value of 100 pounds of dry matter fed as alfalfa-molasses silage was 108.0 pounds of dry matter fed as alfalfa hay plus 4.2 pounds of shelled corn. Further results indicated that such forage made into alfalfa-molasses silage has a feed replacement value, when used as the sole roughage for fattening steers in dry lot, which exceeds by 10 to 50 percent that for the same crop when made into hay.

Beeson et al. (1953) conducted experiments to determine the need for a supplement when corn is fed with grass silage. The results show that yearling steers can be fattened rapidly and efficiently on a combination of grass silage (50 pounds) and corn (7 pounds), fed with or without a supplement (2 pounds replacing 2 pounds of corn), as a daily ration. The feeding of 2 pounds of "Supplement A" in place of corn gave a slight advantage in gain (0.10 pound), which was found to be non-significant. On a cost basis, the gains on corn and silage (no supplement) were one cent per pound cheaper. Either ration, with or without a supplement, was satisfactory and economical for fattening cattle.

Dowe et al. (1953) also conducted experiments to obtain information on the use of alfalfa silage in wintering rations. This trial was designed to secure information on the value of alfalfa silage, alfalfa silage plus dry roughage, molasses and alfalfa silage, alfalfa silage with additional protein, and the combined effects of roughages, protein and molasses with alfalfa silage as wintering rations for calves. The feeding of hay with the silage yielded a total gain of 4 pounds per head over a 112-day period in favor of the hay-fed lots, in comparison to lots fed no hay. This small amount does not indicate any advantage of adding hay to an alfalfa-silage ration. Substituting 1 pound of liquid molasses for 0.7 pound of corn was of no value, in that the difference in total gain of 6 pounds per head was in favor of the lots receiving no molasses. The substitution of 2 pounds of soybean oil meal for 2 pounds of corn showed a difference in total gain of 23 pounds per head. This gain was in favor of the lots receiving 2 pounds of soybean oil meal. These results indicate some advantage for substituting 2 pounds of soybean oil meal for 2 pounds of corn. Whether or not the additional gain is economical depends on the comparative costs of corn and soybean oil meal.

Burroughs et al. (1953), in connection with experiments in determining the value of grass silage as a steer wintering ration, came to the following conclusions. Grass silage, made without a preservative and fed without a supplement, is not a

balanced ration for cattle when a high rate of gain is desired. A limiting factor, and first consideration in a grass-silage supplement, appears to be a need for a high-energy feed such as corn or molasses. Further it appears that grass silage can be improved by supplementing with a feed, such as soybean oil meal and minerals, which aid in promoting the fastest rate of gain in wintering cattle. From the standpoint of economy of gain, the supplements which promote the most rapid gains also produce, in general, the cheapest feed cost per unit of gain. Where cattle are to be marketed following the feeding of grass silage, faster and cheaper costs per unit of gain are of primary importance. The feeding of no supplement with grass silage, or just enough to keep cattle in good health, would be most economical when cattle are not to be marketed immediately, but are to be put on pasture or in the feed lot for finishing. When approximately 1 pound of gain per steer daily is desired during the wintering period, it can be obtained by full-feeding grass silage, made with ground ear corn as a preservative, and fed with little or no supplement. One pound per day of gain can also be obtained by feeding grass silage, made without a preservative, and fed with a few pounds of corn-and-cob meal per steer daily, or other supplements.

Work on preservatives has been done by Beeson *et al.* (1953) who conducted experiments to determine the reaction of cattle fed on grass silage made without a preservative.

Results showed that grass silage made with a small amount of preservative (200 pounds of corn cobs per ton of silage to absorb moisture) is not a balanced ration for wintering steers. These steers gained only 0.32 pound per head daily at a cost of 50 cents per pound during the first 84 days of their feeding period. Through the remaining 42 days of the period, the steers were fed 1.25 pounds of "Supplement G" (grass-silage supplement of 12 percent crude protein), which increased the rate of gain to 1.09 pounds per head daily and reduced the cost of a pound of gain to 20 cents. Addition of a supplement to grass silage, according to Beeson, improved over-all feed efficiency about 200 percent, by reducing silage required per pound of gain from 102 to 31 pounds. Over-all indications show that grass silage, fed as the sole feeding ration, lacks some nutritional factor or factors which are essential for maximum utilization.

It appears that the wilting or nonwilting of alfalfa has a marked effect on wintering steer calves, according to data released by Cox et al. (1952) on comparisons of wilted and nonwilted alfalfa silage. Wilted or nonwilted alfalfa silage, put up without a preservative, did not prove satisfactory as the only roughage for wintering steer calves. In producing steer gains, wilted alfalfa silage was somewhat superior to the nonwilted alfalfa silage. Calves on nonwilted alfalfa silage did not consume enough silage to meet their dry matter

requirements, although they were fed all they would clean up. Steers fed 25 pounds of nonwilted alfalfa silage per day during the 86-day feeding period lost 15 pounds of weight, whereas steers fed 22 pounds of wilted alfalfa silage per day gained 25 pounds.

The amount of research concerned with the chemical composition, coefficients of digestibility and digestible nutrient content of alfalfa silage has been limited. Garrigus (1951) conducted digestion trials over a three-year period with three steers per year. First-cutting alfalfa was harvested in the quarter-bloom stage of maturity, wilted for approximately three hours in the swath and ensiled with the addition of 60 pounds of blackstrap molasses per ton of forage. Alfalfa-molasses silage ranked high in over-all feeding value because of its high content of digestible crude protein. In total digestible nutrients, even though grown on fertile land and harvested in the quarter-bloom stage of maturity, alfalfa silage ranked relatively low. The average coefficient of digestibility for the three years was 59.2 percent for dry matter, and the average digestible nutrient content was 59.2 percent.

In this review of literature, it has been expressed that considerable work has been done on time of cutting, wilting time, silo construction, silage formation, losses due to shrinkage and spoilage, preservatives, comparisons between

hay and silage, chemical compositions and feeding trials. It also appears from this work that there is some question in relation to the most efficient beef production from the use of alfalfa under the various methods of storage. A producer must account for any losses which may occur during the storage stage of a forage. Maximum beef production from a given acreage is of primary concern.

EXPERIMENTAL PROCEDURE

The experiment reported herein was conducted to compare the conventional upright silo, the trench silo and the above-surface pile as methods of storing alfalfa silage, and to determine the feeding value of the silage for fattening cattle. Information was obtained on the weight-loss and the amount of spoilage under the various storage conditions. The experiment was conducted so that the amount of gain per unit of forage, stored under the various conditions, could be determined. This method gives a more accurate measure of the feeding value of silage stored in different ways, or of silage in comparison to hay, than does a comparison based on the weight of forage actually fed.

First-cutting alfalfa that contained an abundance of sweet clover was used for the experiment. Although the alfalfa put in the trench and pile came from another field than that put in the upright silo and used for hay, the quality from the two fields was similar. Approximately an equal number of acres were used for each method of storage.

The forage was cut with a swather and allowed to wilt for two or three hours, depending on weather conditions, to reach a moisture content of approximately 65 to 70 percent. Field choppers were used to pick up the forage from the swath, chop it and blow it into trucks. Each load was weighed and a record kept of all forage put in the three silos. All silage

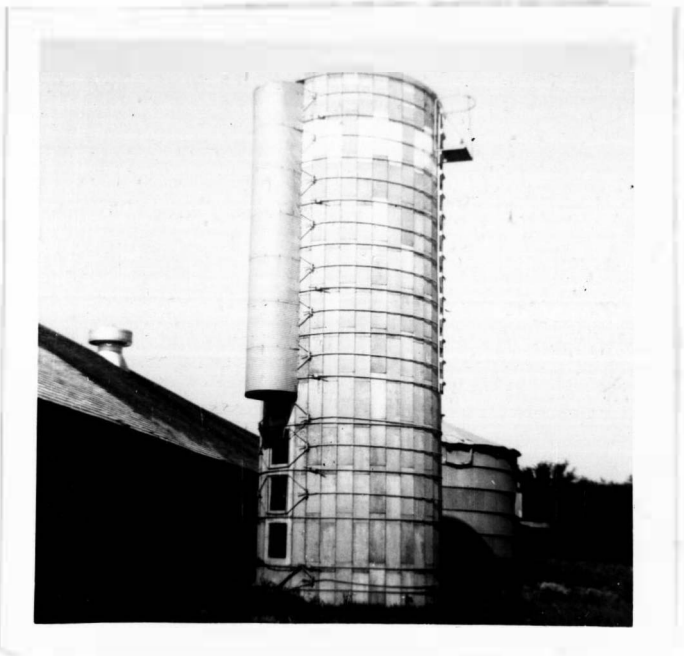

Figure 1. Concrete-stave silo used for storage of silage for steers in Lot I.

Figure 2. Above-surface pile used for storage of silage for steers in Lot II.

Figure 3. Trench silo used for storage of silage for steers in Lot III.

Figure 4. Lot I steers. The other steers used in the experiment were very similar.

was put up without the addition of a preservative.

This experiment was originally planned to have 35 tons of silage in each silo and the equivalent amount in alfalfa hay. Since silage was trucked in as full loads, the amounts stored in the different silos varied slightly. The green forage blown into the conventional upright or concrete-stave silo (Figure 1) weighed 69,260 pounds. The silage pile (Figure 2), stacked with the use of a corn crib as a guide, contained 66,740 pounds. The trench silo (Figure 3) contained 70,120 pounds and was situated partially below and partially above the ground. A 4-foot portion above the ground was supported by planks and posts and lined with a water-resistant paper. It extended approximately 4 feet below ground level. Because of the location, tile was used to provide for adequate drainage, due to seepage. Silage was blown into all three silos and packed as much as possible to remove air pockets. All hay used for the experiment was baled and stacked without cover near the feeding sheds. The weight of the hay at time of stacking was 17,040 pounds.

Forty long-yearling feeder steers grading good (Figure 4) were allotted at random to the four lots on the basis of weight. Starting weights, 28-day weights and final weights were recorded for determining the amount of gain obtained. Weights were also taken of all lots when silage for any one lot was completely fed. Steers were quartered in adjoining

sheds, open to the south, having earth floors bedded with straw. All four lots had concrete floor outdoor pens south of the shed openings.

Past results by other workers have indicated that silage alone, without a preservative or additional supplement, is not a balanced ration for cattle when a high rate of gain is desired. Therefore, some corn was added to the ration in an effort to produce slaughter steers which would grade good to choice. Each of the four lots received the same amount of cracked shelled corn, starting at the rate of 3 pounds per head daily and increasing until all lots received 7 pounds per head daily. Feeding of alfalfa silage was started at 200 pounds per lot daily and was increased up to a full-feed of approximately 500 pounds per lot daily, depending on the amount consumed. Alfalfa hay was fed according to the amount that was eaten without undue waste. Amounts fed ranged from 149 pounds per lot daily at the start of the feeding period to 190 pounds per lot daily at the end of the feeding period. As roughages were full-fed to all cattle, silage and hay were fed once daily. All silage was fed in outside bunks, while hay was fed in mangers inside the sheds. The cracked shelled corn, fed twice daily, was added to the silage and fed separately in bunks to the hay lot.

The respective lots were fed al follows: Lot I, alfalfa silage from the conventional upright concrete-stave silo;

Lot II, alfalfa silage from the above-surface pile; Lot III, alfalfa silage from the trench silo; and Lot IV, alfalfa hay from the stack of bales. All lots had free access to iodized salt, bone meal, limestone and water.

Original plans were to market each lot as slaughter cattle when their silage or hay was exhausted. Due to the condition of the steers in Lots II and III when silage was exhausted, additional alfalfa silage, obtained from a gas-tight silo, was used to continue the feeding program. Total consumable silage from the trench was fed to Lot III in 54 days, while the silage from the surface pile was consumed by Lot II in 64 days. In order that slaughter grades of from good to choice could be obtained, care was taken to remove spoiled silage from the respective silos. Ordinarily a part of this spoiled silage possibly could have been used; but to receive maximum gains from silage, only un-spoiled silage was fed.

Silage in Lot I and Hay in Lot IV was fed for 92 days. Because of considerable freezing occuring in the upright silo during the latter part of January, the feeding of silage to Lot I had to be discontinued when the hay supply was exhausted. Approximately 11,280 pounds of silage were later fed to other cattle; but no exact statement can be made as to how much of this weight was made up of spoilage, eatable silage or additional moisture. No spoilage was observed in the baled hay stack and all bales of this stack were fed.

Upon completion of the 92-day feeding period, individual weights were taken prior to the truck shipment of 60 miles to market. On arrival at the packing plant, approximately 2 hours later, each steer was again weighed as well as graded by the plant buyer. The difference between the weight at Brookings and the weight at the market was the amount of shrinkage en route. The steers were sold direct to the packing company, and the buying price was quoted for each steer as he was being weighed and graded. Slaughtering was done the same day steers arrived at the plant. Carcass weights and grades, issued by a federal meat inspector, were obtained approximately 48 hours after steers were slaughtered.

RESULTS AND DISCUSSION

The results of the feeding trials with alfalfa silage stored by different methods are shown in Table 2. In the design of the trial, approximately equal amounts of silage were to be stored by each of the methods, and the cattle were to be fed until all of the silage was consumed. Average daily gains of the four lots showed very little difference, with Lot I gaining 2.05 pounds; Lot II, 1.88; Lot III, 1.83; and Lot IV, 1.99. However, there were large differences in the amount of total gain obtained per head from the silages originally stored. Lot I (upright silo) and Lot IV (alfalfa hay) made average total gains per head of 188.2 and 183.4 pounds, respectively. Lot II (pile silo) and Lot III (trench silo) made an average total gain of only 120.4 and 99.0 pounds, respectively. Average daily rations were similar for all the silage lots. The large differences in total gain were due to the silage being fed up much earlier in Lots II and III than in Lot I.

There were large differences in the weight-loss, spoilage and the length of feeding periods. Silage from the pile and the trench was exhausted after 64 and 54 day periods, respectively. Silage from the upright silo and the hay were fed for an equal period, or 92 days.

TABLE 2.

Beef produced from alfalfa hay and silage stored from similar acreages.

Lot No.	I	II	III	IV
	Alfalfa Silage Upright silo Corn	Alfalfa Silage Pile Corn	Alfalfa Silage Trench Corn	Alfalfa Hay Baled Corn
No. of steers	10	10	10	10
No. of days fed	92	64	54	92
Av. initial wt., lbs.	741.0	739.6	741.2	740.0
Av. final wt., lbs.	929.2	860.0	840.2	923.4
Av. gain per head, lbs.	188.2	120.4	99.0	183.4
Av. daily gain, lbs.	2.05	1.88	1.83	1.99
Av. daily ration, lbs.				
Silage	44.57	46.25	47.50	-----
Hay	-----	-----	-----	15.86
Corn	6.27	5.95	5.75	6.27
Minerals	0.07	0.07	0.08	0.07
Feed per cwt. gain, lbs.				
Silage	2,178.5	2,458.5	2,590.9	-----
Hay	-----	-----	-----	795.4
Corn	306.3	316.0	313.6	314.3
Minerals	3.48	3.42	4.10	3.62
Silage or hay originally stored, lbs.	69,260	66,740	70,120	17,040
Actual wt. of silage or hay fed, lbs.	41,000	29,600	25,650	14,587
Spoiled silage not fed, lbs.	19,320	16,520	20,520	-----
Loss in wt. of silage or hay overstorage period, lbs.	8,940	20,620	23,520	2,453
Percent of stored silage or hay fed	59.2	44.4	36.6	85.6
Feed costs per cwt. gain based on feed fed *	$15.82	$17.16	$17.64	$15.25
Feed costs per cwt. gain based on feed purchased at storing time	$21.83	$29.50	$35.61	$16.59

* Fed prices used are as follows: corn, $1.29 per bushel; alfalfa silage, $8.00 per ton; alfalfa hay, $20.00 per ton; bone meal, $5.45 per cwt.; limestone, $1.30 per cwt.; and salt, $1.30 per cwt.

In calculating feed prices, average current prices for the various feeds were used. Calculations, based on these prices and the amounts of feed consumed, showed that alfalfa hay produced slightly cheaper gains than silage in this experiment. Feed costs, based on amount of feeds consumed, were cheaper when the silage was stored in the upright silo than when stored in the pile or trench.

When feed costs were calculated on the basis of forage stored, costs of gain were greatly increased for the silage-fed lots. The increase was much greater for the steers fed silage from the pile and trench than for those fed from the upright silo. Calculations in this manner gave only a slight increase in cost of gain for the hay-fed lot. These latter feed costs represent the cost of the gains, since the losses in weight and spoilage were purchased as well as the silage consumed by the steers. However, they do penalize Lot I to some extent; since as mentioned under 'Experimental Procedure', silage feeding in this lot had to be discontinued, due to severe freezing before all the silage was used. This silage was weighed and later fed to other cattle, and the amount was 11,280 pounds. No doubt much of it could have been fed to the steers in Lot I had weather conditions been more favorable. Even with this loss, the upright silo provided considerably more feed than the trench or pile.

Feed costs, based upon the amount of forage stored, do

not take into consideration the field loss occurring in harvesting hay, and thus would favor the hay-fed lot. Total gains obtained were about the same from approximately equal acreage of forage put up as hay or as silage in the upright silo. This indicates that storage of forage in the upright silo was fully as efficient as making it into hay.

TABLE 3.

Beef produced from alfalfa hay and silage over a fifty-four day feeding period.

Lot No.	I	II	III	IV
	Alfalfa Silage Upright silo Corn	Alfalfa Silage Pile Corn	Alfalfa Silage Trench Corn	Alfalfa Hay Baled Corn
No. of steers	10	10	10	10
No. of days fed	54	54	54	54
Av. initial wt., lbs.	741.0	739.6	741.2	740.0
Av. final wt., lbs.	853.6	854.0	840.2	837.2
Av. gain per head, lbs.	112.6	114.4	99.0	97.2
Av. daily gain, lbs.	2.09	2.12	1.83	1.80
Av. daily ration, lbs.				
Silage	45.00	45.74	47.59	-----
Hay	-----	-----	-----	15.39
Corn	5.75	5.75	5.75	5.75
Feed per cwt. gain, lbs.				
Silage	2,158.08	2,159.09	2,590.91	-----
Hay	-----	-----	-----	855.25
Corn	275.75	271.42	313.64	319.44
Silage or hay originally stored, lbs.	69,260	66,740	70,120	17,040
Actual wt. of silage or hay fed, lbs.	24,300	24,700	25,650	8,313
Percent of stored silage or hay fed	35.1	37.0	36.6	48.8
Feed costs per cwt. gain based on feed fed*	$14.98	$14.88	$17.58	$15.90

* Feed prices used are as follows: corn, $1.29 per bushel; alfalfa silage, $8.00 per ton; and alfalfa hay, $20.00 per ton.

Table 3 gives results when all lots were fed 54 days, at which time the supply of silage from the trench silo was exhausted. Average daily gains per head of 2.09 and 2.12 pounds in Lots I and II were very much alike, whereas gains of 1.83 and 1.80 pounds resulted in Lots III and IV.

Average daily rations per head of the silage-fed lots were similar. Although approximately 2 pounds more of silage were consumed per head daily in Lot III, average daily gains per head were smaller. The percentage of stored forage consumed was similar in Lots I, II and III, being 35.1, 37.0 and 36.6 percent, respectively, at the end of the 54-day period. The 36.6 percent consumed in Lot III represents the total of the forage originally stored which was available for feeding for this lot. Silage was fed for an additional period of 10 days to Lot II and 38 days to Lot I.

TABLE 4.

Marketing data of steers on completion of feeding trials with alfalfa hay and silage.

Lot No.	I	II	III	IV
	Alfalfa Silage Upright silo Corn	Alfalfa Silage Pile Corn	Alfalfa Silage Trench Corn	Alfalfa Hay Baled Corn
Av. starting wt. Brookings, lbs.	741.0	739.6	741.2	740.0
Av. final wt. Brookings, lbs.	929.2	920.8	919.2	923.4
Av. final wt. Sioux Falls, lbs.	905.5	903.0	892.0	895.5
Av. shrink, lbs.	23.7	17.8	27.2	27.9
Av. dressing percentage	58.94	59.51	59.05	57.00
Av. live grade at Sioux Falls *	3.9	4.5	3.9	3.2
Av. carcass wt., lbs.	534.2	537.8	527.0	510.8
Av. carcass grade **	13.9	13.9	13.6	14.4
Av. selling price per cwt.	$17.50	$18.03	$17.80	$17.13

* high good - 6; good - 5; low good - 4; high commercial - 3 commercial - 2

** choice - 13; good - 14; commercial - 15

Data obtained on carcass information are given in Table 4. Very little differences between lots were shown in average final weights at both Brookings and Sioux Falls. Relatively similar results were obtained in both shrinkage and dressing percentage. Lot II had the least shrinkage and highest dressing percentage of the four lots; while Lot IV, fed alfalfa hay, had the greatest amount of shrinkage and the lowest dressing percentage. Average live grade and selling price per hundred weight were the highest for Lot II, with 4.5 and $18.03, respectively, and lowest for Lot IV, 3.2 and $17.13,

respectively. A great deal of difference was not shown in average carcass weights or average carcass grades of the silage-fed lots, but a noticeable drop was noted in the hay lot. No objectionable off-color in carcasses was noted from the four lots.

Because steers in Lots II and III were fed from another source of alfalfa silage for 28 and-38 day periods, respectively, a definite statement cannot be made as to the accuracy of the carcass information in relation to the different treatments cited herein. Data shown in Table 4 have been given to merely show a comparison between the four different lots.

When total gains per head of the four lots were statistically analyzed (Table 5), there was a highly significant difference noted between the different lots due to feed treatment.

TABLE 5.

Analysis of variance - average total gain per head over uneven feeding periods.

Source of Variance	D/F	Sum of Square	Mean Square	F.
Total	39	92,481.5		
Between Lots	3	60,317.1	20,105.7	
Error	36	32,164.4	893.5	22.5032**

In this discussion the words "highly significant", indicated by the double asterisk (**), have been used to indicate that a difference this large or larger would be expected to occur by chance in less than 1 percent of similar trials.

No significant difference was shown in Table 6 when average daily gains per head of the four lots were statistically analyzed.

TABLE 6.

Analysis of variance - average daily gain per head over fifty-four days of the feeding trial.

Source of Variance	D/F	Sum of Square	Mean Square	F.
Total	39	9.2253		
Between Lots	3	0.8207	0.2736	
Error	36	0.4046	0.2335	1.1717

As has been previously mentioned, Lots II and III were fed on alfalfa silage from a gas-tight silo until the end of the trial. Lot II was fed 12,000 pounds during 28 days and made an average daily gain of 2.17 pounds. Lot III was fed 15,850 pounds during 38 days and the average daily gain was 2.08 pounds.

Further studies are needed and are being planned. The results of this one year's work should be applied only under conditions similar to those outlined in this experiment.

SUMMARY

Results of one year's work in feeding alfalfa silage, stored by different methods, or alfalfa hay, showed that yearling Hereford steers, full-fed either alfalfa silage or hay plus approximately 6 pounds of cracked corn, will gain nearly 2 pounds per head daily. Little difference was observed in the actual amount of feed consumed on an equal dry-matter basis.

Under methods of storing relatively small amounts of silage it was found that, of the total feed stored, alfalfa hay yielded the highest percentage of available feed, 85.6 percent of that stored. Due to spoilage and storage losses, lower percentages of stored feed were fed to the silage lots, 59.2 percent for the upright silo, 44.4 percent for the pile and 36.6 percent for the trench. These results show that different methods of storage may have a decided influence on the amount of forage that can be fed. The greater losses occurring over the storage period in the pile and trench silos, as compared to the upright silo, resulted in a reduction in the length of feeding period of 28 and 38 days, respectively.

No decided difference between alfalfa silage and hay was found in feed cost per 100 pounds of gain when the cost was based on amounts of feed fed. A decided difference was obtained in feed cost per 100 pounds of gain when the cost was

based on feeds purchased at storing time. Cost of gains on feeds stored was increased because of losses occurring during storage, but this does not take into account any loss of nutrients during harvesting of the hay.

A definite statement cannot be made concerning the carcass information obtained, since additional silage was fed to Lots II and III. From the results that are shown at the end of the 92-day feeding period, it appears that the silage-fed lots were somewhat superior to the alfalfa hay lot in average amounts of shrinkage, dressing percentage, live grade, carcass grade and carcass weight. The average selling prices of the silage-fed lots were all greater than the alfalfa hay lot because of the higher live grades at the time of marketing.

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