Making Baled Silage

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INTRODUCTION

In many parts of the United States, spring rains interfere with hay making. Also, the heaviest growth of grass takes place at this time in many areas. Therefore, the quality of hay is always a gamble, even under conditions of potential optimum production.

The method of making silage described herein is perhaps an emergency method and may be only justified during wet springs when it is impossible to make hay. If labor-saving recommendations are followed, this method might be economical at other times. If a man has the machinery for making baled hay, with very little change in his equipment he could make baled silage. Because of the large capital outlay required for making grass silage in the conventional way, this method would be useful to those making a small amount of grass silage (200 tons or less) per year.

The idea of ensilaging whole bales of green grass is not new; this has been done in England (1, 3, 4)[1], New Zealand (2), and possibly in many other places. Also, the idea of making silage in a stack with no sides and relying entirely on a plastic cover is not new. The general plan of combining these two methods (whole bales with plastic covers) and handling the silage entirely with hay-making equipment is perhaps unique.

This method requires very little equipment other than conventional hay-making machinery. A sled and a jack, some black plastic, a sprinkler can for applying the preservative, and sufficient preservative are all that are needed. Details for making the sled are shown in Figure 1. Methods for making the stacks (Figure 2) and feeding the silage (Figure 3) are also shown.

It has been found that the bales are easily pulled out of the stack for feeding. The "hot band" system of feeding the bales (Figure 3) has proved to be easy and flexible.

While the idea of making baled silage may seem simple, there are a few techniques that must be followed rather carefully if satisfactory silage is to result.

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[1] Numbers in parentheses refer to References, page 11.

EXPERIMENTAL METHODS AND RESULTS

All alfalfa and grass for these experiments was taken from the experimental plots at Oregon State University, Corvallis. The first cutting consisted of Talent variety alfalfa in which many grasses such as orchardgrass, alta fescue, and ryegrass were growing. The second cutting was usually pure Talent alfalfa.

Baling was done with a standard baler that was in current use. The bales were 16 x 18 inches and the length was adjusted to 36 inches. The bales were packed to about 100 pounds per bale unless for some special reason a less dense or a more dense bale was desired.

All the tests were made with two types of stacks--a 6-bale stack and a 16-bale stack (except for the 8-ton stack described on page 8). The 6-bale stack consisted of two bales placed parallel to one another, two bales on top of these at right angles to the bottom pair, and a layer on top parallel to the bottom bales (Figure 4). The 16-bale stack was made with eight bales on the ground and four bales on the top; another four bales were broken open and used to fill the corners and odd places of the stack (Figure 5). This 16-bale stack was used in the experiments from 1960 to 1964 because the plastic cover at the edges of the bales was not punctured by the alfalfa or grass stems.

The extent of spoilage was determined by breaking open each bale in at least three places and measuring the penetration of the mold. The amount of spoilage in a stack was determined by an average of all sections tested.

A composite sample was collected from various places throughout the stack, placed in a labeled plastic bag, and sealed with a rubber band. It was then immediately taken to the laboratory. The pH was determined by making a slurry of 100 grams of silage with distilled water in a Waring blender. An equilibrium was reached a short time after mixing, and the acidity of the resulting mixture was determined with a Beckman pH meter. To determine the dry matter content, the remainder of the sample was placed in an oven and dried to a constant weight. The dry matter was then ground in an Abbe Mill (No. 000) through about an 80 mesh screen, and the sample was composited for a nitrogen analysis according to procedures described in "Methods of Analysis", Association of Official Agricultural Chemists. The crude protein percent was determined by multiplying the percent nitrogen by 6.25.

The Effect of Hard Baling Versus Soft Baling

A mixture of grasses and alfalfa was cut the afternoon of May 19, 1958; on the 20th, it was baled, covered with 6-mil black polyethylene, and sealed at the edges with sawdust. Six stacks of six bales each were soft baled and six stacks were hard baled. All stacks were made on a concrete foundation. On October 1, 1958, the stacks were opened and the percentage of good silage of each stack was determined. The estimated weight of hard bales was 100 to 110 pounds; estimated weight of soft bales was 60 to 70 pounds.

Table 1. Influence of Soft Versus Hard Baling

	Average percent of good silage[1]
	%
Soft baled	23.2
Hard baled	65.7

[1] Statistically significant at the 5% level.

Evidently, it is necessary to consolidate the bales to a reasonable degree. Hard baling proved to be one of the significant factors in making good baled silage.

The Effect of Covers and Additives

On June 15, 1964, 16 stacks of a combination of alfalfa and grass were baled and formed into stacks of 16 bales each in the conventional manner described in these experiments. These stacks contained approximately one ton of fresh alfalfa each. The stacks were opened September 16, 1964, and tested for pH, percent of good silage, percent of crude protein, and percent of dry matter. The results of this experiment are shown in Table 2.

Table 2. Effect of Single, Double, and Ground Covers

	Avg. pH	Avg. percent good silage	Avg. percent crude protein	Avg. percent dry matter
		%	%	%
Double cover on top . .	5.3	58	8.83	29.9
Single cover on top . .	5.2	58.5	9.26	31.4
Ground cover beneath stack	5.1	64.5	9.26	31.4
No ground cover beneath stack .	5.4	51.5	8.78	28.8

A ground cover beneath the stack appeared to improve the percentage of good silage and slightly improve the pH, but neither difference was significant. While a second top cover did not significantly improve the quality and quantity of silage, it gave some protection from small animals walking over the top of the stacks.

A test was also made August 24 to October 31, 1963, of double cover versus single cover and the effect of phosphoric acid as an additive. In this experiment, 16-bale stacks of alfalfa were used, with no replication of trials. The covers on top were new 6-mil black polyethylene. Under each stack was one old piece of 6-mil black polyethylene. The results of this test are shown in Table 3.

Table 3. Effects of Single and Double Covers With Phosphoric Acid as an Additive (August 24 - October 31, 1963)

	No Additive		Additive[1]	
	pH	Percent good silage	pH	Percent good silage
		%		%
Single cover on top . .	7.9	70	5.4	80
Double cover on top . .	6.2	90	5.3	90

1 The stacks weighed approximately one ton each; 3½ pounds of 85% phosphoric acid in 4 gallons of water was sprinkled on each stack. There was no significant difference between single- or double-covered stacks; the difference between an additive or no additive also was not significant.

In contrast with the previous experiment, it appears there was some benefit from a double cover of new polyethylene; however, it was not statistically different. The second cover for the experiment in Table 2 was an old piece of 6-mil black polyethylene; in Table 3, the second cover was new polyethylene.

Effect of Polyethylene Thickness On Percentage of Good Silage

A test was set up July 18, 1961, to determine the effect of the thickness of black polyethylene as a covering. Six stacks of 16 bales each of alfalfa were cut, baled, and covered the same day. Each pair of stacks had either 4, 6, or 8-mil black polyethylene as a top cover. The stacks were opened October 6, 1961. A polyethylene cover with a thickness greater than 6 mils did not improve the pH or the percentage of good silage (Table 4). There was little effect upon the pH value. Even the 6- and 8-mil thicknesses were not significantly different from the 4-mil thickness.

Table 4. Effect of Thickness of Polyethylene Cover on Keeping Qualities of Alfalfa Silage

Polyethylene thickness[1]	Average percent good silage[2]	pH average
	%	
4 mil	57.5	6.0
6 mil	68.0	5.5
8 mil	68.0	5.7

1 All covers were black polyethylene; all stacks were covered the same day the alfalfa was cut.

2 Average of two stacks. Not significantly different.

Effect of Sawdust Over Vinyl and Black Polyethylene

A comparison was made between the effects of various silage covers on the keeping qualities of baled silage. The results of this experiment are shown in Table 5. Eight-mil vinyl and four-mil black polyethylene, both with a sawdust cover and without a sawdust cover, were compared as to their efficiency in preserving silage. There were 12 stacks and each trial was triplicated. Each stack consisted of six bales each (Figure 4). These stacks were placed on concrete and covered at the edges and on top with sawdust for those so indicated (Table 5). The sawdust-covered bales had a minimum of at least two inches of sawdust, and this was wetted down with water immediately after covering.

A mixture of alfalfa and mixed grasses was cut the afternoon of June 2, 1959; it rained slightly on June 3, so the alfalfa was baled on June 4, covered with plastic on June 5, and covered with sawdust on June 9. The stacks were opened October 5 to November 17, 1959, and the percent of good silage, the pH, and the percent of crude protein were determined.

It can easily be seen that sawdust covering improved the quality of silage in all cases and that 4-mil polyethylene was not as good a covering as 8-mil vinyl, but the difference was not statistically significant.

Table 5. Effect of Sawdust Over Vinyl and Black Polyethylene in Preserving Silage

	Average percent good silage	Average pH	Average percent crude protein
	%		%
8-mil vinyl - sawdust covered	94.7	4.98	11.3
4-mil black polyethylene - sawdust covered	70.7	5.18	11.0
8-mil vinyl - no sawdust	51.7	5.85	11.4
4-mil black polyethylene - no sawdust	4.1[1]	5.52	10.8

1 Several of these stacks had the plastic broken by some outside mechanical force.

The percent of good silage was significantly different at the 1% level between stacks not covered with sawdust and those covered with sawdust. This was one of the most important discoveries of these experiments. Only when the plastic was covered with a minimum of 2 inches of sawdust was there a large percentage of good silage. There was no significant difference between the plastics.

Effect of Additives Upon Lowering the pH

All of these experiments were carried out with alfalfa or a mixture of alfalfa with a small amount of grass. As a result, the pH was high. Experiments were set up to find methods of lowering the pH.

Use of molasses was effective in lowering the pH of alfalfa silage (Table 6). A mixture of equal parts by volume of water and molasses was sprinkled over the top of each layer of bales with a garden sprinkling can. This was applied at the rate of 12 gallons to a 16-bale stack. To lower the pH to 4.5 or less, perhaps a slightly higher rate of about 15 gallons of the mixture per 16-bale stack would be needed.

Table 6. Effect of Molasses on Lowering the pH of Alfalfa[1]

	pH	Percent good silage	Percent crude protein	Percent dry matter
		%	%	%
Average of all stacks receiving molasses	4.9	65.5	9.11	30.6
Average of all stacks receiving no additive . .	5.7	50.5	8.97	30.1

1 There was a significant difference at the 2.5% level between the pH values.

Liquid phosphoric acid also was effective in lowering the pH (Table 3). Each of the stacks in that experiment consisted of 16 bales of nearly all alfalfa. Here, again, while phosphoric acid was effective in lowering the pH, more was needed. Perhaps twice the amount would be required to lower the pH to 4.5 or less for straight alfalfa.

One experiment was set up July 18, 1961, to determine the effect of ground barley upon reducing the pH in 16-bale stacks of alfalfa. A device was used to meter the ground barley into the bale as it was made. No attempt was made to determine how effective this device was in adding the barley to the bales. An average of 33 pounds of barley was added to each stack. The results of this experiment were determined October 6, 1961, and are shown in Table 7.

Table 7. Effect of Ground Barley Upon Reducing the pH Value of Alfalfa

Test No.	Additive	Cover thickness[1]	Percent good silage	Time of covering	pH
1A	Check	4 mil	40.0	Immediate	6.4
2A	Check	6 mil	50.0	Immediate	5.4
3A	Check	8 mil	60.0	Immediate	5.5
4A	G. barley	4 mil	75.0	Immediate	5.7
5A	G. barley	6 mil	86.0	Immediate	5.6
6A	G. barley	8 mil	75.0	Immediate	5.9

1 Black polyethylene was used for all covers. Percent of good silage for ground barley versus no barley was significantly different at the 2.5% level.

Ground barley was not very effective in lowering the pH, but it did improve the percentage of good silage. Perhaps some of the air space was taken up by the barley.

There were other experiments with dry-type additives such as ground corn, ground wheat, beet pulp, and kaylage (a mixture of sodium nitrate and calcium formate). These additives were applied on top of each layer of bales, and they had very little effect upon the pH. In view of the success of liquid additives and their easy application by sprinkler can, it is recommended that they be used for baled silage.

Some experiments were made with sodium metabisulphite. The results were not conclusive.

Effect of Delay in Covering the Silage

This experiment was set up to determine the effect of delay in covering the silage. Two stacks of 16 bales of alfalfa were cut on October 6, 1961. One was covered immediately with 6-mil black polyethylene; two days later the other stack was covered (Table 8). The results were determined November 14, 1961.

Table 8. Effect of Two-day Delay in Covering the Stack

Additive	Cover thickness[1]	Percent good silage	Time of covering	pH
		%		
Nothing	6 mil	60	Immediate	6.3
Nothing	6 mil	15	Two-day delay	6.6

1 Black polyethylene was used for covers.

From observing the bales in the field, it was found that during summer weather mold formed inside the bale on the second day if the bales were not covered. During cooler weather, mold did not form as rapidly. There is no question that immediate covering of baled grass or alfalfa will add to the quantity of good silage.

Experiment With an Eight-ton Stack

A larger stack of about 8 tons of wilted baled alfalfa and grass was made. The alfalfa and grasses were cut the afternoon of June 2, 1960, baled June 3, hauled to the feed lot and made into a stack June 4; on June 6 they were covered with 8-mil vinyl and sawdust and sealed at the edges with dirt. This stack was opened October 15, 1960, and fed out for a period of one month. The silage was of excellent quality with little spoilage, but with a higher pH value than expected (Table 9). Inasmuch as this silage contained no additive and a high amount of protein, a high pH could have been expected. With straight alfalfa, it evidently is necessary to use an additive to make the best alfalfa silage. Near the end of the feeding period, the bales of silage tended to show some spoilage.

This suggests that silage should be fed out at a reasonably rapid rate to prevent spoilage in the back part of the stack. Or, perhaps pieces of plastic should be inserted through the stack at various intervals.

Table 9. Condition of Silage in an Eight-ton Stack

	pH	Percent dry matter	Percent crude protein	Percent good silage in whole stack[1]
		%	%	%
Grass and alfalfa (June 2)				
1st sample		44.48	10.78	
2nd sample		44.92	11.86	
3rd sample		47.54	11.48	
Silage (Oct. 15)				
1st sample	5.83	42.50	11.52	
2nd sample	5.60	50.00	14.06	95

1 Nearly all the 5% loss occurred near the end of the feeding period due to the stack being open too long.

Effects of Various Factors Upon Quality and Quantity of Baled Silage

A number of factors influenced the quantity and quality of good silage; this made it difficult to set up an experiment to prove the effect of different factors.

One of these factors was the need of a good seal at the edge of the stack of silage. The difference between a good seal and a poor seal is difficult to state, and it is even more difficult to set up an experiment to show the difference between the two. Nevertheless, two types of plastic seals proved satisfactory. One of these was a trench 6 inches deep and at least 8 inches to 10 inches wide all around the edge of the stack (Figure 6). The plastic was placed in this trench, soil was backfilled into the trench, and the soil was wetted and tramped into place by walking over the backfill. The other type of seal (Figure 7) proved effective on concrete. The edges of the polyethylene were sealed with wet sawdust 6 inches deep. There was at least 12 inches of the plastic on the concrete.

Baled grass or alfalfa has many stiff and protruding stems. Frequently, when plastic (either polyethylene or polyvinyl chloride) was stretched over these rough edges, holes were made in the plastic. To avoid this situation, the stacks in the latter part of this investigation were made by forming the sides of the stack into the form of stairs and filling in the corners with cut grass (Figure 5).

Another factor that caused poor silage and was difficult to measure was the condition of the grass or alfalfa. Dry, coarse stems that had very little nutritive value to begin with usually did not make good silage.

Finally, the stack should be given reasonable protection. If small animals such as dogs, cats, rats, and mice are allowed to dig under the stack or slide down the cover, poor silage will result. A second cover of old plastic or sawdust over the top helped protect the stack. Lastly, livestock should be kept off the top of the stack by the use of a fence.

SUMMARY

The decision as to whether baled silage should be made is an economic one. Will the value of the silage saved justify the expenditure of money for plastic, sawdust, and labor? This oftentimes will depend upon the probable value of forages for some time in the future. Nevertheless, with the materials and equipment outlined in this publication, a large expenditure for capital equipment is not necessary. Standard hay-making equipment, a few accessories that can be built in an afternoon, and plastic and sawdust are all the requirements necessary. This method should appeal to the man who puts up a small amount of grass silage per year -- 200 tons or less.

On advantage of baled silage without a silo is its flexibility. The stacks can be made into any width or length to suit a particular size herd. One method suggested here was to feed the front of the stack by means of a "hot strip" consisting of an electrified strip of metal approximately 30 inches off the ground in front of the open stack. The strip of metal is moved forward from time to time as the silage stack is consumed. No difficulty was experienced in these tests with the steers or cows eating the baling strings when silage was consumed in this manner. However, it is recommended that the strings be removed from time to time because digestive disorders may originate from this source. Six inches of feeder space per cow or steer appears adequate.

A good concrete platform for making and feeding silage would be an advantage to this system. Sawdust may be substituted for a hard stand.

In general, it is possible to store grass and alfalfa as baled silage with very little expenditure of money by use of conventional hay-making equipment. However, directions must be carried out with care in order to reduce spoilage to a minimum.

To make good baled silage it was necessary to cover the entire stack with 6-8 mil polyethylene or polyvinyl and to seal the edges tightly in the earth or with sawdust. Also, it was necessary to cover the entire stack with sawdust to a minimum depth of two inches. Best results were obtained when the sawdust was wetted down.

There are a number of minor recommendations that should be followed to obtain the best results, such as stacking the bales close together, making the edges of the stack round to prevent the stems from breaking the plastic, covering the stack reasonably soon after baling, baling alfalfa that is neither too wet nor too dry (about 60% moisture), and baling to a reasonable tightness (100 to 120 pounds per bale, 16" x 18" x 36"). A ground cover is helpful if the ground is dry. A solution of 50% water and 50% molasses sprinkled on at a rate of 15 gallons per ton of alfalfa was helpful in lowering the pH to a reasonable level.

An electrified strip of metal at least 3/4 inch wide stretched 30 inches above the ground and in front of the silage proved to be an inexpensive, practical method of feeding the silage.

If the silage was made in the same field in which the alfalfa was cut, there were considerable savings in labor if the bales were stacked on a sled drawn by the baler and slid off the sled in a continuous stack (Figures 8A, 8B, and 1). If the stack of silage is made at a considerable distance from the field, mechanical methods of stacking the bales and moving them from a trailer drawn by tractor or truck should be used.

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3. Murdoch, J. C. (The National Institute for Research in Dairying.) Personal correspondence, September 24, 1956.

4. Murdoch, J. C. Making and Feeding Silage. Leagrave Press Limited, London, April 1961, pp. 75, 76.

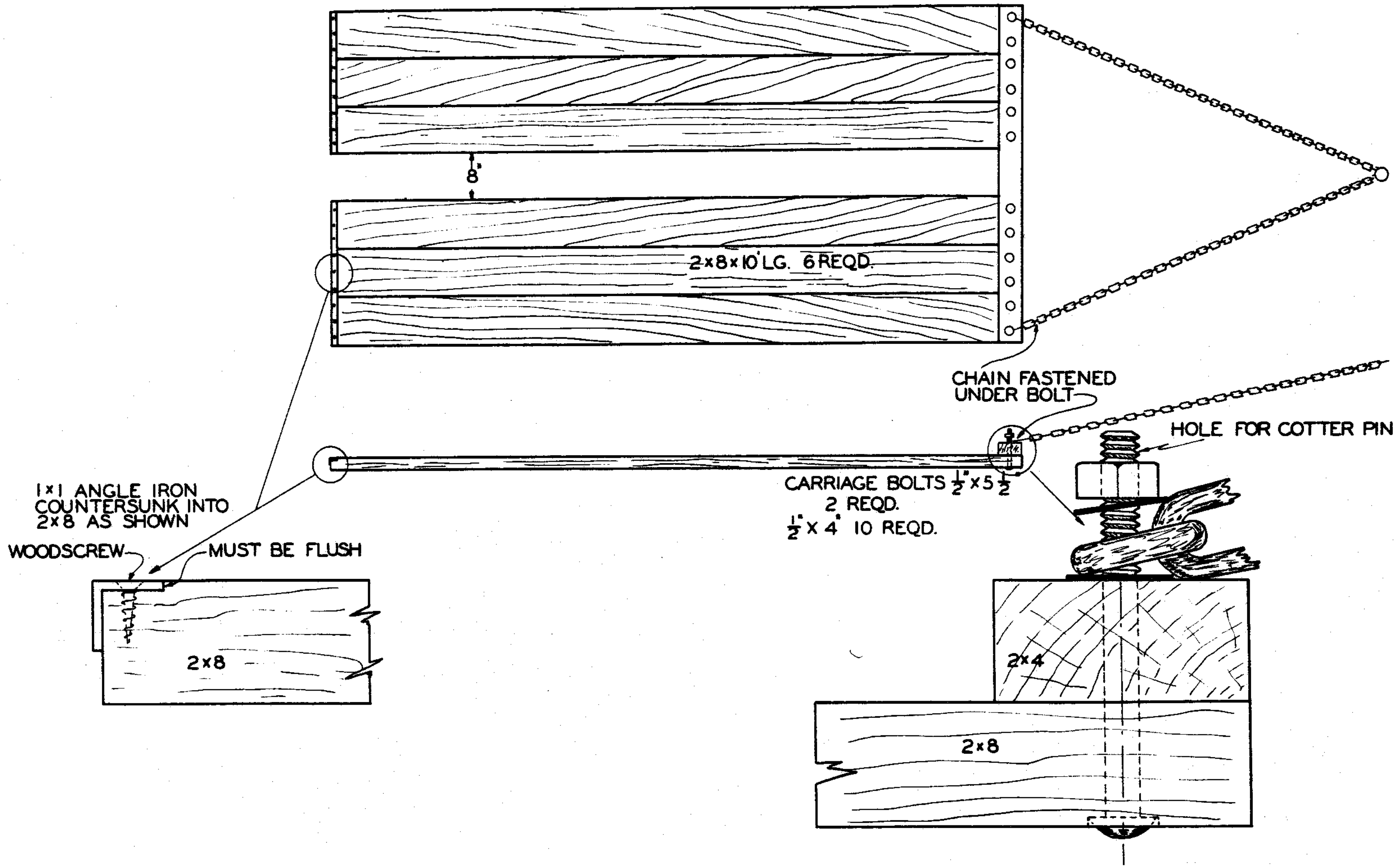

Figure 1. Sled used in making silage.

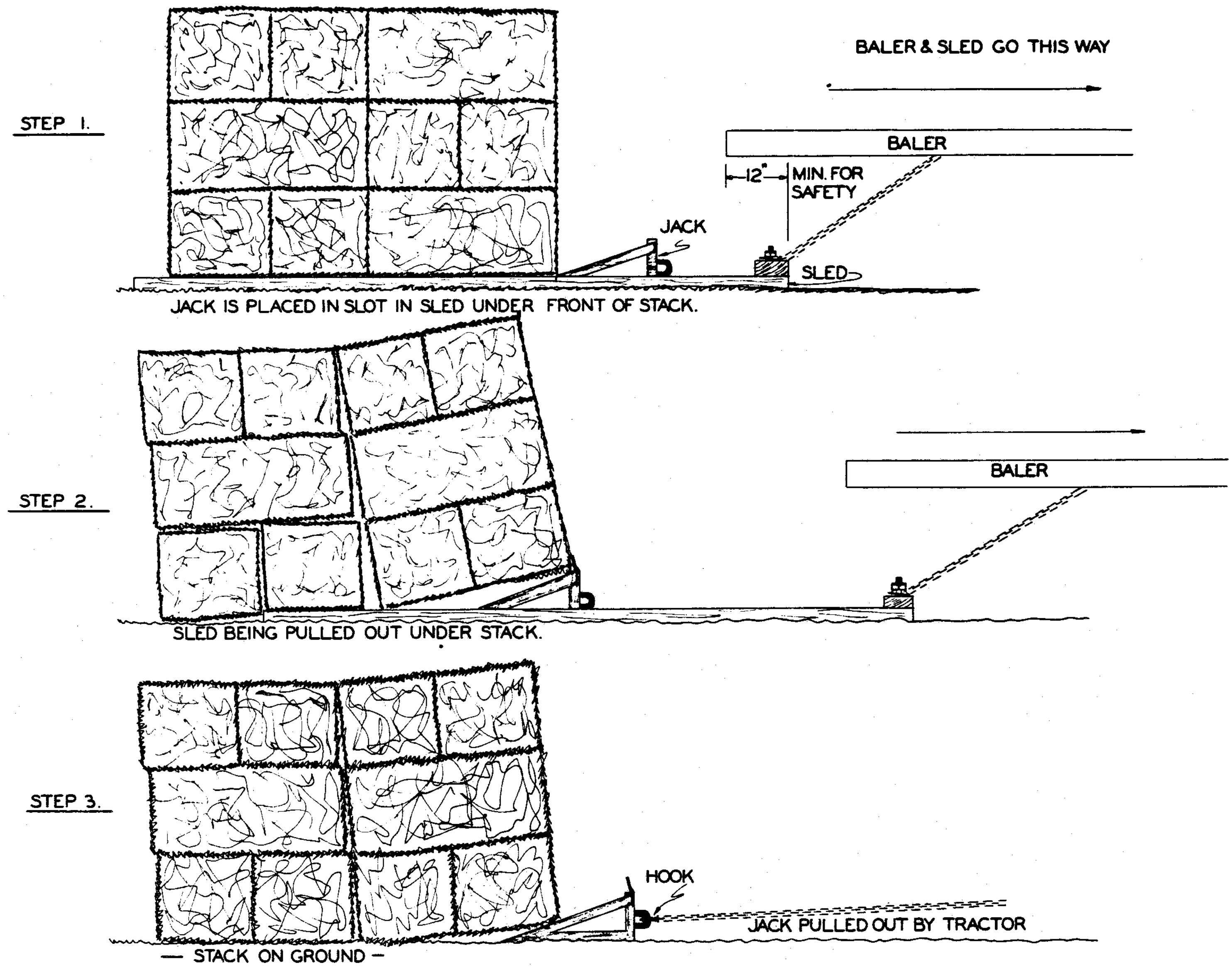

Figure 2. Method of removing bales from sled.

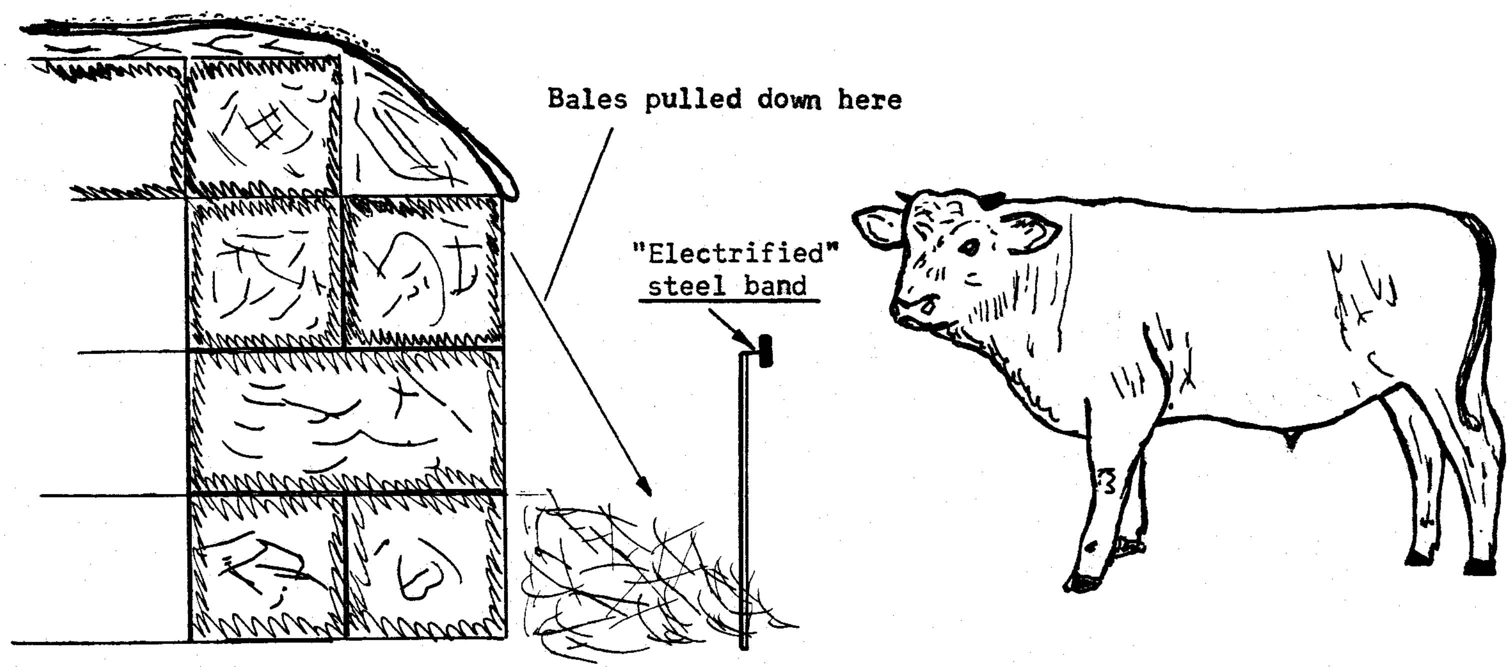

Figure 3. One method of feeding baled silage.

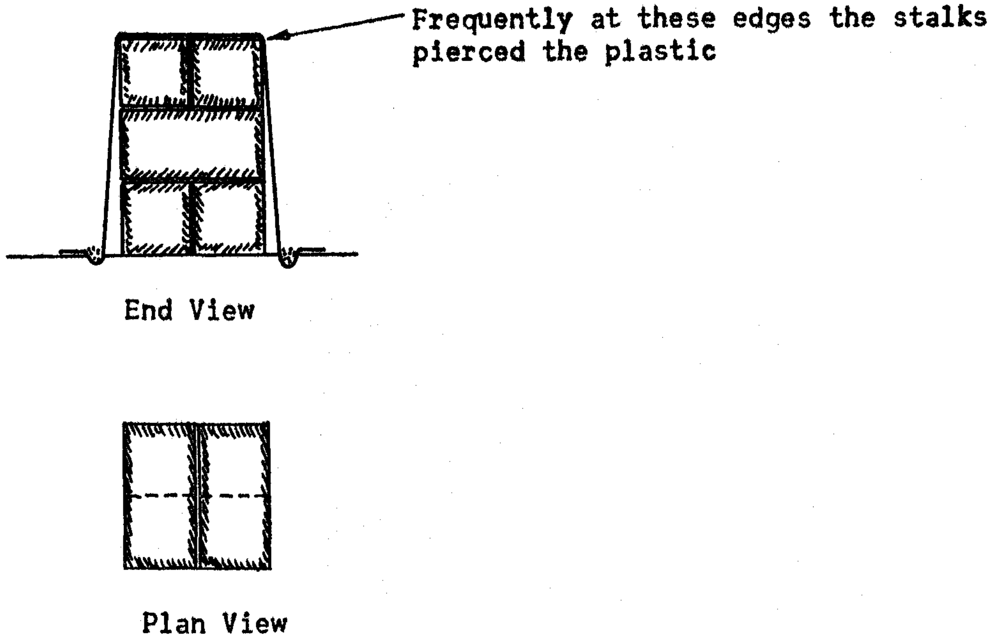

Figure 4. Six-bale stack used in the experiments.

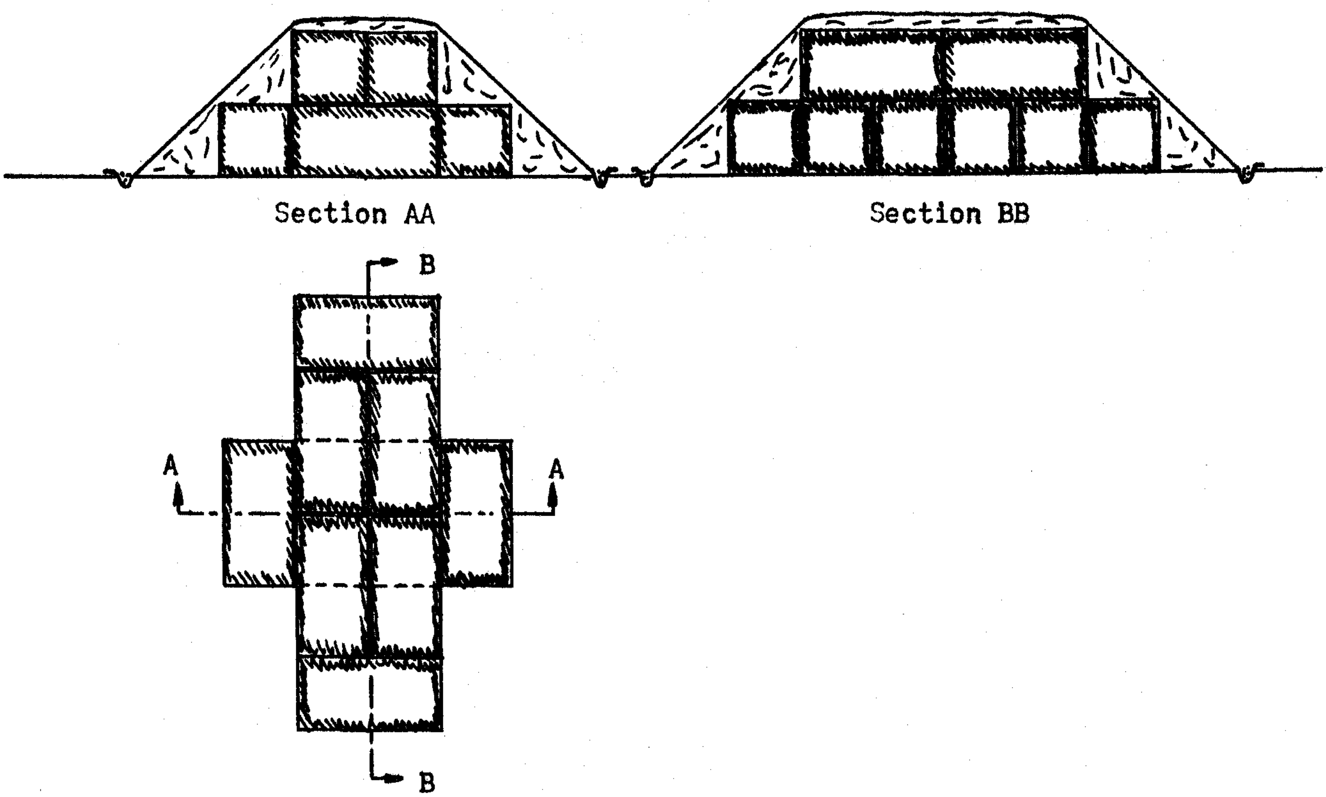

Figure 5. Sixteen-bale stack used in the experiments.

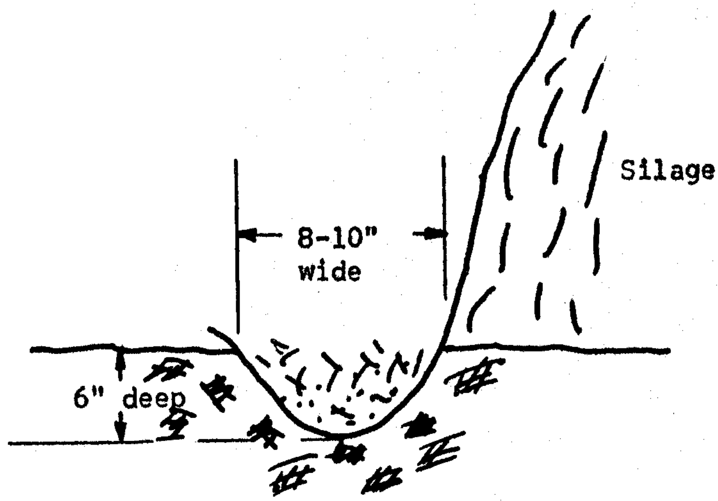

Figure 6. Method of sealing plastic in earth.

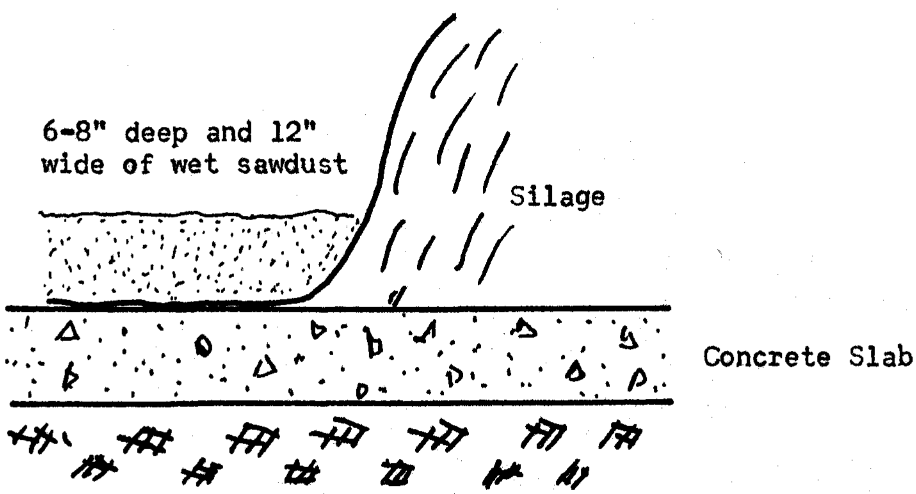

Figure 7. Method of sealing plastic on concrete.

Figure 8A. Loading the sled.

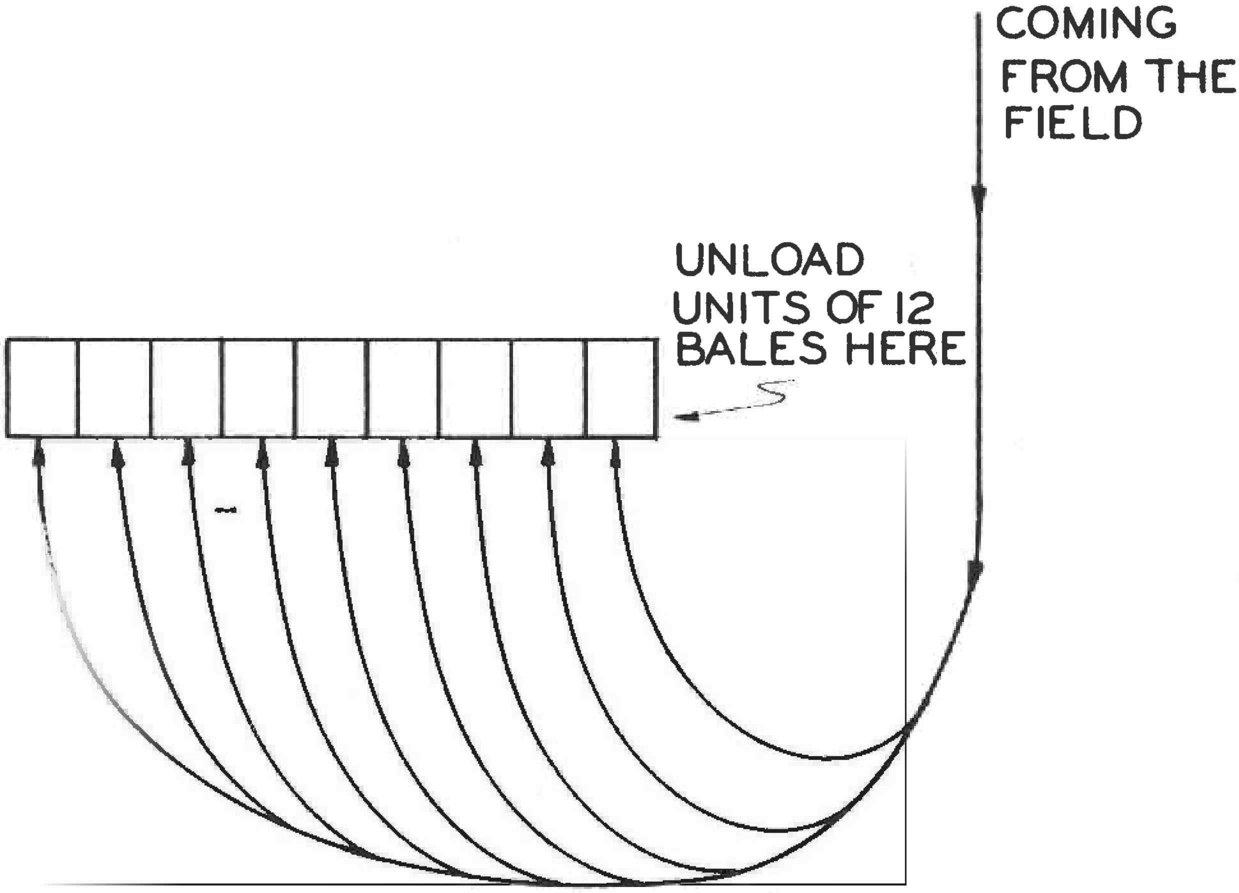

Figure 8B. Making a continuous stack with the sled.