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THE STORAGE OF BEETS BETWEEN THE TIME OF HARVESTING AND SLICING IN SOUTHERN ALBERTA, CANADA

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The chief hazard encountered so far in the production of sugar beets in southern Alberta has been the possibility of injury of beets by freezing occurring before the beets were all harvested. The length of the harvest period, that is considered quite safe, that is between the time the beets are ready and the final freeze-up is approximately forty days, commencing about September 20. Freezing temperatures usually occur during this period and in one-third of the seasons since 1925, temperatures have been low enough to freeze the crowns of unharvested beets before the 15th of October. Beets remaining in the ground after the middle of October definitely run the risk of being frozen. This condition has made it necessary to develop methods of storing partially frozen beets. The shortness of the season has made it essential also to adopt practices of handling the crop that would interfere as little as possible with the speed of harvesting operations.

Loss from Small Field Piles:

Several years ago, it was the practice of inexperienced beet growers in the Alberta territory to pile their beets in small piles in the field and, if there was no frost expected at night, the beets were left uncovered until it was convenient to haul them to the loading station. An experiment was conducted at the Lethbridge Station in 1931 to determine the probable loss that might be incurred from this practice under our climatic conditions. Freshly dug and topped beets were weighed into piles containing 200 pounds each and the piles were left uncovered. Beets in these piles were weighed daily and the following losses in weight were recorded:

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Table 1.--Loss in Weight of Topped Beets Placed in 200 Pound, Uncovered Piles. Expressed in Percent of Original Weight

Day	Loss %	Day	Loss %
1st	6.00	8th	1.35
2nd	4.25	9th	1.65
3rd	2.50	10th	2.00
4th	2.15	11th	1.60
5th	3.75	12th	1.00
6th	3.00	13th	1.75
7th	2.00	Total loss for 13 day period	33.00

Loss in 13 days from similar piles covered with 4 inches of beet tops 22.72%

It will be noted in Table 1 that the loss in weight in the first 24 hours was 6% while in the next 24 hours the loss was 4.25%, or in 48 hours, 10.25% of the original weight of the beets had been lost. From that time until the end of the experiment, the daily losses were relatively uniform. By the end of 13 days the beets had decreased one-third in weight. When this excessive shrinkage was brought to the farmers' attention, it helped them to see the necessity of more care in handling their beets. Naturally the value of covering beets that could not be hauled was considered. Piles of beets similar to those left uncovered were covered with 4 inches of freshly cut beet tops. The loss from these piles was 22.7% in 13 days as compared with 33% from the uncovered piles. This reduction of about one-third in the loss by covering was important and undoubtedly justified the cost of covering, but the loss was still excessive. Naturally when the farmers came to a realization of these losses they were anxious to move their beets out of the field and deliver them at the loading station as rapidly as possible. This created a condition of the deliveries being more rapid than the loading stations could receive cars to handle them.

Piling at Loading Stations:

The sugar company attempted to meet the situation by placing the beets in large piles at the loading station as they wished to encourage the practice of removing the beets from the small field piles daily if possible to prevent loss in weight and especially to remove the hazard of having the beets frozen when freezing temperatures occurred. Table 2 contains the data of losses in weight occurring in loading station piles for 8 seasons, as compiled by the Canadian Sugar Factories Limited, who have kindly provided this information:

Table 2.--Loss in Weight of Beets in Piles at Loading Stations, Stored about 30 Days.

Year	Average Size of Piles	Height of Piles	Loss in Weight
	tons	feet	%
1926	24	8	6.1
1927	60	8	7.8
1928	214	8	9.6
1929	370	8	11.6
1930	1436	8	20.6
1931	372	8	10.8
1937	10385	18	10.5
1938	18177	18	4.6
Average			10.2

The average loss in weight for the 8 seasons, it will be noted, was 10.2% which was less than a third of the loss in uncovered small field piles but was still quite high. More important, however, than the average loss is the wide fluctuation in different seasons, which varies from 4.6% in 1938 to 20.6% in 1930. The small loss in 1938 and some other seasons indicates the possibility of safely storing beets if the season is satisfactory, while the very heavy loss in 1930 shows the results of attempting to store beets in large piles when some of the beets have been frozen. It may be thought that it would be possible to prevent putting any frozen beets into storage piles and this the receiving agents at the loading stations attempted to do. Their instructions were to place any loads that contained frozen beets directly into the cars to be shipped to the factory for immediate slicing or to refuse to accept them at all. However, it was found that regardless of the precaution taken, some frozen beets would slip into the piles and hot spots were the result. Similar but lighter losses were noted in the beets stored at the factory sheds as recorded in Table 3.

Table 3.--Loss of Weight in Beets Stored at the Factories. Average Storage period, 42 days.

Year	Loss in Weight	Year	Loss in Weight
	%		%
1925	14.1	1932	3.2
1926	4.1	1933	4.5
1927	7.9	1934	4.8
1928	6.0	1935	4.9
1929	6.4	1936	5.0
1930	19.9	1937	3.5
1931	5.7	1938	4.5
Average			6.7

Here again the excessive losses in 1930 are indicated.

Unfortunately, no satisfactory data are available of the sugar content and purity of the beets as they went into these piles.

Field Silo Piles for Storing Beets:

The experience with large piles stored at loading stations and at the factory was so disastrous in 1930 that the Canadian Sugar Factories Limited, who buy all of the beets produced in the Alberta territory, decided that some other method of storage must be followed and so mediumly-large covered piles, which have been called field silo piles, were constructed in the fields. After some experimentation, it was found that beets, even if partly frozen, could be kept fairly well in properly constructed piles.

Figure No. 1 shows a diagram of the field silo pile as it is now being used in the Alberta beet area:

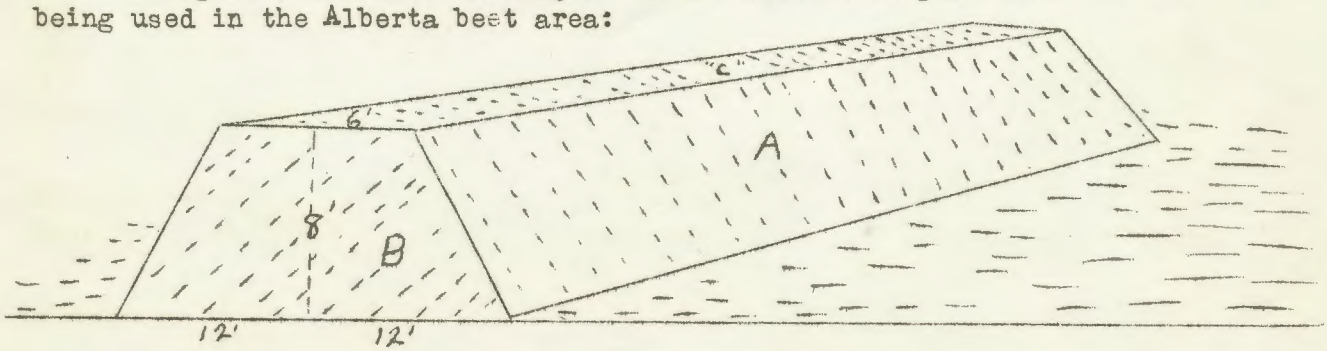

Fig. 1 Field Silo Pile

The dimension of the piles as now recommended are:

Unfrozen beets:	Width at base	20' to 30'	
	Width at top	6' to 10'	(top always flat)
	Height	7' to 9'	
Partly frozen beets:	Width at base	16'	
	Width at top	4'	
	Height	6'	

These piles are covered with beet tops and soil to reduce shrinkage and frost injury. It has been found that beets will heat if covered too much when first piled, so the sides (A) and ends (B) are protected with about 6 inches of dry tops and this covering sealed over with soil. The top (C) is always flat and is covered with about 4 inches of tops through which heat can escape. As the pile settles and cools more soil is added to the sides until the soil is about 10 inches thick at the base and 4 inches at the top. If partly frozen or badly frozen beets are being piled they are covered with tops only until excessive heating stops, then the sides are sealed with dirt as with unfrozen beets. One end of the pile is completed as soon as possible and covered immediately on the finished end, sides and top to check shrinkage and prevent freezing. Only the end on which the beets are being piled is left open and it is recommended to protect this face with canvas or other covering between loads and at night, especially if freezing temperatures or wind prevails. Incidentally, wind is one of the elements of Alberta's weather.

The storage of beets in these field piles placed the responsibility of assuming storage losses on the farmer, where previously this had been mainly borne by the manufacturer. Immediately the beet growers requested adjustments to be made in their contract to reimburse them for the losses sustained in storage and for the extra labor involved. Therefore, it became necessary to secure some information regarding losses occurring in this type of pile, so all of the beets produced at the Dominion Experimental Station at Lethbridge, Alberta, were weighed into a silo pile with careful attention being given to proper taring and the beets were weighed out when moved to the factory, with the same care being taken in securing tares. Purity and sugar content tests were made of the beets both when they went into the piles and when they were removed. The losses in weight each year and the average changes in purity and sugar content for the 8 years are shown in Table 4:

Table 4.--Field Silo Storage Piles

Year	Loss in Weight	Days Stored	Year	Loss in Weight	Days Stored
	%			%	
1931	6.2	29	1935	6.3	48
1932	10.3	34	1936	10.7	61
1933	5.6	54	1937	3.6	27
1934	10.7	88	1938	6.2	36
Average (8 years)				7.5	47

	Before Storage	After Storage	Increase
Average Purity	85.0%	85.3%	0.3%
Average Sugar Content	16.7%	17.9%	1.2%

It will be noted in Table 4 that the average shrinkage for a mean storage period of 47 days was 7.5% of the original weight. It appears that the length of time that the beets were in storage influenced to some extent the amount of loss incurred but the loss in weight was not entirely in proportion to the length of time that the beets were held in storage. The condition of the beets when placed in the piles, especially the presence of any frosted beets, influenced the losses. Other than this, the amount of wind seemed to be an important factor and indicates the necessity of applying sufficient cover to prevent the beets from being dried by excessive air movement through the pile. Excessive covering could not be used, however, or heating developed.

On the whole, the beets coming out of the piles were in good condition for slicing as indicated by the purity tests made. This is in agreement with the generally observed condition at the factory of the beets working up well through that period of the run when deliveries were being received from the siloed piles.

The data secured on the sugar content indicate a slight, although not a statistically significant, increase in percentage of sugar present when the beets were removed as compared with the sugar content when the beets were placed in the pile, indicating that there may have been less loss of sucrose than of total weight. This too is in agreement with factory experience.

The value of the field silo storage pile as a means of caring for beets during the period between the harvest and slicing has been considered carefully in the Alberta district. Some of the advantages are that it is quite convenient for the farmers to move their beets from the field on to these piles as the beets are topped and this definitely encourages them to pile the beets immediately. A number have developed the practice of topping on to low flat racks and hauling directly to the silo piles while others fork the beets on to wagons or trucks and haul them to the piles. It appears that the loss in storage with fresh beets tends to be lighter than in the large unprotected station piles and the risk from spoilage where frozen beets must be handled is decidedly less in properly constructed field silo piles than in the large storage piles at the loading stations or at the factory sheds.

There is an indication also that in the Alberta territory the general run of beets can be kept with greater safety for longer periods in the field piles than they can in the large storage piles. This suggests the possibility of lengthening the period the factories could operate by using field silo storage.

The objections of the farmers to the field silo pile are principally two: first, they do not like to take their beets out of the silo piles and deliver them during the cold winter weather but much prefer to clear up the entire operation and have the beets off their hands at the end of harvest and, second, the beets must be unloaded into the piles and loaded again. The use of nets or other equipment for unloading is reducing the work of this double handling. There also is a small loss of beet tops used in covering the pile as it is difficult to salvage all of the tops when removing the dirt from the piles.

One difficulty encountered by the manufacturer is that with a contract based on the growers receiving a percentage of the total revenue obtained from

the manufactured sugar, the question of placing the cost involved in field storage and reimbursement for loss in storage requires one more item for reckoning. The practice that has developed in Alberta is that the farmers are paid 65 cents per ton extra for beets that are properly stored in silo piles and 50 cents per ton, or total rejection, for improperly siloed beets. This amount of 65 cents is calculated on the following basis:

Loss to grower due to shrinkage	$0.25
Cost of extra labor	0.40
Total payment	$0.65

In this arrangement the manufacturer assumes the payment of 40 cents for extra labor while the 25 cents paid for shrinkage is charged one half to the manufacturer and one half to all the growers, sufficient being deducted from the price paid for all beets to meet the growers' share of this payment. The division of the 25 cents between the manufacturer and growers is based on the assumption that there is no decrease in the amount of sucrose during the silo period but that the shrinkage is all of non-sucrose. As the payment for beets in this territory is on a pool basis and on a fifty-fifty arrangement between the grower and manufacturer, it is assumed that each benefits equally by the higher sugar content of beets delivered from silo piles.

From 10% to 41% of the Alberta beet crop has been siloed each year for the last 10 years. The actual amount siloed each year depends on the weather during harvest. The practice now followed in handling the crop is for the sugar company to receive all of the fresh, undamaged beets after they are ready to dig, as fast as the farmers can make delivery but all beets damaged by frost or exposure that cannot be immediately sliced must be placed in silo piles until they can be used at the factory.

Where there is no special reason for siloing beets, the farmer may receive the siloing payment for any beets siloed only up to a maximum of 10% of his crop. This arrangement seems to meet the situation and to be satisfactory both to the growers and manufacturers. About the only phase that is still unsettled is the payment that should be allowed for field siloing. To adjust this equitably may require more information as to shrinkage, possible loss of refinable sucrose and especially the extra cost involved in siloing. As to the value of field siloing, there is full agreement that under Alberta conditions the field silo pile is essential and that it has done more to insure the satisfactory harvesting of the crop than has any other development.