Observations on the Dehydration of Beets after Receiving and During Storage in Northern Montana

ROWLAND M. CANNON[1]

During the past three years in the Chinook, Montana, district of the Utah-Idaho Sugar Company, there has been evidence that considerable dehydration or evaporation of moisture from beets takes place after they have been delivered to receiving stations. (See Tables 1 and 2.) It is felt that this may have been important both in fresh beets enroute to the factory in railroad cars and in beets which have been piled.

For some years, it has been felt by the author that such may be the case under certain conditions, and that the extent to which such dehydration occurs is largely dependent upon climatic and atmospheric conditions, particularly relative humidity.

It is entirely possible that the large swing toward mechanical harvest of the crop may be significant in this regard, since in most cases the time between harvest and delivery of the beets is reduced materially, and during this interim the beets are seldom laying out in windrows. This condition would decrease moisture loss in the beets before they are delivered, and might increase the opportunity for such loss after delivery.

This evaporation loss may be alarming in some respects, but it does have the advantage of making available a tremendous source of cooling capacity for storage beets if it can be utilized. The cooling potential of such evaporation may best be illustrated by example. Samples placed at the bottom of beet piles (Table 2) lost weight at the average rate of 0.2% per day during the storage period. If this loss is all moisture, water would be evaporated from the beets at the rate of 4 pounds per ton per day. Each pound of moisture so evaporated would remove nearly 1,000 B. T. U. of heat energy from the beets, or nearly 4,000 B. T. U. would be removed per ton of beets per day.

According to respiration values given by Fort and Stout[2], this rate of evaporation would absorb the heat given off by the respiration of beets at about 70° F. For beets at 50° F., it would absorb the heat of respiration and require enough additional heat to cool the beets at the rate of about one degree F. per day. In other words, such a rate of dehydration can do the same job of cooling which is requiring elaborate and expensive air-conditioning installations under different atmospheric conditions.

Following observations made in 1947, a number of modifications was made in piling procedures in order to try to build piles which would best utilize the potential cooling power of dehydration. It was felt that piles

[1] Agricultural Superintendent, Utah-Idaho Sugar Co., Chinook, Mont.
[2] Fort and Stout. Respiratory Heat of Sugar Beets and its Influence on the Practical Harvesting and Storage Problem. U. & I. Cultivator, Vol. 6, No. 3, October, 1946, pp. 10-13.

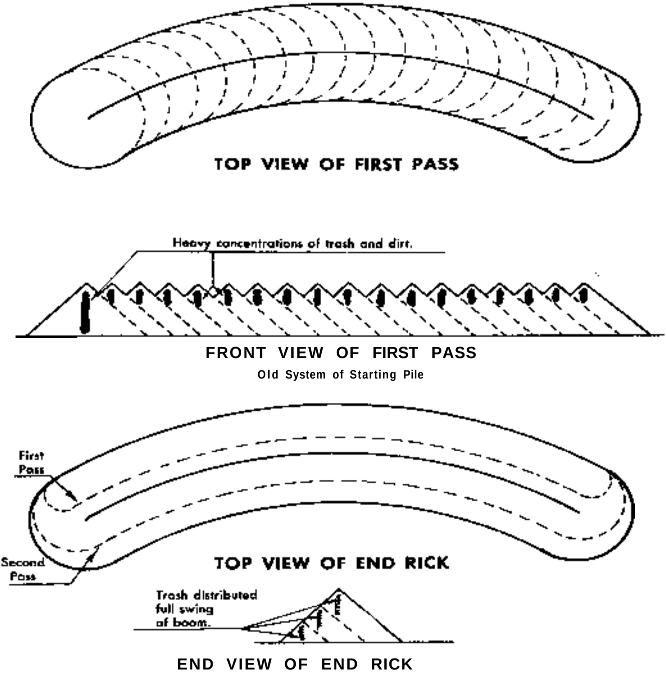


Figure 1. Diagram of old and new methods of starting piles.

should be so made that atmospheric air could reach all parts of the pile freely. In order to accomplish this objective, two fundamental factors were considered: (1) the elimination of any concentrations of trash or dirt at any places in the pile, and (2) the height and width of the pile.

A number of procedures was adopted to accomplish these purposes as follows:

1. Wherever possible, new screens were installed on pilers to do a more effective job of screening out dirt and trash.
2. Maximum care was exercised with growers to eliminate dirty loads and generally reduce trash and dirt in beets delivered, and, of course, frozen beets were not piled under any consideration.

Table 1.—Sugar Content Comparisons at Chinook, Montana, Factory Campaigns 1947, 1948 and 1949.

Year	Average Sugar Content of Beets Sliced Directly after Receiving	Estimated Average Sugar Content of Beets as They Were Piled [1]	Average Sugar Content of Beets Sliced from Piles	Estimated Average Sugar Content of All Beets as Received [1]	Average Sugar Content of All Beets Sliced	Number of Piles	Percent Total of Beets Piled	Average Number of Days in Pile
1947	16.56	16.76	16.97	16.60	16.79	9	55%	46
1948	15.74	15.73	16.26	15.71	16.03	7	55%	39
1949	15.43	15.34	15.82	15.37	15.56	5	54%	33

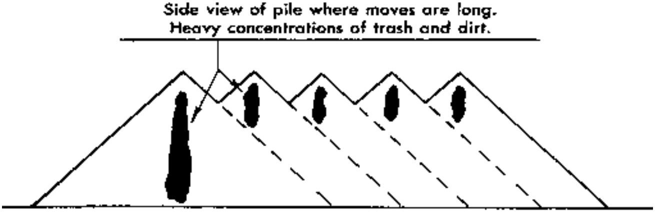
[1] These values are cossette test equivalents, since they were determined by assuming that the beets piled during a given period were of the same average sugar content as the beets sliced directly after receiving during the same period.

3. The method of starting a pile was changed. The practice had been to start out by building up a cone of beets to the height desired, then swinging the boom and carrying this pass on around to the desired width. This system was modified as follows: The boom was lowered to the lowest position and beets were discharged in an arc with a rick about six feet high being built. The boom was swung over this arc three or four times in order to build up to this height. The boom was then raised to about 11 feet and the piler moved back to the point where beets would just flow over the back surface of the first rick when the pile reached a height of 11 feet.

   Several swings of the boom were made in reaching the 11-foot height. The boom was then raised to 15 feet, the piler moved back, and the process repeated. Whenever the boom is held in one place a mechanical separation of beets from dirt and trash results. For the most part, the dirt, trash and muddy and small beets stay where the material discharged from the boom hits the pile, and the larger, cleaner beets roll down the sides. Where the boom is held stationary for a period, a concentration of trash and dirt results. The old system and new system of starting a pile are illustrated in Figure 1.

4. Pile heights were limited to 15 feet wherever piling areas would permit. The quantity of trash and dirt accumulated in any place in the pile is dependent on the length of time material is discharged from the boom to that place. By reducing the height of the pile from 20 to 15 feet, these concentrations were reduced accordingly.

5. Provisions were made for continuous or near-continuous movement of booms. Where volume was heavy, a mechanism was installed to provide continuous oscillation of the boom back and forth. Where smaller pilers with hand cranks for moving the boom were used, extensions were provided on the cranking mechanism so the operator could move the boom from the back end of the piler. In such cases the boom was swung back and forth over the face of the pile



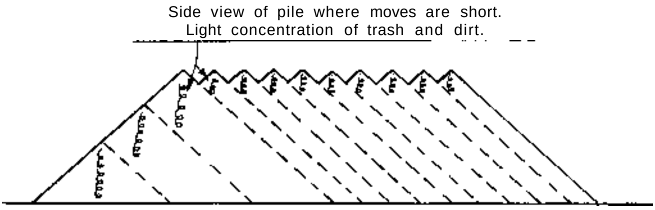


Figure 2. Diagram of effect of short and long moves on trash and dirt concentrations in pile.

two or three times between moves. Particular care was taken to spread out loads containing excessive amounts of dirt and loads of small beets. Where the boom was left stationary at the ends of the swing to fill out the corners of the pile, an attempt was made to have beets from clean loads going over it.

6. The distance the piler moved back was shortened. Wherever volume was not too heavy, 3-foot moves were used. Moves of four feet were made where volume was so heavy as to cause receiving delays with 3-foot moves. Short moves reduce the volume of dirt and trash going into one place, as shown in Figure 2.

7. Piles were immediately leveled on top to reduce the possibility of channeling air up through the pile.

8. Piles were made as narrow as possible. In each case, the cubic content of the maximum estimated tonnage to be piled was determined and the width of the pile was determined by correlating this cubic content with the full length of piling ground available.

Some of these procedures were used in 1947; others were added in 1948; and in 1949 they were followed very carefully. A study of sugar contents and days of storage as listed in Table 1 would indicate that the rate of dehydration of piled beets was increased each year. While results as far as condition of piles is concerned are not conclusive, it might be observed that in both 1948 and 1949 all of the beets came out of the piles in excellent condition with practically no regrowth and no evidence of spoilage.

Table 2.—Shrinkage of Samples Placed in Piles.

Placement in Pile	Average No. of Days in Pile	Average Weight of Samples into Pile	Average Weight of Samples Out of Pile	Average Percent Shrink	Average Percent Shrink per day Storage
Near Bottom	41	86.71	79.58	8.22	0.200
At Top	41	87.96	65.71	25.30	0.617

A question may arise as to the effect of high dehydration on shrink between beets received and beets sliced. This matter certainly presents a problem worthy of further study. There are many factors involved and the relative importance of each needs evaluation. The question arises as to which is the most costly: the loss of moisture from high dehydration or the weight losses from increased sugar losses from respiration and other weight losses which would be encountered where dehydration rate are lowered and pile temperatures are higher. While a number of other factors can and probably did affect shrink, it might be observed that, of the three years studied, the highest shrink was encountered in 1947 where the indicated rate of dehydration was lowest, and the lowest shrink was encountered in 1949 where the indicated rate of dehydration was highest.

Conclusions

In areas where the humidity of atmospheric air is normally low during storage periods, there is evidence of considerable dehydration of beets after they are received and particularly in storage. If storage conditions can be modified to take advantage of the cooling power of this evaporation of moisture, it has a tremendous potential as far as cooling piles is concerned. It is felt that much was done at Chinook to accomplish this end in the past two years and that it resulted in reduced storage losses and an improvement in the condition of beets from storage.

This work is of a very preliminary nature in the study of the problem and it certainly seems to be of sufficient economic importance to warrant concentrated detailed study.