THE STORAGE OF SUGARBEETS

By: Whitney Newton, II [1/]

The beet sugar industry has been aware of the occurrence of storage losses for many years, however, in the advent of larger crops and longer storage periods, it has become increasingly evident that something should be done to conserve more sugar and as important to preserve the processing quality of the sugarbeet during the full period of storage.

It is unfortunate that the industry does not at all times take full advantage of the facts that are already known. Believe it or not, we still, on occasion, pile beets when the ambient temperatures are too high. On occasion, we put frozen beets into piles. Everyone is aware of the excessive trash that occasionally gets into piles.

It is possible that some day we will be able to put beets into storage at higher temperature, but the time has not arrived. We hope that more effective trash removal equipment will be devised. Certainly, a lot of progress in the removal of trash has been accomplished. Unfortunately, more severe handling has been required which must increase respiration rates caused by bruising and shattering of the beets.

Other factors that cause sugar loss and reduce processability are dehydration and freezing and thawing. Nothing raises the blood pressure of a Superintendent more quickly than a train load of rim beets, thousand of man-hours of conversation have been spent in discussion of suitable means of mixing good beets with bad beets to preserve slicing rates.

With the introduction of The Great Western Sugar Company into the Eastern territory, different practices had to be learned. The harvest and climatic conditions were different. Great Western had discarded the idea of ventilating piles years before. In Ohio, ventilation is a must and everyone is aware of this. Now, we are not so sure that ventilation would not improve conditions in the West. There is no doubt that different areas are going to need different storage conditions. In Ohio, our weight shrink is practically nil as compared to the West, but Ohio sugar shrink amounts to more than twice that of the West.

It is a terribly frustrating feeling to climb on top of a pile and observe conditions of deterioration over which one has little control, but it is downright embarassing to add up the dollars of sugar losses that occur between harvest and processing.

In recent years, a number of people have contributed to the determination of sugar losses in storage. The Eastern group, Dr. Dexter and Maury Frakes reported on losses occurring in different areas of a pile. Their contribution in preparing captive samples by gravity separation of beets has been a real help in improving the reliability of the results when reporting storage losses. Dr. Dilley has studied respiration rates of sugarbeets, under different temperature conditions. He has shown the effect of mechanical injury. Further work

[1/]Vice President - Research
The Great Western Sugar Company
Denver, Colorado

in studying respiration rates of beets coated with anti-respirants may lead to practical methods of reducing respiration during storage.

If practical means for accomplishing the reduction of sugar losses in beets by control of respiration and spoilage and rolling in the pile, and by reduction in decomposition of the beets on surface of the pile by dehydration and freezing and thawing, certainly more sugar can be put in the bag and greater tonnage rates can be maintained in the factory operation.

A method of storing beets was devised whereby some control of the pile temperature could be achieved through mechanical ventilation and control of weathering could be provided by covering the surface of the pile with plastic sheets.

In studying this problem, test sites were selected in several different areas to give a good cross section of the type of weather encountered in Great Western territory. Two test piles were constructed adjacent to the regular commercial storage pile. These test piles contained approximately 4,000 tons of beets each. One pile was covered on the sides with 6 mil black polyethylene while the other pile was left uncovered as a check. In addition, on some covered piles, ducts made by welding open end barrels together were laid lengthwise through the bottom of the pile. One-fourth to one-half inch gaps were left between each barrel to provide passage for the air. Fans were placed at one end of the duct and the other end was sealed. The first year the fans were set to blow outside air into the pile. The second year the fans were reversed so as to draw air through the pile and out the ducts. Thermostats were placed on the fans so they would operate only when the ambient temperature was between 30° and 40° F. The purpose was to attempt to cool the piles using cool night air during warm weather to bring the pile temperature down as quickly as possible and to protect the pile surface from extreme weathering.

As the two test piles were built, each 20 tons of beets were sampled and the sample divided in half. The first half was analyzed at once and the second half was placed in a nylon mesh bag for inclusion in the pile. Each test pile contained approximately 200 captive samples including some placed very near the surface to show the rim effect. Construction of the piles was carefully supervised to assure that the sides were as smooth as possible and that the top was smooth and level. The piles were then ready to be covered.

There were two general methods of covering a pile. One was to move the materials to the top of the pile and then to roll the plastic down from the top. Old automobile tires used to weight the plastic down were tied together and lowered from the top, also. Taping of the seams with plastic tape and cross tying of the tires was done from ladders laid on the side of the pile. The second method was to mount the roll of plastic on a boom truck. The plastic was unrolled longitudinally as the truck drove alongside of the pile. Taping and placement of the tires was done from a platform suspended from the boom. This latter method kept movement on the surface of the pile at a minimum and presented less opportunity for tearing the plastic sheet. In both cases, after the plastic was in place, the ends were attached to 1" x 4" boards which were anchored to the pile with long iron rods driven deep into

the pile. Provision was made along the bottom of the pile to roll it up a few feet to provide additional ventilation should a hot spot occur.

Temperature measurements of the pile were made regularly by suspending thermometers in pipe thermometer wells driven down into the pile from the top. Figures 1 and 2 show the comparison of the test and check pile temperature and the ambient temperature at the Mathers Station, Gering, Nebraska for 1967-68 and 1968-69 test periods. In the test pile, polyethylene covering was applied to the sides of the pile. No mechanical ventilation was provided. Figures 3 and 4 show the test pile temperature comparisons, and the ambient temperature of the Hambert station in Greeley, Colorado. The test pile was covered on the sides with polyethylene and mechanical ventilation was provided. In 1967-68, the outside was blown through the ducts out into the pile. In 1968-69, the air was drawn through the pile and exhausted through the ducts. Figure 5 shows the comparison of the pile temperature and the ambient temperature of the Lovell, Wyoming factory site. The air was blown through the pile by the ventilating fans. The test pile was covered on the sides with polyethylene. It is quite typical in the northern territory for the pile temperature to remain warmer than the maximum ambient during the cold later stages of storage.

At the end of the test period, the piles were uncovered and the beets moved by means of a front end loader back to a piler. The beets were then passed over a single section of a grab roll screen to remove any loose dirt. This additional dirt was carefully collected, weighed and checked for tailings content so that beets in and out of the pile could be corrected for tare. The beets were then sent to the factory tare laboratory for analysis. The samples were analyzed without topping so that the total amount of the sugar in and out of the pile could be determined.

In most cases, the barrels could be collected and salvaged for future use, but most of the plastic had to be discarded.

The results for this year's experimental piles is not yet available. In Ohio, the piles are still intact. There were experimental piles in 10 locations. Hopefully, some significant information will be gathered.

1967-68 results would indicate that no statistical differences were measured between the covered and uncovered piles. However, the loss of sugar in the pile amounts to approximately 4-6 pounds of sugar per ton of beets per day, uncorrected for raffinose and invert formation. This year's data will be corrected.

This year, an attempt was made to cover piles with plastic on a commercial basis. Although this practice has been followed by other companies, for a number of years, only in Ohio has covering been practiced by Great Western.

Thirty piles of commercial size (20 - 40,000 tons) were covered with varying success. The only part of this program that was not variable was that it was hard work everywhere. The most successful job that was done was probably in Lovell, Wyoming. The manager contracted the job to a local contractor. I am told his cost figures will be as low as any in the Company.

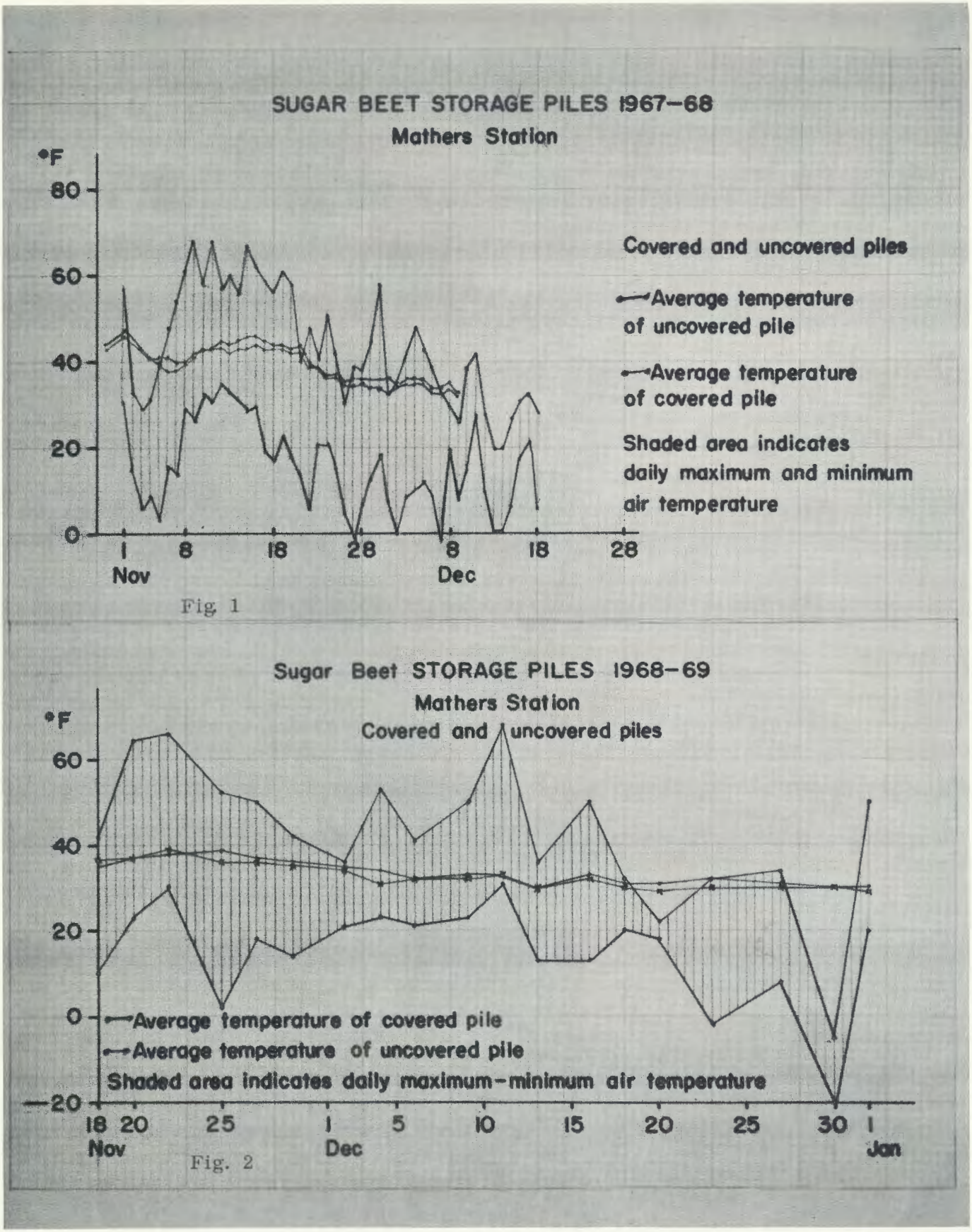
SUGAR BEET STORAGE PILES 1967–68
Mathers Station
°F
80
60
40
20
0
1
8
18
28
8
18
28
Nov
Dec
Covered and uncovered piles
Average temperature of uncovered pile
Average temperature of covered pile
Shaded area indicates daily maximum and minimum air temperature

Fig. 1

Sugar Beet STORAGE PILES 1968–69
Mathers Station
Covered and uncovered piles
°F
60
40
20
0
−20
Average temperature of covered pile
Average temperature of uncovered pile
Shaded area indicates daily maximum−minimum air temperature
18
20
25
1
5
10
15
20
25
30
1
Nov
Dec
Jan

Fig. 2

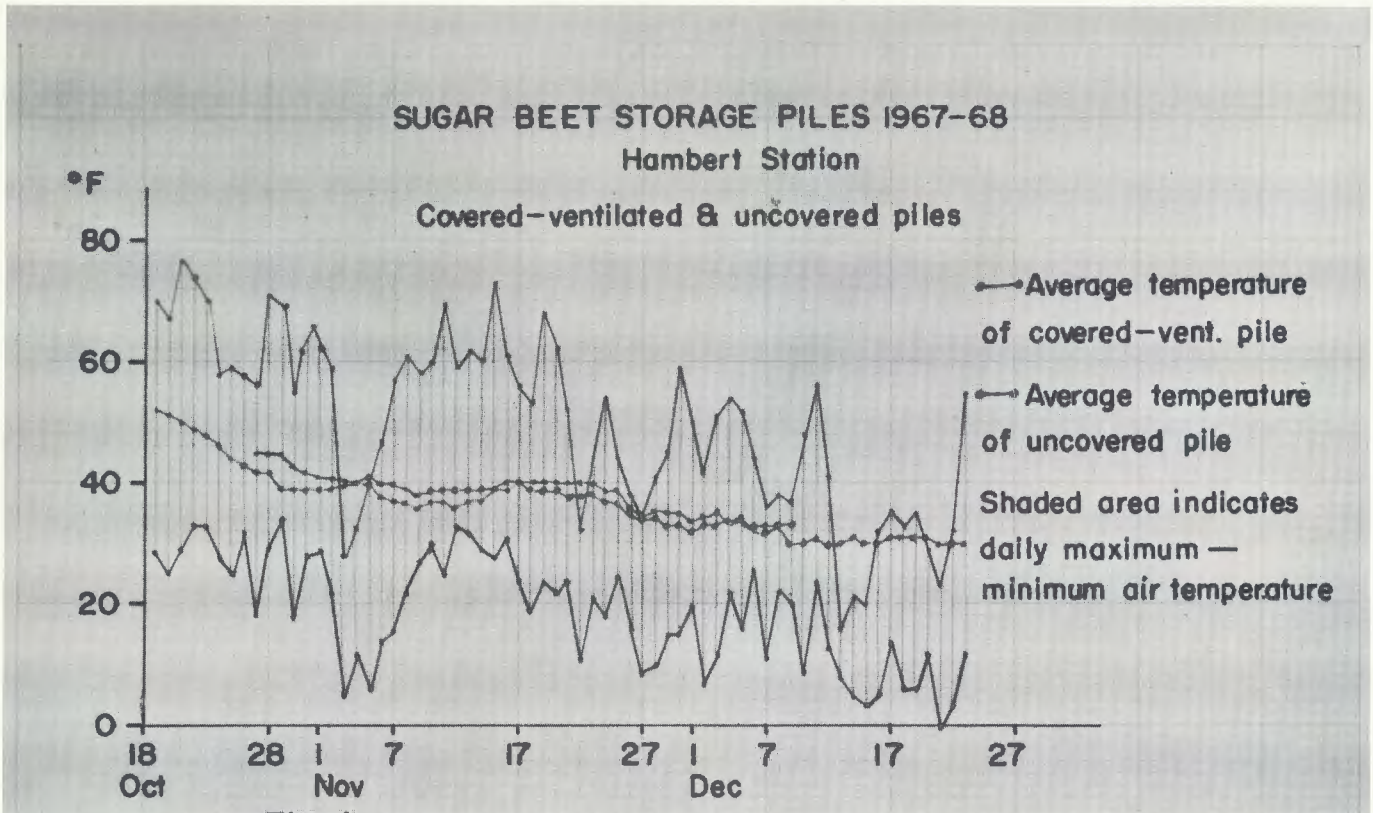
SUGAR BEET STORAGE PILES 1967-68
Hambert Station
Covered-ventilated & uncovered piles
°F
80
60
40
20
0
Average temperature of covered-vent. pile
Average temperature of uncovered pile
Shaded area indicates daily maximum — minimum air temperature
18 Oct
28
1 Nov
7
17
27
1 Dec
7
17
27

Fig. 3

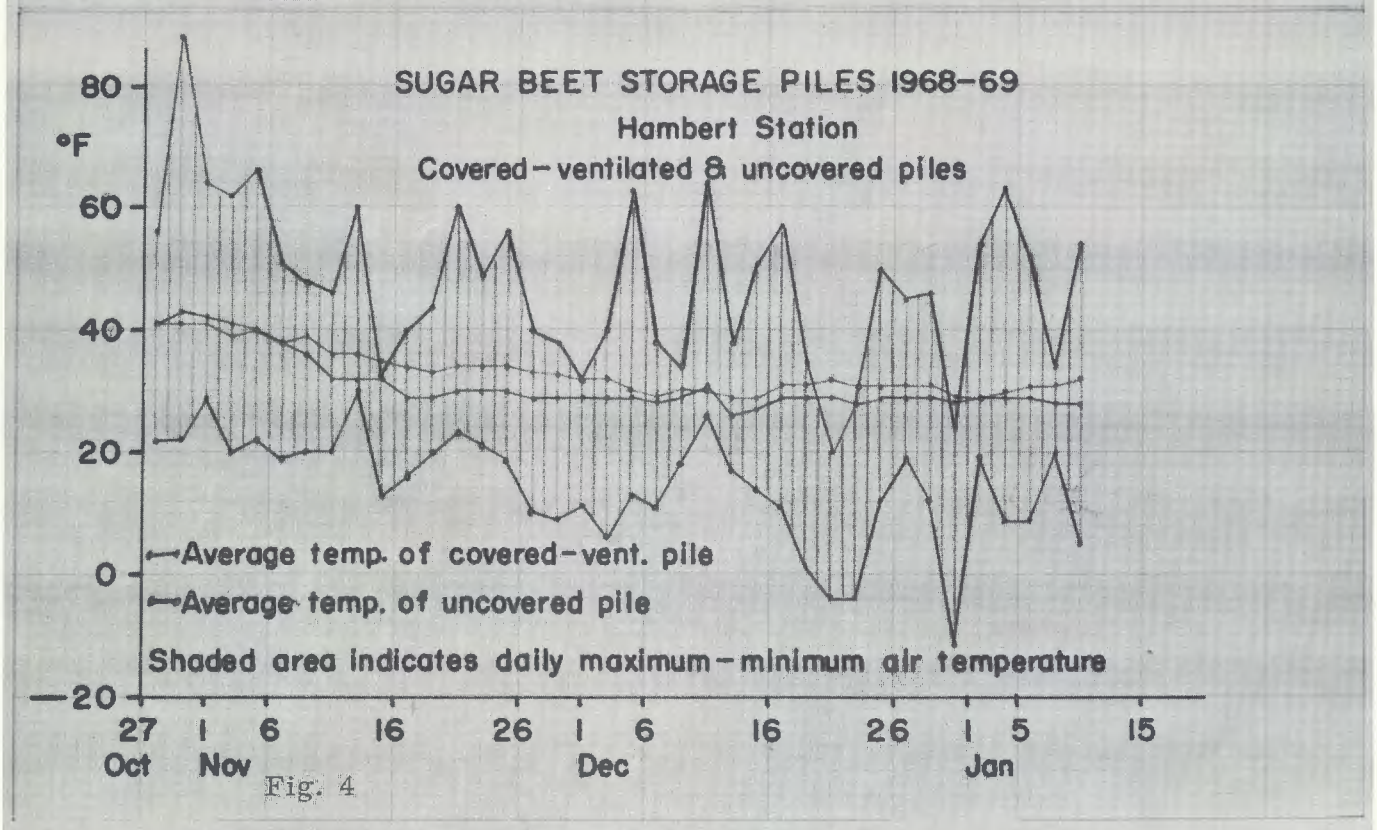
SUGAR BEET STORAGE PILES 1968-69
Hambert Station
Covered-ventilated & uncovered piles
°F
80
60
40
20
0
-20
Average temp. of covered-vent. pile
Average temp. of uncovered pile
Shaded area indicates daily maximum-minimum air temperature
27 Oct
1 Nov
6
16
26
1 Dec
6
16
26
1 Jan
5
15

Fig. 4

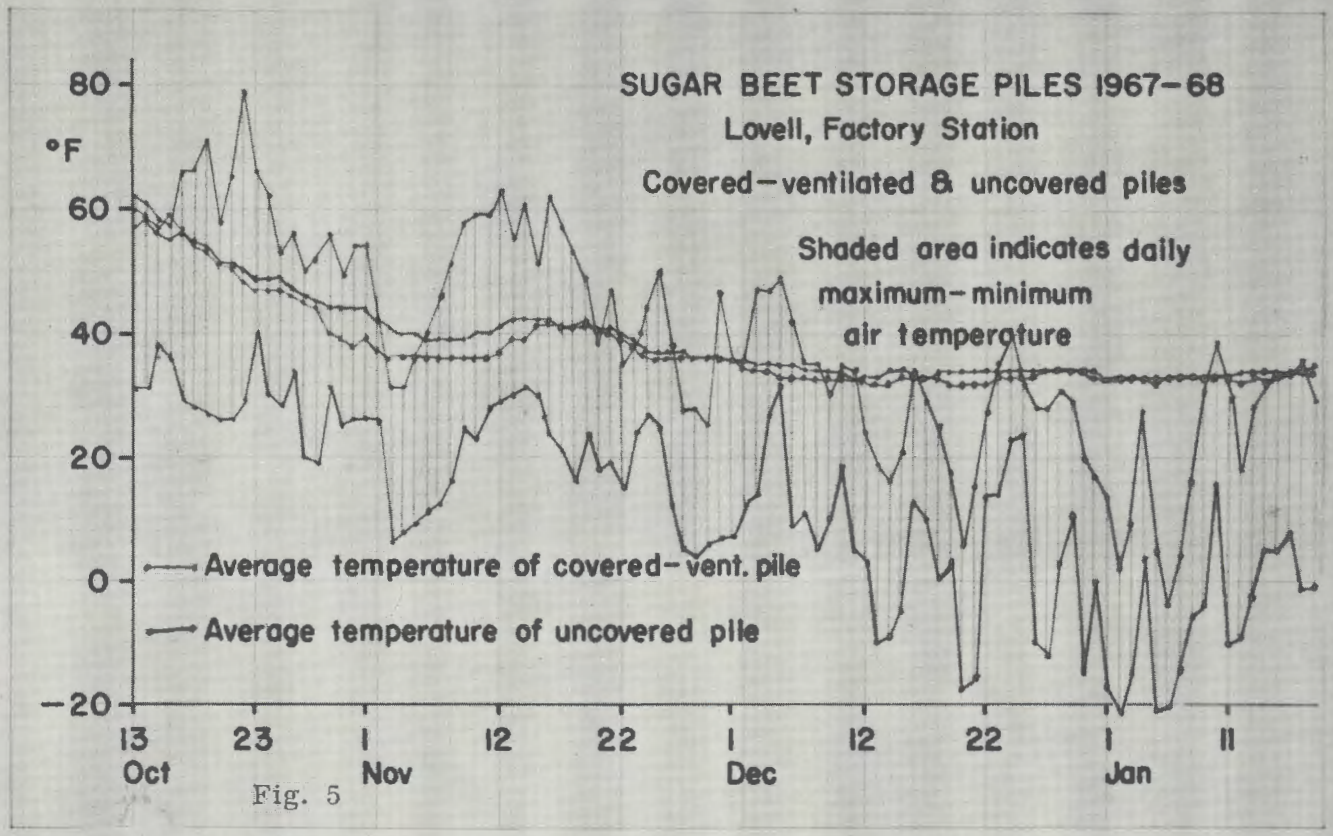
SUGAR BEET STORAGE PILES 1967–68
Lovell, Factory Station
Covered–ventilated & uncovered piles
Shaded area indicates daily
maximum–minimum
air temperature
°F
80
60
40
20
0
–20
Average temperature of covered–vent. pile
Average temperature of uncovered pile
13
Oct
23
1
Nov
12
22
1
Dec
12
22
1
Jan
11

Fig. 5

To try to determine the effectiveness of this program is an impossibility. Each manager has his own opinion of the results. The cost seem to vary from 6¢ to 8¢ per ton of beets. The only observation that was universal was that it was hard work. Except for that Wyoming Manager. The following points can be made, at least tentatively.

1. The piles do not freeze in as far when covered.
2. More sprouting occurs particularly with southern exposure.
3. The covered piles tend to freeze in the center. They appear to alternate warm and cold areas lengthwise in the pile.
4. Mold forms on the beets directly under the plastic. Whether or not this mold is harmful is unknown.
5. The rims are still rims whether covered or not. In the West particularly, dehydration takes place before covering can be accomplished.

The consensus is there must be a better way. Other methods of pile covering have been tried and are being considered for next year. In Ohio, straw was blown on the southern exposure with good success. It appears that two applications of straw may be even more beneficial. No binder seems to be needed to hold the straw on the sides. The most successful application of straw probably was at Findlay where the rim was removed before application. These beets seem to have kept the best.

In Colorado, a cellulose material was slurried with water and sprayed on the side of one pile. It would appear this method would cost about the same as plastic. This method will be tried again next year.

The reason other methods of pile covering are needed is that the Western territory is frequently subjected to high winds. Once this wind gets under the plastic, it soon tears it to shreds. This necessitates much repairing or recovering. It may be possible to cover the plastic with netting or snow fence to hold it in place. Also, on the south side of the pile, the warm sun during the fall days caused a "greenhouse" effect which was conclusive to mold growth on the surface beets.

For the next year in Ohio, plans are being made to wash and ventilate the beets for one complete circle pile. At Fremont, an underground ventilating system will be installed. It is contemplated to have outlets flush with the ground at 10 foot intervals. Under the conveyor belt of this circle piler, a washer will be installed that will handle the capacity of a 25 ton truck. The beets will be delivered in the same manner as presently. However, the excess dirt and trash will be removed in a washer of the Silver type. This washer has been selected because this piece of machinery will allow the maximum trash removal. For the dirt, captive samples will be inserted in the pile at frequest intervals. It is hoped these samples can be pre-selected in the fashion developed by Dexter & Frakes. Recirculated flume water will be used for washing with an application of treated water. It is estimated this installation may cost $250,000. A rather costly experiment.

Other avenues of approach have been used experimentally to determine respiration rates; one is the use of the Warburg apparatus to measure oxygen consumed on thin slices of beet tissue. This technique was reported by Wort and Shrimpton in 1958. And, is available to study respiration when suitable means of varying the respiration rate in beet tissue are found.

Larger facilities for controlling the atmosphere have also been built. Barrels that will hold 25 to 30 pounds of beets have been installed in a refrigerated room. Water saturated atmosphere of varying CO_2 concentrations is circulated through the drums, and semi-automatic control of the CO_2 or Nitrogen atmosphere can be maintained. An automatic CO_2 analyzer continuously records the atmosphere being passed through these drums. Excess CO_2 is absorbed in caustic on an intermittent timed basis. Hopefully the effect of controlled atmosphere can be evaluated.

In conclusion, it is anticipated that evaluation of semi-commercial and commercial piles with necessary laboratory studies will allow us to connect some conclusions about the storage of beets. These studies should help toward the reduction of sugar losses and improvement in processability.