

QUALITY AND SUGAR BEET STORAGE

By: Gordon Rudolph 1/

Storage pile quality has become an important factor in delivery schedules and factory processing in the Northern Ohio Sugar Company area. This importance is especially true at the factory located in Fremont, where all the sugar beets produced by area farmers are stored in one location. With a rather small slicing capacity at both Fremont and Findlay (1500 tons rated capacity at each plant), and a large volume of beets, long storage periods are quite common. The harvest of the crop usually starts late in September, however, temperatures do not allow stockpiling until the middle of October. Even with delayed piling, care must be used to protect beet quality with ventilation as storage piles are built.

Fremont is located inland from Lake Erie at 41°- 21 minutes latitude and an elevation of 640 feet above sea level. This latitude compares with 46°-36 minutes for Bay City, Michigan, and 39°- 45 minutes for Denver, Colorado. Bay City is 529 feet above sea level and Denver is 5,280.

The mean temperature for the month of October is 55.2° and the average maximum is 66.8°. The average low temperature is 43.7°. These figures are misleading since the weather pattern may produce three to five days of temperatures in the 80° range and night temperatures in the 60° range. Under such conditions, no cold air is available for ventilating systems to reduce temperatures of storage piles. With two row harvesters, growers are able to deliver 10,000 tons of the crop in a single day. In a few days, a month of slicing for the plant is on hand in storage piles.

To reduce risk of storage pile losses, piling is delayed until cool temperatures reduce root temperatures into the 45° to 55° range. If root temperatures move above this range, deliveries are stopped until the safe range is again present.

Losses from pile surface exposure to drying and freezing are also a factor in the eastern area. Frozen beets are more difficult to reload and convey into the factory and process once they have arrived in the factory. To reduce this difficulty and improve the quality of stored beets, a system of storage pile insulation was studied at Fremont, Ohio in 1961.

1/ Northern Ohio Sugar Company

MATERIALS AND METHOD - 1961

Approximately 600 tons of beets were stored in the factory pile from selected loads and before any freezing of tops occurred in the fields before harvest. A portion of one storage pile was covered with insulating material to prevent freezing and thawing of the exposed pile surface.

Two types of materials were used. One was a latex furnished by the Dow Chemical Company and the other a plastic covering and straw insulation. The latex was difficult to hold on the side of the storage pile and did little to protect the beets from freezing. The plastic film of 4-mill thickness was first placed over the sloping side of the pile. Two widths of the plastic were used. One 20 feet wide and the other 10 feet wide. Scrap lumber was used to hold down the plastic at the two ends of the 100 foot length pieces. The combined width of the two pieces was 28 feet and this width covered the sloping side of the pile. No covering or insulation was placed over the top of the pile.

Straw and asphalt was blown by machine over the clear plastic covering to a depth of 6 to 10 inches. A machine used to chop and mix straw with asphalt applied the insulation.

On November 6, 1961, twenty-seven tared beet samples were placed at three different depths in the insulated portion of the stored beets and another twenty-seven samples taken from the same grower's deliveries were paired with the trapped samples for weighing and sugar analysis at the start. The results of the comparison of these samples which were placed in the pile on November 6, together with the results forty-seven days later are shown in Table I.

(See following page for Table I)

COMPARISON OF SAMPLES FROM INSULATED PILE

SAMPLE	Total Weight into pile (11-6-61)	Total Weight out of pile (12-23-61)	Percent Sugar Out of Pile	Percent Sugar Of Paired
	<u>Number</u>	<u>In Ounces</u>	<u>In Ounces</u>	<u>12-23-61</u>
A1	298	287	13.5	14.5
A2	228	225	13.3	13.1
A3	241	239	13.7	13.5
A4	272	268	13.9	14.0
A5	248	245	14.6	12.9
A6	256	253	12.4	13.3
A7	191	189	14.3	13.8
A8	Lost	Lost	Lost	14.2
A9	270	268	13.4	13.6
B1	254	252	14.2	14.2
B2	220	215	13.5	13.6
B3	185	183	13.1	14.7
B4	269	266	13.2	14.2
B5	237	235	14.0	13.4
B6	222	221	14.5	12.9
B7	278	273	12.0	13.0
B8	239	238	13.6	14.9
B9	252	251	14.0	13.2
C1	175	172	15.3	15.4
C2	211	209	13.0	13.1
C3	192	188	14.0	14.1
C4	210	207	14.0	13.9
C5	253	248	14.9	14.3
C6	260	258	13.3	14.4
C7	168	165	14.5	12.7
C8	218	215	14.4	14.9
C9	Lost	Lost	Lost	14.3
AVERAGE	233.8	230.8	13.78	13.85

The samples identified with the letter "A" were placed about four feet from the top surface of the pile. The "B" samples were about eight feet from the top surface and the "C" samples about twelve feet from the pile surface.

It will be noted that during the storage period, the samples that were trapped, compared with the original weight, lost 1.28 percent in weight. No comparative samples in the untreated or check portion of the pile were available.

Temperature readings during the storage period are shown in Table II. It will be noted that readings were on the mild side and little freezing of the pile surfaces occurred. The insulated portion of the pile did not shrink or wilt from exposure to the weather. The straw remained in place and was easily removed when the beets were reclaimed. The plastic also kept the straw from mingling with the beets and causing difficulty in factory operations.

(See following page for Table II)

TABLE II

TEMPERATURE READINGS - 1961

<u>Date</u>	<u>STORAGE PILE CHECK AREA</u>							<u>INSULATED STORAGE PILE AREA</u>				<u>OUTSIDE TEMPERATURES</u>		
							<u>Avg.</u>				<u>Avg.</u>	<u>Max.</u>	<u>Mean</u>	<u>Min.</u>
Nov. 9	36	36	36	37	38	40	37					51	44	37
Nov. 10	34	34	34	36	39	39	36					62	51	40
Nov. 11	34	33	33	38	39	40	36					53	43	32
Nov. 13	50	46	46	47	46	50	48					59	48	36
Nov. 14	50	54	52	49	43	49	50					42	37	32
Nov. 15	50	56	52	50	54	56	53					41	37	32
Nov. 16	52	56	54	52	56	56	54	50	55	53	53	47	34	21
Nov. 17	53	56	54	48	50	48	52	50	53	48	50	24	19	14
Nov. 18	40	46	48	48	49	50	47	48	53	48	50	33	23	13
Nov. 20	34	36	38	40	47	41	39	48	50	49	49	40	32	24
Nov. 21	33	34	35	38	44	43	38	47	50	50	49	50	41	32
Nov. 22	34	35	34	46	41	46	38	45	49	48	47	58	47	35
Nov. 24	42	41	40	40	40	46	42	45	48	45	46	46	39	32
Nov. 25	41	42	42	38	40	46	42	44	48	43	45	32	30	27
Nov. 27	42	43	44	40	42	42	42	43	43	39	42	34	32	30
Nov. 28	42	39	41	41	41	42	41	41	42	38	40	36	30	23
Nov. 29	42	39	39	40	40	43	41	39	41	39	40	36	30	24
Nov. 30	34	34	35	38	40	42	37	40	42	40	41	36	32	27
Dec. 1	34	32	32	38	42	40	36	39	42	40	40	42	37	32
Dec. 2	36	34	34	38	42	40	37	40	43	42	42	47	40	32
Dec. 4	45	45	40	41	44	42	43	44	45	43	44	46	40	34
Dec. 5	40	45	44	38	40	37	41	42	45	40	42	45	41	37
Dec. 6	32	45	42	36	40	39	39	40	45	40	42	38	35	32
Dec. 7	33	36	37	36	38	40	37	39	45	39	41	33	31	28
Dec. 8	30	32	31	36	39	36	34	37	43	38	39	44	38	31
Dec. 9	30	30	30	33	39	35	33	37	41	39	39	44	37	30
Dec. 11	30	31	30	34	37	34	33	37	40	40	39	47	42	36
Dec. 12	32	37	30	35	37	34	34	37	40	40	39	48	42	36
Dec. 13	31	31	30	33	36	34	33	34	39	38	37	43	37	31
Dec. 14	30	30	30	32	35	34	32	33	37	36	35	45	37	28
Dec. 15	30	29	30	30	34	33	31	33	37	37	36	46	41	35
Dec. 16	38	30	29	30	30	31	31	32	34	36	34	54	46	38
Dec. 18	42	30	30	30	30	30	32	33	35	37	35	41	36	30
Dec. 19	42	31	30	31	30	30	32	35	37	37	36	42	34	26
Dec. 20	42	30	29	32	32	33	33	33	34	36	34	33	30	26
Dec. 21	38	30	28	33	30	33	32	33	34	36	34	36	28	20
Dec. 22	37	30	28	33	31	33	32	33	34	36	34	30	24	18

The record of temperatures indicates the insulated portion of the pile was more constant than the check portion. The insulated pile temperature was a little higher, also. This can be explained by the fact that outside temperatures did not affect the insulated pile as it did the pile with no protection. Winds could not penetrate this insulated pile and lower the interior pile temperature. In addition, no ventilating equipment was used to control pile temperatures.

In the following Table III is given information relative to the purity and sugar content of the insulated portion of the pile which was sliced in the first shift on December 23, 1961. The comparison with the remaining two shifts that were not treated shows slightly more sugar content and purity.

	<u>TABLE III</u>		
	<u>1st Shift</u>	<u>2nd</u>	<u>3rd</u>
Tons Sliced	588	580	528
Average Purity	85.0	84.3	84.6
Average Sugar Content	14.10	13.94	13.50

MATERIALS AND METHODS - 1962

Two separate piles of similar volume were built in 1962. The piles were started on October 17, and completed on October 19. Thermometers were installed and recordings made each day commencing October 19. Both piles of about 2,000 tons each were ventilated with two tubes spaced 25 feet apart. Each pile occupied a space of about 100 feet by 100 feet and was seventeen feet high. Tare samples were collected from each load to accurately determine the net pounds of beets placed in each pile and to compute the average percent sugar of beets in each test pile.

On November 2, the plastic film was placed over the sloping sides of the one pile and the straw-asphalt mixture blown onto the surface. Old discarded tires were used to hold the plastic on the upper and lower edge. The plastic used was 4-mill thickness, clear, and in sheets 32 feet wide and 100 feet long.

Ventilating of both piles was continued whenever outside air temperatures were below the thermometer readings inside the pile. When outside temperatures were below freezing, the ventilating was discontinued.

Temperature readings during the storage period are shown in Table IV:

(See following page for Table IV)

TABLE IV

Date	PILE "B" CHECK PILE							Avg.	PILE "A" INSULATED							OUTSIDE TEMPERATURES			
	Avg.	Max.	Mean	Min.	Avg.	Max.	Mean		Min.	Avg.	Max.	Mean	Min.	Avg.	Max.	Mean	Min.		
Oct. 19	60	64	56	56	58	60	59	56	60	62	63	62	64	61	68	55	43		
Oct. 22	60	68	63	59	61	63	62	60	63	62	68	60	65	63	57	47	38		
Oct. 23	59	64	64	61	59	62	62	59	65	59	69	55	72	63	64	50	36		
Oct. 24	51	60	61	60	53	52	56	56	60	58	66	50	55	58	49	38	28		
Oct. 25	47	54	53	57	46	47	51	50	54	48	62	43	50	51	43	34	26		
Oct. 26	43	52	48	56	40	40	47	48	49	39	59	39	40	46	41	31	22		
Oct. 27	40	51	44	51	40	32	43	46	47	41	56	40	34	44	39	29	20		
Oct. 28	41	44	40	44	43	36	41	42	43	45	51	39	35	43	55	40	25		
Oct. 29	43	49	42	48	44	40	44	46	46	42	50	38	40	44	68	50	33		
Oct. 30	41	44	42	46	44	40	43	46	45	48	48	40	42	45	50	42	34		
Oct. 31	42	44	40	46	45	42	43	46	46	43	47	41	44	45	47	37	28		
Nov. 1	43	44	41	44	45	43	43	46	45	44	46	42	46	45	46	38	30		
Nov. 2	43	42	43	43	43	44	43	44	45	44	42	43	41	43	51	43	36		
Nov. 5	44	42	45	48	44	44	45	48	46	44	46	42	45	45	44	38	33		
Nov. 6	41	42	43	49	43	44	44	48	46	43	44	42	44	45	47	34	22		
Nov. 7	43	44	45	49	43	46	45	47	48	45	42	44	43	45	48	36	25		
Nov. 8	42	44	45	48	43	44	44	48	46	45	47	42	44	45	49	42	35		
Nov. 9	43	43	46	50	44	43	45	49	48	45	50	44	44	47	50	43	37		
Nov. 12	46	48	46	48	48	48	47	50	51	46	48	46	46	48	45	39	34		
Nov. 13	45	48	47	50	45	49	47	50	50	47	48	45	46	48	42	34	27		
Nov. 14	44	48	48	50	45	48	47	50	51	48	48	45	47	48	49	37	26		
Nov. 15	45	48	48	50	44	48	47	50	52	57	48	44	47	48	50	39	28		
Nov. 16	46	47	47	49	46	47	47	50	51	48	46	46	48	48	56	46	42		
Nov. 17	46	48	47	48	48	46	47	50	52	47	46	45	46	48	49	46	43		
Nov. 19	42	46	46	46	43	46	45	48	49	47	40	42	43	45	40	32	24		
Nov. 20	43	45	45	46	42	46	44	46	47	47	36	44	40	43	41	33	25		
Nov. 21	43	44	43	46	40	42	43	48	43	46	39	42	40	43	45	39	34		
Nov. 23	42	48	43	40	40	40	42	44	46	49	32	44	44	43	36	29	23		
Nov. 26	40	44	41	42	40	36	41	46	35	46	34	40	44	41	45	32	19		
Nov. 27	41	44	41	41	40	37	41	44	35	47	34	43	43	41	47	34	21		
Nov. 28	42	42	42	40	42	37	41	40	35	47	34	42	40	40	49	34	20		
Nov. 29	41	42	42	39	42	38	41	39	35	46	36	40	40	39	53	37	21		
Nov. 30	43	43	45	44	40	39	42	40	35	45	37	40	39	39	58	40	23		
Dec. 1	43	42	44	42	40	37	41	40	35	45	36	40	39	39	60	41	22		
Dec. 3	42	43	44	43	40	37	41	40	38	43	37	40	39	39	60	40	21		
Dec. 4	42	43	43	42	39	40	41	40	39	45	38	40	40	40	60	43	27		
Dec. 5	42	42	43	42	40	41	41	40	39	45	40	40	40	40	59	44	29		
Dec. 6	39	42	42	42	38	40	41	40	40	42	41	38	38	40	41	34	28		
Dec. 8	39	42	39	38	37	33	38	40	33	39	34	37	39	37	27	24	22		
Dec. 10	39	42	35	38	37	33	37	40	27	33	30	36	35	34	22	15	8		
Dec. 11	39	41	35	37	33	30	36	42	27	30	29	35	31	32	17	10	3		
Dec. 12	39	41	34	36	33	30	36	43	27	30	29	34	31	32	14	11	-8		
Dec. 13	38	38	30	37	30	30	34	44	26	32	30	34	29	32	11	9	-7		
Dec. 14	38	37	31	36	30	30	34	44	26	34	34	32	29	33	19	10	-2		
Dec. 15	35	36	32	34	31	30	33	44	27	37	38	33	30	35	24	14	4		
Dec. 17	35	36	32	34	32	30	33	43	27	37	42	34	31	36	32	27	22		
Dec. 18	35	36	32	32	33	32	33	43	27	37	44	35	31	36	34	26	18		
Dec. 19	35	36	33	34	33	32	34	42	27	37	44	35	33	36	42	34	27		

Date	PILE "B" CHECK PILE								PILE "A" INSULATED						OUTSIDE TEMPERATURES		
								Avg.						Avg.	Max.	Mean	Min.
Dec. 20	35	36	33	34	32	34	34	40	27	35	42	35	32	35	43	34	25
Dec. 21	34	37	34	30	32	30	33	36	27	35	38	35	28	33	25	21	18
Dec. 22	34	36	34	31	34	30	33	35	27	35	30	35	29	32	28	25	22
Dec. 24	34	35	33	31	34	30	33	38	26	36	30	32	31	32	23	12	1
Dec. 26	33	34	31	32	31	30	32	40	26	35	30	32	31	32	33	23	13
Dec. 27	32	34	32	32	31	30	32	42	26	34	30	32	30	32	18	13	-8
Dec. 28	31	32	31	32	31	30	31	42	26	34	30	32	30	32	18	10	-3
Dec. 29	31	32	32	31	31	30	31	42	27	35	30	32	31	33	35	23	11
Dec. 31	30	31	31	30	30	30	30	41	25	34	30	30	30	31	16	8	-1
Jan. 2	29	31	32	30	30	30	30	40	25	35	44	32	30	34	19	10	-1
Jan. 3	29	31	32	30	30	30	30	39	26	34	42	32	30	33	26	15	-4
Jan. 4	30	34	32	31	31	30	31	38	26	30	43	33	31	33	31	26	22
Jan. 5	31	32	33	31	31	30	31	38	26	35	44	33	31	34	33	29	26

MONTHLY AVERAGES 1961-1962

	1961-62	1961-62	1961-62
	<u>MAXIMUM</u>	<u>MEAN</u>	<u>MINIMUM</u>
OCTOBER	53	41	30
NOVEMBER	43	47 36	28 28
DECEMBER	42	32 37	31 13
JANUARY	27	20	11

COST OF EXPERIMENT 1961-1962

Expenses for the storage pile insulation are listed below.

<u>ITEM</u>	<u>1961</u>	<u>1962</u>
Labor hauling straw and feeding blower	\$ 15.12	\$ 81.47
Hauling and placing old tires		22.40
Blower rental and asphalt	22.60	109.60
Straw	31.20	51.00
Clear plastic, 4-mill. Thickness	25.43	86.16
Removing straw and plastic		57.20
Freight	4.41	
TOTAL	\$ 98.76	\$407.83

In 1961, one hundred feet of pile length was insulated and in 1962 the perimeter of the insulated pile was about 360 feet.

In Table V, the results of the relative purity and sugar content of the insulated pile and the check pile sliced on January 9, 10 and 11 are given. The length of storage for the two piles was 82 days.

TABLE V

	<u>INSULATED PILE A</u>	<u>CHECK PILE B</u>
TONS PLACED IN PILE	2010.4	1829.3
TONS SLICED OUT OF PILE	1980.0	1822.1
TONS DIFFERENCE	30.4	7.2
PER CENT SHRINK	.0151	.0058
PER CENT SUGAR INTO STORAGE PILE	15.99	15.74
PER CENT SUGAR OUT OF PILE	15.35	14.56
DIFFERENCE IN PER CENT SUGAR	.64	1.18
PER CENT SUGAR SHRINK*	5.453	7.859
COSSETTE PURITY	85.40	85.45

* Based on difference between pounds of sugar into pile and pounds calculated out of pile.

RESULTS OF THE TESTS

Temperatures during the 1961 test were quite mild and there was little freezing of the pile surfaces. In 1962, temperatures were much lower and storage pile surfaces became frozen. The insulated pile did not freeze to as great a depth as the unprotected check pile. Depth of pile freezing was greater on the north and west surfaces exposed to prevailing winds in both piles. Little freezing occurred on the east and south sides of the insulated pile.

Both the insulated and check piles had less growth of sprouts from crown buds than other storage piles. This is no doubt due to the greater circulation of cool air through the smaller pile mass.

Wilting of beets on the pile surface was reduced by the insulation. Weight shrink differences in the two piles was small and not significant. Sugar shrink was greater in the pile not protected with insulating material.