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Sugarbeet Injury

A Significant Factor in Loss of Sucrose

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Like other perishable agricultural commodities, sugarbeets deteriorate in storage. The general estimate is that beets lose about one-half pound of sugar per ton per day of storage, or 50 pounds of sugar per ton of beets during a 100-day storage period.

When sugar is 12 cents per pound, this loss amounts to $6 per ton for the 100-day storage period. If average yield is 20 tons per acre and growers receive 60% of the value of the sugar, then the loss amounts to $72 per acre to the grower, $48 per acre to the processor.

We can never hope to eliminate storage losses but we can reduce them by careful harvesting and handling. This is true even when beets are to be processed immediately after harvesting. As Fig. 1 shows, sugar losses are high initially, decrease gradually as the beets are held in storage and then gradually increase toward the end of the storage period. The top line in Fig. 1 indicates sugar loss from beets in poor condition when they went into storage; the bottom line, losses when beets were in good condition for storage.

A series of studies were conducted by the University of Idaho and cooperators in 1975 and 1976 to determine the extent of injuries to sugarbeets during harvesting and handling, and the effect these injuries have on sugar losses. Mechanical damage was evaluated by several methods — by measuring sucrose and impurities in storage, by measuring respiration and by visual assessment. These studies help to point out the problem areas where mechanical injury is most severe and where immediate steps can be taken to reduce sugar losses.

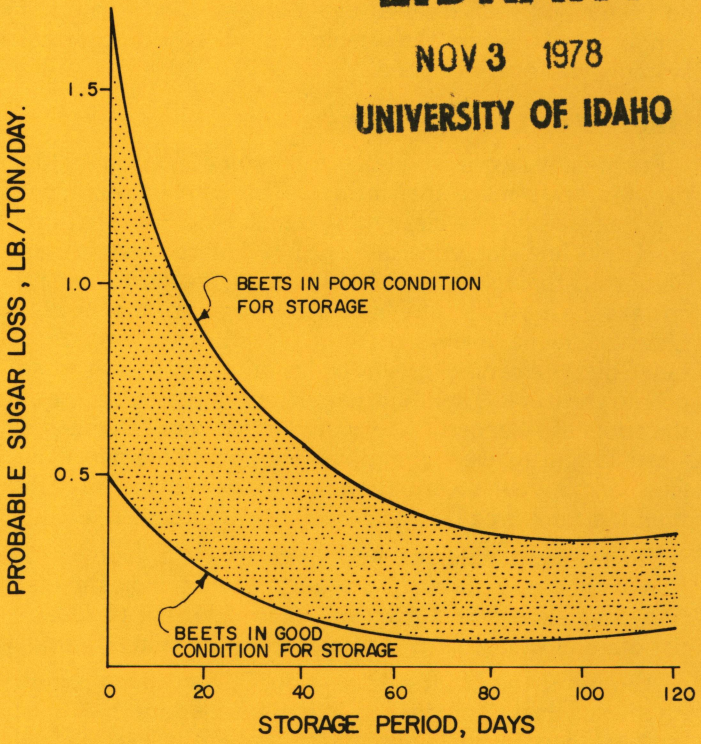

Fig. 1. Probable range of sugar losses expected in typical sugarbeet storage conditions.

Harvest and Handling Damage

The University work clearly demonstrates that handling systems now in use severely damage beets, resulting in high sugar losses during storage.

In a 1975-76 storage study, beets that were untopped, hand-harvested, damage-free and treated with a fungicide lost less than 0.13 pound sugar/ton/day during 140 days in an environmental storage chamber. Beets that had been mechanically harvested, piled with conventional equipment and treated with a fungicide lost 0.4 pound sugar/ton/day; mechanically harvested and piled beets without the fungicide treatment lost 1.1 pounds sugar/ton/day.

Damage levels increase at each step of the handling system. By the time beets are in the storage pile, each beet will have several damaged areas as Tables 1 and 2 show.

Table 1 compares a bruise damage index during harvesting and handling with both a tank-type and lifter-loader machine in the Twin Falls area in 1976. Note the increase in damage index from field to pile. Table 2 shows the average respiration rate of beets that were hand-harvested and undamaged compared with beets harvested and handled by machine and beets with artificially induced damage. Note that the highest rate of respiration, and therefore the highest sugar loss, comes from beets collected from the piler. Beets from the top of the truck had the same respiration rate as those dropped 8 feet onto a concrete floor.

Damage and Tare

Are sugarbeets damaged excessively in the cleaning process? The 1976 tare studies suggest that they are. As part of the work at Twin Falls, beets were dug by hand and sent through the piler with no prior cleaning. The tare on these examples was as low as tare on beets cleaned on the harvester and then cleaned again on the piler. From the conditions of this test, the cleaning ability of the mechanical systems was over-designed.

Harvester Comparisons

Preliminary work suggests that some harvesters do damage beets more than others. The difference is most likely caused by the cleaning systems. Machines that use steel rinks and star wheel damage beets more severely than harvesters that use grab-rolls. In general, the more cleaning rollers and rinks, the more damage to the beets. Lifter-loader harvesters show increased damage to roots taken off the cleaning screens and another increase as roots go into the truck. Tank-type harvesters increase damage as the roots are cleaned and elevated to the tank. Damage is also different between the top and bottom of the tank. The lifter-loader machine is inherently a lower damage machine than the tank type because the roots are handled less.

For normal conditions, all harvesters do a good job of removing dirt. However, our tare studies indicate that harvester cleaning actually isn't needed except to reduce the amount of dirt carried to and from the piling ground.

About one-third of the damage during harvesting occurs on the cleaning screen and lifting wheels, another third while moving the beets from harvester to truck and the final third while moving them from truck to pile. Large drops to the bottom of the tank or from harvester to truck can increase damage at those points, however. One study also showed that previously undamaged beets received about two-thirds as much damage from the piler alone as from the complete mechanical system.

Temperature and Damage

Both laboratory and field experiments show that beets become more susceptible to damage as root temperature decreases. When beet temperatures drop below 40 F, damage to beets going into storage will greatly increase. Fig. 2 shows bruise damage caused by dropping a weight on beets at temperatures from 32 to 70 F, and Fig. 3 shows the bruise index of samples taken from piler and truck at different temperatures. Beets taken from the top of the truck had no temperature-bruise differences, but beets taken from the piler showed one-third more damage at 35 F than at 44 F.

Table 1. Sugarbeet damage at various points in harvesting and handling system, Twin Falls storage study, 1976.

Sampling location	Bruise index*
Untopped check sample	0.46
Topped check sample	0.5
Off rollers, lifter	8.47
Top truck tank	11.5
Top tank	11.93
Bottom tank	15.12
Hand-dug, through piler	17.01
Top truck lifter**	32.72
Off pile lifter	33.75

*Bruise index is a total damage evaluation that includes weighted scores for slight, moderate and severe damage to roots and broken root tip.

**Damage level of beets taken off the top of the truck was unusually high because the harvester operator was straddling a guess row when samples were taken. This damage did not show when samples were collected but was obvious after 151 days in storage.

Table 2. Effect of harvest and handling damage on respiration rate of sugarbeets in storage, Moses Lake, 1976.

Sampling location	Respiration rate*
Topped check sample	3.37
Untopped check sample	3.54
Artificial damage – gouge**	3.68
Partial machine-topped	4.04
Hand dug, off piler	4.35
Artificial damage – impact**	4.55
Top of truck	4.56
Off pile	4.85

*Actual CO_2 respired during days 54 to 68 of storage.

**Damage artificially applied to beets. In gouge treatment, roots were given three gouges from 1 to 1¼ inches deep and 1¼ inches in diameter; in impact treatment, roots were dropped from 8 feet onto concrete floor.

Reducing Harvesting and Handling Damage

The technology is available to improve the sugarbeet handling system by reducing damage while still maintaining a high cleaning efficiency. The three chief causes of damage to roots while harvesting and handling are:

1. dropping or throwing the roots;
2. striking or scraping the roots with a moving part of the machine;
3. handling beets when cold.

Improvements to the harvesting system should seek to minimize these factors. Following are several suggestions for improving beet harvesting and handling:

1. Handle beets when root temperatures are above 40 F. Harvesting later in the day and continuing later in the evening is better than early morning harvesting. Since the beet harvest occurs late in the fall and harvest time is limited

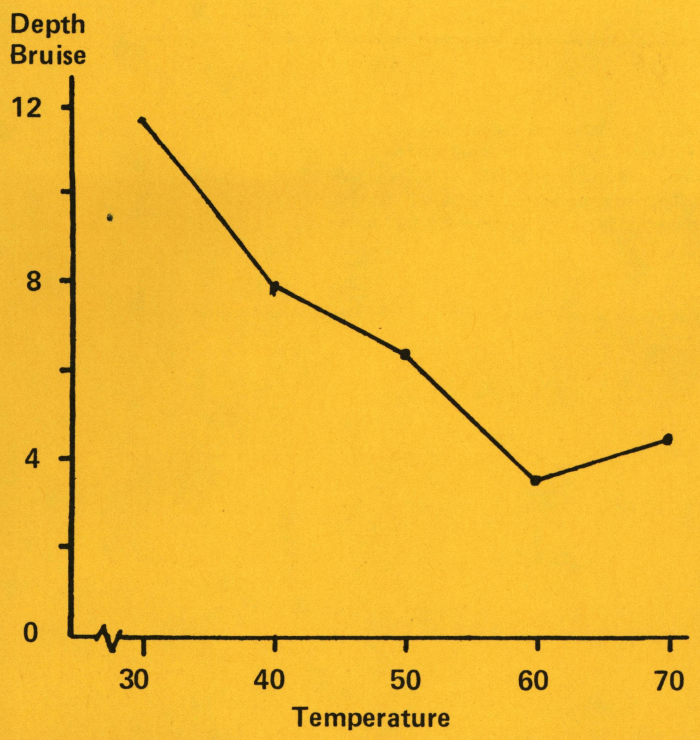

Fig. 2. Effect of root temperature on damage in controlled impact test. Researchers dropped a 4.41-pound spherical plug on sugarbeet from a height of 2 feet.

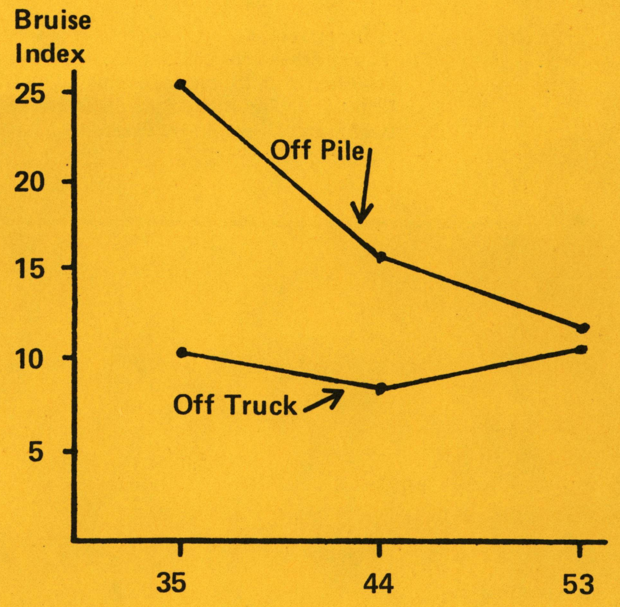

Fig. 3. Effect of root temperature on sugarbeet damage during harvesting and handling.

by weather, stopping harvest because of low temperatures generally is not feasible. Therefore, compromises will have to be made. Improve where possible. Begin earlier or obtain additional harvester capacity. Factories can process badly damaged beets earlier by monitoring temperature and damage and scheduling the poorer beets first.

2. Use only enough cleaning on the harvester to remove excess dirt. In most lighter soils the beets will end up in the pile just as clean with little or no pre-cleaning. Eliminate sharply pointed, rough cleaning systems in favor of grab-rolls or potato chain. Most beet harvesters have been designed with little consideration for handling the beets carefully.

Steel flights, abrupt direction changes, high internal chain speeds, on-board tanks, fixed position booms all contribute to higher than necessary damage. In changing the harvester design, consider using rubber flights, shorter drops, movable boom extensions and cleaning systems designed for the soil conditions. When unloading tank-type machines, leave a cushion of beets in the bottom of the tank.

3. Many researchers feel that cutting off the crown is detrimental to sugarbeet storability. Storage and processing of uncrowned beets should be given more consideration.

4. Unloading systems presently require the piler hopper to be emptied following each truck so (1) the grower can retrieve his own tare dirt, and (2) a tare sample can be taken. In so doing the advantages inherent in continuous flow are lost. Less beet damage would occur if tare samples were taken as the truck unloads into a partially filled hopper and the piler were kept full with a continuous flow of beets. All drops would then be reduced to a minimum. A secondary advantage would be about a 10% improvement of throughput for the piler, since trucks would not have to wait while the piler is emptied. Tare dirt could then be hauled away by dump trucks.

5. Beet trucks should be used which allow for a minimum drop into the hopper. Back dump trucks appear to be best, with side dumps second. Trucks with unloading drag chains cause considerable beet damage. They have been observed dropping every beet the full truck height into a continuously empty hopper with each beet consequently receiving considerable damage.

6. Cleaning systems on the piler should be designed to reduce damage. This is an area which needs considerable work before an adequate solution can be found. The cleaning system itself should be adjustable to meet existing conditions. In areas where the soil is very sandy, very little cleaning should be needed under normal conditions. Criterion on how dirty beets can be and still be safely piled should be established. There should be enough rollers and, if need be, rubber rinks added to the cleaning system to meet but not exceed cleaning requirements. It does unnecessary harm to over-clean beets. Since cleaning is related to damage, the piler is the logical place to control the amount of cleaning done to the beet — not on the harvester.

A good system should also contain a back-up system for muddy beets. This could be as simple as directly processing the muddy beets or adding a quick attach auxiliary cleaning system to the piler. Current systems are designed for the most adverse conditions and because of this beets are excessively damaged 95% of the time. The system should be designed for the least damage under normal conditions and should have an auxiliary system for the small percent of time when conditions are bad.

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