ONTARIO SUGARBEET PILE RECOVERY INNOVATION PROJECT

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Introduction:

An innovative method to load transfer beets from large permanent beet piles has been successfully operating for Michigan Sugar Company at the Dover (Canada) beet receiving station since 2007. The new loading method utilizes a Maus (mobile beet loading machine built by Ropa of Germany) that was adapted to load trucks out from large sugar beet piles thereby eliminating the need of a large wheel loader.

The Maus is a machine built to recover (load) and clean small sugar beet piles from farm fields; a typical practice in Europe. The Maus machines used in Europe have a header (much like a combine) that picks up and cleans sugar beets from farm fields, a grab-roll screen (much like a sugar beet piler) that cleans out soil and debris and a conveyor (similar to a piler boom) that can move in almost any direction to convey beets up and into trucks.

The first Maus came to North America in 2002 to complement the unique beet field storage system in the Lambton, Ontario growing area. Since that time, two other Maus machines have been put into service in other Michigan Sugar Company growing areas for loading and cleaning field piled sugar beets. In the summer of 2005, a prototype header to recover piled beets from large long term storage piles was built in Canada by John Noorloos, a Michigan Sugar Company shareholder. This header was built to accommodate the large volume and mass of long-termed stored sugar beets; a totally different application than the stock header that comes with the Maus from its German manufacturer. The prototype header was tested at the Dover, Ontario sugar beet storage yard in 2005 and 2006 with very favorable results. Recovery of the beet pile was around the outside exterior (or pile shoulders) of each pile instead of recovery from the ends of each pile (the common industry-wide practice).

Background:

In January of 2007, the Maus was used to load all transfer loads for a 15 day trial period at the Dover, Ontario beet storage site. During that time 32,012 tons of beets were loaded out and over 2000 tons of excess soil was screened out by the Maus. The freight savings alone from not shipping the excess tare soil was $19,788.50. Besides a significant savings in freight costs, it was realized how beet storage benefited by pile shoulder removal and how factory performance could be impacted from this system.

Michigan Sugar Company partnered with Ropa North America in the summer of 2007 by entering into a three year lease of a new Ropa Maus. Company employees were trained to operate the machine and daily manage the transfer operation. The entire Dover receiving facilities 2007 and 2008 sugar beet crops have been successfully loaded out with the Maus machine.
Objectives and Results for the 2007/2008 Campaign:

A) Remove excess soil from the sugar beet pile while loading the trucks at the Dover Centre facility.
   - 8,664.20 tons of tare (soil and plant material) was removed.
   - The 8664.20 tons represented 4.9% of the entire stored sugar beets.
   - Use of an auxiliary wheel loader was needed to “clean-up” tare on a daily basis.
   - Fuel and labor were an extra cost.

B) Less soil transported means less fossil fuel consumed and freight cost reduction.
   - Freight saved was $97,905.46 since tare was not shipped. The freight savings equated to 206 less trucks traveling a round trip of 130 miles for each load.
   - Over 26,000 liters of diesel fuel was saved.

C) Maus system to reduce sugar beet root damage.
   - Less root damage occurred at the machine header when compared to the loading bucket of a wheel loader.
   - Some root damage was created at the final loading conveyor of the Maus machine which was not expected. This area will be addressed in the future.

D) Removed tare composted or returned to environment.
   - Most of the tare returned to adjacent farm as a soil enhancement.
   - Studies are needed in subsequent years to determine level of enhancement and possibly if over concentration would be an environmental concern.
   - Some form of composting is being considered.
   - Tare disposal costs were $10,840.10 or $0.06 per ton if beets piled.

E) Sugar beet pile shoulder removal before deterioration occurs.
   - Typical industry-wide procedure for pile recovery is from pile ends by wheel loader. This method does not address the sides of each pile that is subjected to freeze-thaw cycles if the typical winter. Pile sides deteriorate rapidly and are mixed with interior of the pile throughout the typical process.
   - The innovative pile recovery project utilizes the Ropa Maus to recover pile shoulders continually; the machine works around the outside of each pile in a circular pattern.
   - As shoulders of piles are “loaded out” deterioration is minimal thereby supplying better quality raw material to the refinery.
   - As part of the research segment of this project, pile shoulders of one area of Pile #1 were not recovered until January 28, 2008. The reason for leaving this pile section alone was to analyze the shoulder and let samples within the pile stay for storage comparison analysis. Analysis showed a drastic reduction in Juice Diffusion Sugar Percent and an extreme increase in Factory Lime Salt Concentration (an indication of beet deterioration).

F) In November of 2007, sugar beet samples were placed in mesh bags and those bags placed in well ventilated mesh cages. The cages were placed near the base of the pile and covered with loose piled beets. Groups of sugar beet samples were removed throughout the recovery campaign following the Maus machine activity; a path of loading out the crop from the exterior (or shoulder) of the piles. A section of beet pile #1 was left intact until the end of the recovery campaign (no shoulder removal).
Beets tested from piles that had been recovered all season from the Maus machine tended to have significantly higher quality and less sprouts from re-growth.

Research found that pile management had a large impact on beet quality over time. After 104 days of storage (February removal date), when beets from the “intact” pile were compared to beets from the pile which had the shoulder (rind) removed, weigh loss was significantly less, presumably due to reduced pile ventilation. However, purity, sugar content and resulting RWST were all significantly reduced in the “intact” pile. This suggests that continual rind removal maintains sugar quality in beets stored in large piles.

In summary, the analysis from February samples showed dramatically higher purity, % sugar, and RWST (recoverable white sugar per ton) of the sugar beets that were recovered from stripped piles (Maus) versus sugar beets from the intact pile. Increases in purity were 3.7%, sugar of 1.0%, and RWST of 38.80 more pounds of recoverable sugar per ton of beets processed.

This data substantiates the theory that pile shoulder removal would be a superior way to recover sugar beets from long-term storage piles. Reducing or slowing down the process of root respiration by pile shoulder removal potentially allows more sugar to be available for extraction at the processing refinery.

Reduced contamination and factory maintenance costs due to less soil being received with the transferred sugar beets at the sugar refinery.

- Since 8,664.20 tons of tares were segregated out of the sugar beet piles at the Dover Centre yard, we can directly calculate the disposal cost savings realized if this material would have been shipped to the refinery.
- Before the sugar beets are processed at the factory all soil, stones and vegetative material must be removed.
- The 8,664.20 tons not shipped to the factory saved at least $45,000 in direct disposal costs.
- During each twelve hour period that the Dover sugar beets were delivered to the factory a slight productivity gain was observed.
- Factory officials’ evaluated degree of factory wear to the plants “beet end” since a substantial amount less of tare was received with the Dover beet delivery; results were difficult to quantify.
Reduced damage to the Dover beet pile yard with the use of the Ropa Maus.

- The use of a wheel loader to recover sugar beets from long-term storage piles causes excessive damage each season to the gravel pad or base under the beet piles. Both the loader bucket and four wheels of the loader create an aggressive activity.
- The Maus use showed very little damage to the yard surface since the machine moves slowly and the header floats on the yard surface.
- Wheel loaders usually load out a significant amount of gravel surface with each load of beets. This activity creates unnecessary costs by "shipping out" gravel, paying freight on that gravel mixed with the beets and causing extra costs for removal of this gravel from the sugar factory.
- Observation of yard condition after beet recovery shows very little yard damage and better preservation of the gravel surface after Ropa Maus recovery.

Other benefits realized after the first year of this recovery project.

- All frozen chunks of sugar beets are broken apart when entering the Maus. Wheel loaders have difficulty breaking up chunks and usually load many large chunks which greatly hamper the factory’s productivity.
- The truck loading process is much safer for both men and machines with the Maus system.
- Unloading of trucks at the sugar plant is safer since the excess tare and snow was removed at time of loading by the Maus. Excess tare or snow in truck loads can freeze to the beet load and truck sides causing unsafe dumping conditions.

Objectives and Results for the 2008/2009 Campaign:

A) To analytically measure the impact of two different beet pile environments on storage losses (sugar loss due to degradation). Compare the traditional method of pile recovery (using wheel loader) to that of the Maus recovery system for a second year. This study was carried out much like the study from the 2007/2008 campaign; results were not yet available as of this submission.

B) Removed tare composted or returned to environment.

- Tare soil and crop residue that was hauled and spread to the adjacent farmland for the 2007/2008 storage campaign created no known problems or concerns. Company officials elected to not have a crop of any kind grown on the farmland during the 2008 growing season. Some of the residue was not uniformly spread out and could have possibly caused crop damage. After the season, we can surmise that no crop damage would have taken place and the farmland has probably been enhanced from the organic matter being placed there.
- Monitoring of the tare will continue so that over concentration will not have an environmental impact.
- During the 2008/2009 campaign a more concerted effort was put forth to have the tare material spread on a regular basis. A local grower was utilized to daily spread the material with a specialized truck.
- Some forms of composting are still being considered.
C) Reduced contamination and factory maintenance costs due to less soil being received with the transferred sugar beets at the sugar refinery.
   • Factory officials evaluated degree of wear to the plants “beet end” since a substantial amount less of tare was received with the Dover beet delivery. Significant less factory “beet end” wear was difficult to observe since the volume of beet flow from the Dover site represents only about twenty-five percent of the entire factories supply.
   • A significant less quantity of accumulated tare soil was observed by factory officials in the refinery’s soil settling ponds. The cleaning activity of the Maus recovery system was responsible for this reduction. Less soil in settling ponds reduces environmental impact, reduces cleanout operations, reduces costs, and reduces equipment to harvest and haul away the tare material.

D) Reduced damage to the Dover beet pile yard with the use of the Ropa Maus.
   • Observation of yard conditions after beet recovery showed very little yard damage and better preservation of the gravel surface after Ropa Maus recovery.
   • Condition of the gravel yard surface was the best it had ever been when the spring thaws were complete. In the summer, some minor grading and shaping were done. Very small amounts of gravel patching were required.
   • Past beet storage seasons were very hard on the gravel yard surface due to the constant damage caused by the heavy wheel loader equipment that loaded out each crop. Large quantities of gravel had been purchased each year to repair the damage from the past practices.

E) Use of an in-line weigh scale on the Maus to reduce labor and overweight trucks.
   • The technology of the in-line scale was perfected with the Ropa Company of Germany and placed on the market in 2008.
   • Michigan Sugar Company (Canada, LTD) purchased the scale system in September of 2008. The scale system was installed by Ropa North America and ready for use in the new season.
   • The weigh system proved to be very accurate and was used for every load.
   • The use of the weigh system was not able to replace a truck scale since an onboard printer was not available. A printer is required when scaling trucks so each driver has a printed document of his prospective load.
   • Future correspondence with Ropa of Germany will include suggestions to integrate a printer with the weigh scale.

**Activities and Methodology:**

A) Reduction of Ontario growers’ freight costs.
   • Since the Ontario growers ship their sugar beets a long distance and across the Canadian/U.S. border, their shipping costs are the highest of all growers within their cooperative. All cooperative shareholders are responsible for fifty percent of their direct freight costs; thus the Ontario grower has by far a larger freight expense.
A direct and tangible reduction in freight cost was the 8664.20 tons of tare segregated by the Ropa Maus in the 2007/2008 sugar campaign. The 8000 plus tons of tare was material contained in the beet piles that were usually shipped with the beets using the conventional industry wide wheel loader beet recovery system. The tare that was not shipped was a freight savings of $97,905.46.

The 8,644.20 tons of tare removed from the Dover sugar beet piles represents 4.9% of the entire 176,821.02 tons of beets piled at the Dover facility.

B) Reducing sugar beet storage losses at the Dover facility was regarded as a high priority for Ontario sugar production. Accomplishing this major hurdle for the Ontario growing area will be very important for the sustainability of sugar beet storage in this region. Historically, the beet storage at the Dover facility has been unfavorable to maintain a viable industry in Ontario. From years 2004 through 2006, the Canadian sector of Michigan Sugar Company has lost over $4.5 million worth of revenue due to beet storage losses. Recent climate trends with warmer and more volatile weather patterns have made it increasingly difficult to store sugar beets long term. It has been long known that ventilation of sugar beet piles improves beet storage and therefore sugar recovery. Observations of the progression of the 2005 pile shoulders (rinds) in particular clearly illustrated its effect on the storability of beet piles. Rind degradation restricts air flow, traps heat and increases respiration. Conversely, removal of the rind should promote natural air flow, preventing heat build up and keep respiration to a minimum. This practice also allows better recovery of sugar from the rind itself.

The Ropa Maus recovery system has proven in its first year to be of high value in the way it recovers beets out of long term storage piles. Since the Maus travels a circular (or rectangular) path around each pile as it loads and cleans, a natural form of ventilation is created. Typically, the pile shoulders are exposed to the elements much more than the interior of the large sugar beet piles. In addition, the outside shoulders (about 30 feet deep) contain more loose soil, vegetative material and beet fragments than the interior of the beet piles. Since the Maus recovery system removes the pile shoulders (or exteriors) first, greater sugar recovery has been observed. Not only does pile shoulder removal increase ventilation, the continual exterior pile removal of areas subject to freeze/thaw cycles has proven to greatly benefit sugar quality and reduce impurities at the sugar refinery.

Use of the Maus system to recover long-term piled sugar beets at the Dover facility proved very effective in creating a natural flow of fresh air ventilation into and out of the beet piles.

Data obtained through analysis by the University of Guelph Ridgetown Campus substantiated and supported anticipated benefits of the Maus system. Since the 38.80 RWST was available at the end of the storage season in February, we can conservatively conclude that the benefit from the Maus system would impact the last 50% of the sugar beets stored at the Dover facility by that level. If the impact of the Maus system continues with such dramatic results in sugar recovery then we can conclude that this system will be sustainable and be attractive to any area of North America that places sugar beets in long term storage.

C) Dover Direct: An innovative way to reduce grower’s freight costs. The importance of reducing Ontario growers’ freight costs was one of the main objectives of this innovative
sugar beet project, therefore new ways of doing the business were created and evaluated. Since the Ropa Maus that was available to the Ontario growers is a mobile machine company officials developed a program to bring the loading system directly to the farmer. Dover Direct was created to eliminate grower trucking expense from the farm. In August of 2008 the Dover Direct program was presented to company shareholders. The program allowed certain grower fields to be harvested and field piled therefore bypassing the need for grower trucks to deliver their crop to the Dover facility. Details of Dover Direct follow:

- Growers were allowed to harvest certain approved fields and place crop in field piles for Maus loading.
- The Ropa Maus moved to fields and loaded transfer trucks for direct factory delivery.
- Grower trucks were not used so fuel, labor, and all local field trucking costs were eliminated. Estimated savings to growers was $150,000.
- The Dover facility was idle from the first day of harvest (September 17, 2008) until October 20, 2008. This eliminated havoc of early delivery lines of trucks, labor, piling equipment wear, electricity, road wear, and traffic throughout the municipality. Estimated savings to the Co-Op was $70,000.
- A novel lottery system was used to determine grower’s eligibility for field selection harvest.
- Piling sites were approved before harvest began to allow efficient field Maus loading.
- Several meetings with the municipality’s Public Works Division were held to secure approval for roadside loading.
- Safety was promoted; Dover Direct was deemed very safe by the public.

Discussion of the Project Benefit:

A) This innovative project will directly enhance sugar quality, long-term sugar beet storage, sugar recovery and ultimately generate more funds for sugar beet growers. This increase of farm gate receipts will also benefit the local economies where these growers live and work.

B) Since the system is proving itself on sugar beet pile storage improvement, it has value by reducing pile deterioration. A reduction of beet rot will have less negative environmental impact by the reducing the discarding of rotten beet tissue.

C) The project is moving forward with improvements in the sugar business that are more than was expected. The Ropa Maus is an amazing machine that is being adapted to new areas that were never foreseen. Documented data from the University of Guelph study that shows large increases in sugar available for refinery extraction using the pile shoulder removal path that the Maus follows. The future looks brighter than it did just a few short years ago for the Ontario area that has had its challenges with high freight costs and beet storage problems. The Ropa Maus system is now being utilized in other areas of the Michigan Sugar Company to improve storage quality and sustainability of the industry.