

**TITLE OF PROJECT:** Evaluating potential damage to sugarbeets caused by harvesting and piling equipment using an Impact Recording Device

**NAME OF CONTRIBUTOR(S) AND THEIR AGENCY:**

John Zandstra and Rob Squire, University of Guelph, Ridgetown Campus. Ridgetown ON. N0P 2C0

**BACKGROUND:**

As harvested, topped sugar beets are stored, sugar is lost due to respiration (consumption) by the living beet root. Mechanical injury affects storage losses of beets because of increased respiration rates, as well as providing an entry point for storage rots. In order to reduce tare dirt, sugar beets are exposed to a series of rollers and belts during harvest and piling. If the sugar beet is cracked and bruised, research has shown that respiration rates are higher and sugar loss greater than undamaged sugar beets. Under experimental conditions, severely damaged beets had a respiration rate 4 time that of undamaged beets

Impact Recording Devices (IRD) are sensors designed to identify locations in fruit and vegetable harvesting and processing equipment which cause damage to produce. They are spherical, self contained sensors which are similar in shape to the product and are sent through harvesting equipment and processing lines to record locations where high impacts are experienced. These units were sent through sugarbeet harvesters and piling equipment and measured the impacts experienced by the sugarbeets. This enables the operator to make changes or adjustments to the equipments to minimize potential damage

**METHODS:**

A 3.5" diameter Impact Recording Device (IRD - Techmark Inc, Lansing MI) was borrowed from the Ontario Ministry of Agriculture, Food and Rural Affairs for this study. This instrument was developed to identify locations in fruit and vegetable processing and handling equipment which caused damage to produce. It is a self contained sensor, which records the force of an impact, as well as the duration of the impact. It also records the time of individual impacts, so the location of a specific impact within a machine can be determined. Examples of where IRD's are used are apple and melon packing lines, and potato harvesters.

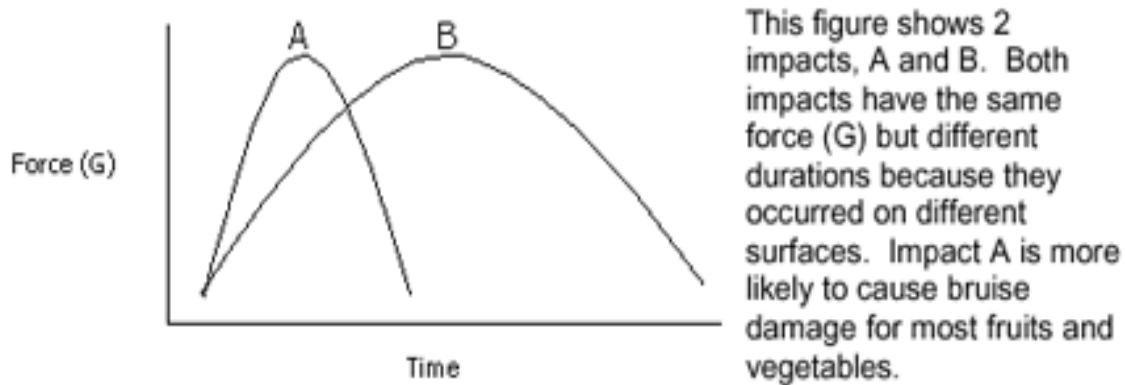
All three pilers at the Dover Piling Station, as well as an Artsway, Euro Tiger and Vervaet harvester were evaluated. At the piling station, we placed the sensor on the unloading cross conveyor, and retrieved it once it reached the boom going to the piles. For the harvesters, the IRD was placed in a beet row and picked up by the harvester. We retrieved the instrument once it reached the hopper on the Tiger and Vervaet harvester, and on the unloading conveyor on the Artsway.

We intended to run the IRD through all the machinery at least 6 times, which was accomplished for all the pilers except # 3, but not for any of the harvesters. We also have yet to determine the level of force which will cause damage to sugarbeets; we assumed this value to be 100 G for the purpose of this study (based on Techmark data which indicates that potatoes are damaged at forces of 80 G), and did not collect data points below this level of impact.

## RESULTS AND DISCUSSION

Impact data can be presented in 2 ways; one approach is to make a graph of force of the impact versus the duration of impact. This is the usual way it is presented in the software which accompanies the IRD; this is because not only the force of the impact must be considered, but also the duration of the force. For further explanation see Figure 1, which comes from the Techmark web site.

**Figure 1.** Explanation of force vs duration. Source: [www.techmark-inc.com](http://www.techmark-inc.com).

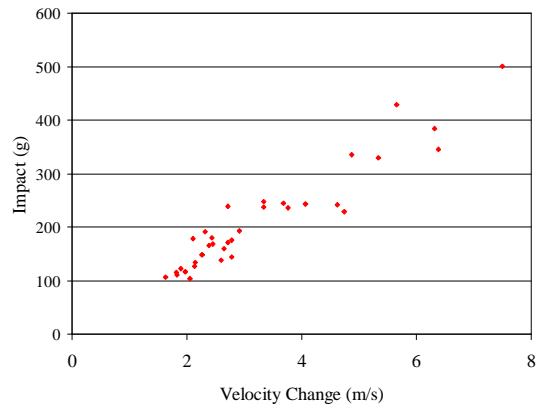


Sample data collected from the 3 pilers at the Dover Piling Station are shown in Figure 2. Each point on the graph represents an impact recorded during 1 pass over the piler. Points which are high in force and short in duration (top right side of the graph) are most damaging. From these graphs we see that while there are no impacts in this range, Piler 1 has the impacts with the greatest force. Table 1 is a summary of the data collected from the 3 pilers and indicates that Piler 1 gives the greatest maximum and average impacts.

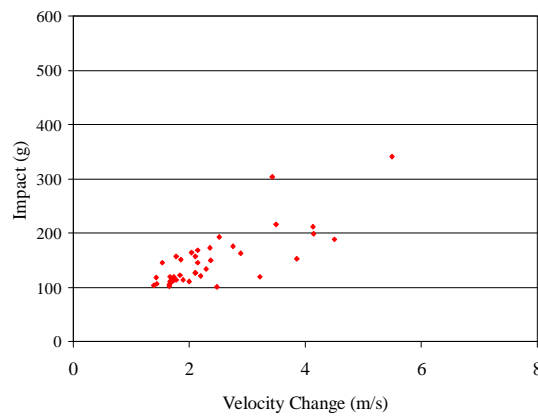
Table 1: Summary of piler impact data.

Piler	Force (g)		Duration (m/s)		Impact #	Time to pass through (sec)	Impacts/second	# of tests
	Max	Avg	Max	Avg				
1	448	208	8.0	3.5	25	25.4	0.99	6
3	384	189	7.0	2.9	27	21.6	1.26	2
2	348	163	7.6	2.9	27	30.8	0.86	6

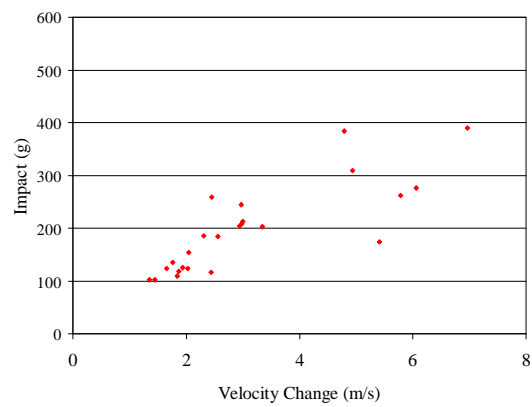
Figure 2: Piler Impact vs. Duration (velocity change) data.



Piler 1



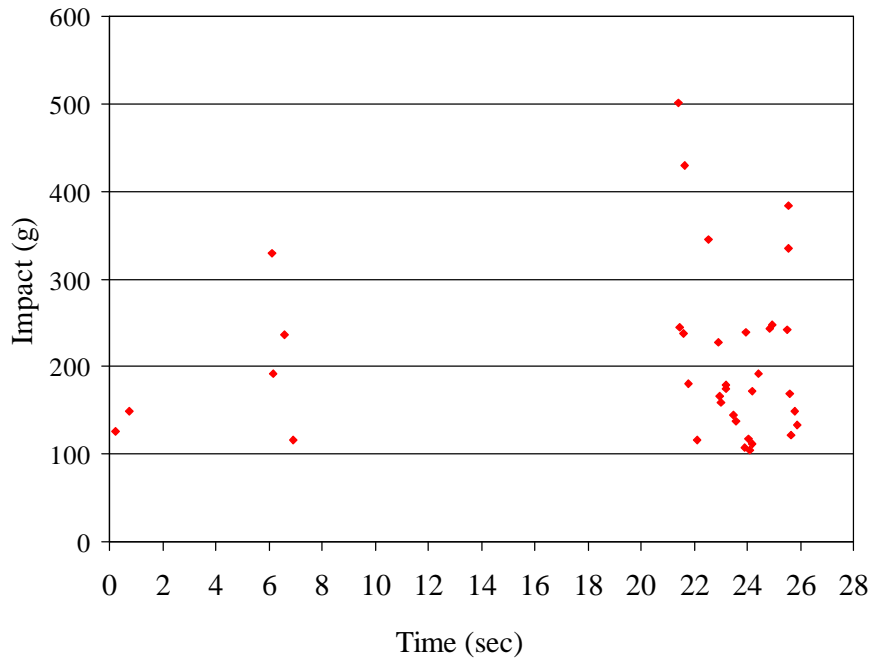
Piler 2



Piler 3

The second way to present impact data is to make a graph of force vs time. This allows the location in machinery where large impacts occur to be identified. Figure 3 depicts impact data over the 26 seconds it takes a sugarbeet to pass over Piler 1. The first cluster of impact points (time = 0) represents the beets falling from the cross conveyor to the belt taking them to the cleaner. The second cluster of impact points (time = 6 seconds) occurs when the beets fall into the roller bed, and we believe the third cluster of impact points (time = 22-26 seconds) are the beets leaving the roller bed and falling to the boom which will take them to the pile. The greatest impacts are noted at the back of the piler, which may be an area which needs modification

Figure 3: Impact versus Time data for Piler 1.



Piler 2 shows the same pattern of impacts over time (Figure 4), but the force of these impacts is not as great as Piler 1

Figure 4: Impact versus Time data for Piler 2.

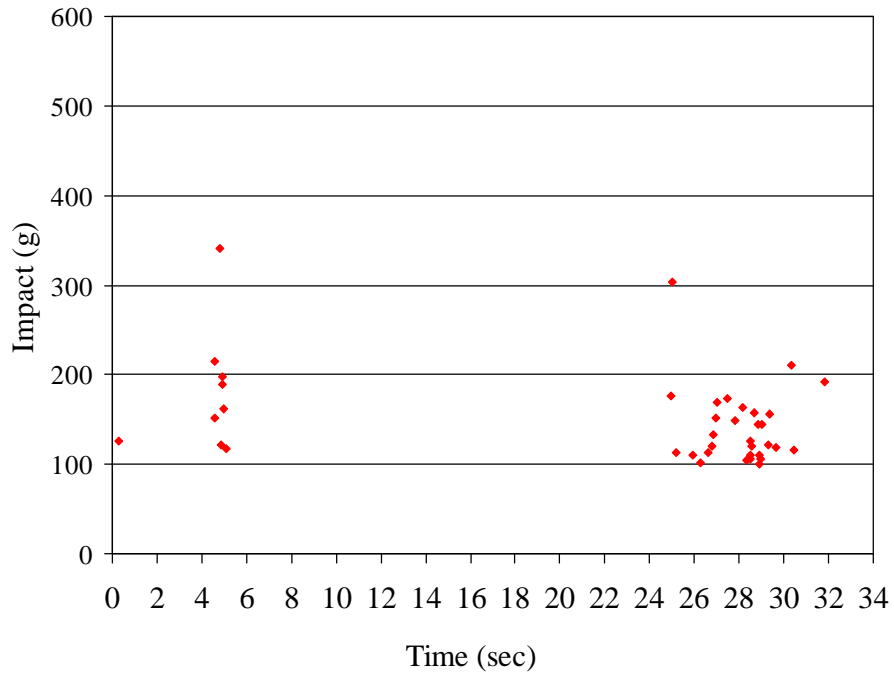
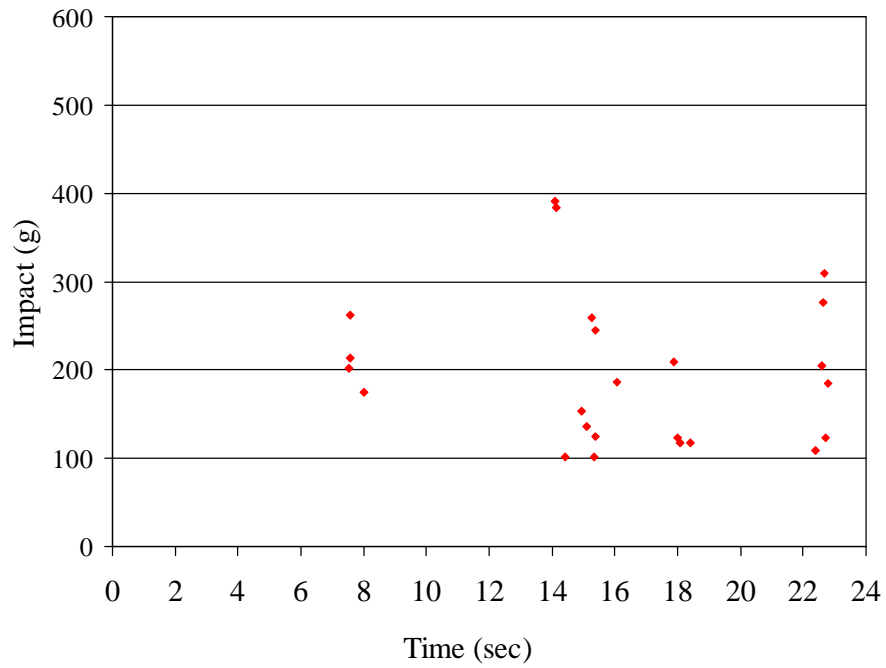


Figure 5: Impact versus Time data for Piler 3.



Impacts recorded from Piler 3 show a different pattern than the previous 2, since the cleaning mechanism is different. The first set of impacts (time = 8 seconds) occurs when the beets fall from the belt into the rotary cleaner. The second of impacts (time = 14 to 18 seconds) occurs at the back of the cleaner and as the beets fall out onto the belt. The third cluster of impacts (time = 22) occurs when the beets fall onto the back boom.

Similar graphs are presented for the Artsway, Tiger and Vervaet harvester (Figures 6, 7, and 8 respectively). Clear clusters of impacts are not noted, as was seen in the Pilers, but areas of high impact are noted, and are usually associated with cleaning equipment, either roller beds or rotors. Clusters at the back of the time course are associated with the IRD falling into the hopper (in the case of the Tiger and Vervaet harvester) or falling onto an unloading chain (Artsway harvester).

The impact data for harvesters is summarized in Table 2. A beet spends considerably less time in the Artsway harvester when compared to the Tiger and Vervaet harvesters. While the maximum and average impact noted in the harvester are similar, the Tiger harvester provides the greatest number of impacts, and the Vervaet harvester appears to be the most gentle harvester with the lowest average force on the beet.

Figure 6. Impact vs Time data for an Artsway harvester

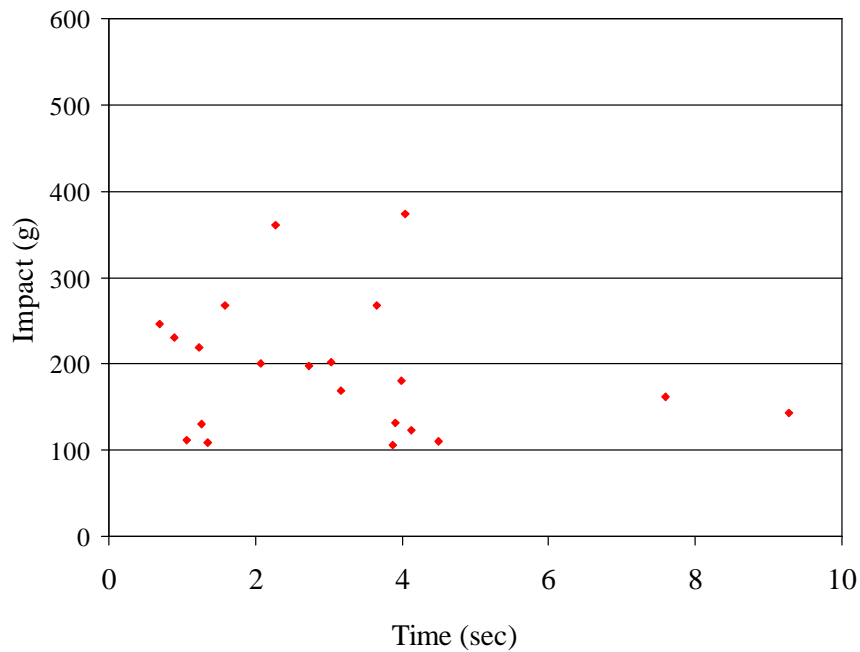


Figure 7: Impact vs Time data for a Euro Tiger harvester.

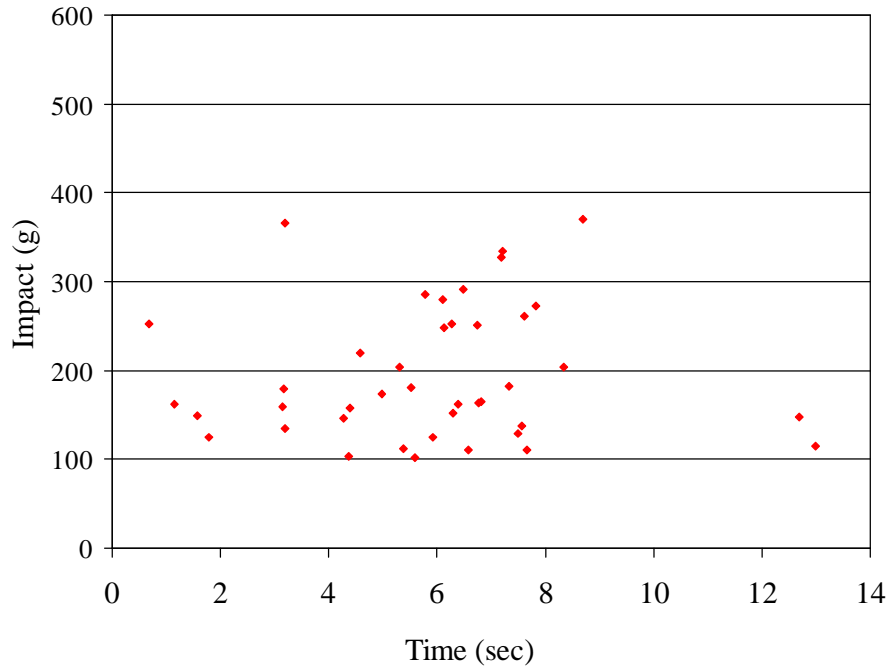


Figure 8: Impact vs Time data for a Vervaet harvester.

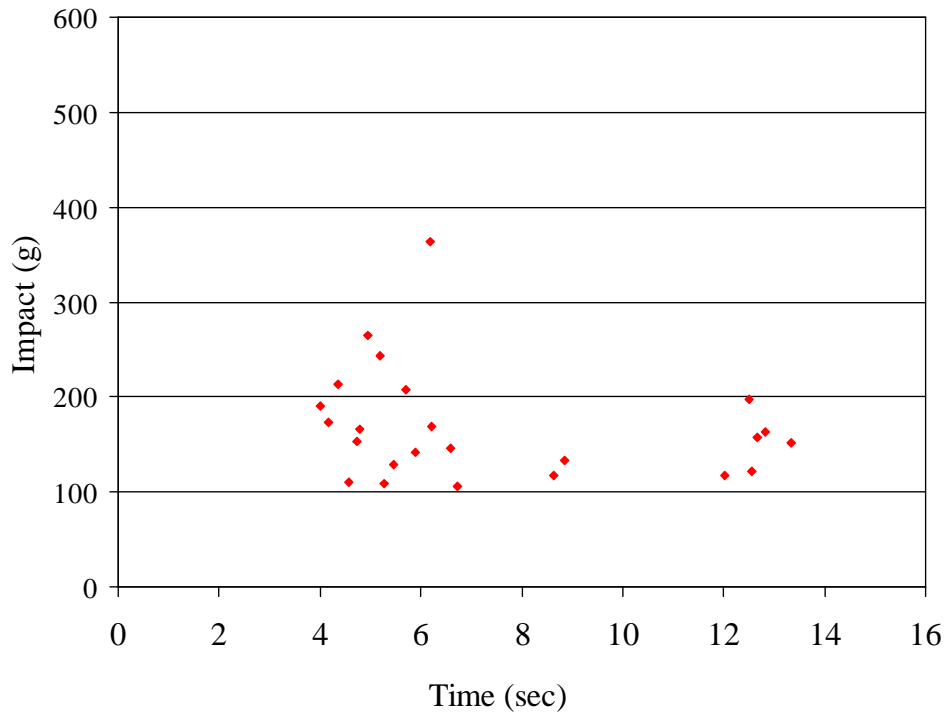


Table 2: Summary of harvester impact data.

Harvester	Force (g)		Duration (m/s)		Impact #	Time to pass through (sec)	Impacts/second	# of tests
	Max	Avg	Max	Avg				
Artsway	383	186	7.6	3.4	15	8.6	1.71	3
Tiger	371	183	9.0	2.9	42	12.6	3.33	5
Vervaet	371	174	6.8	3.0	25	12.0	2.10	4

## **CONCLUSIONS**

1. Pilers differ in the impacts they generate, and provide greater impacts than harvesters.
2. Drops cause the greatest impacts in Pilers
3. Harvesters differ slightly in the degree of impact they impart
4. Interpret data with caution, as impacts generated during the 2006 harvest season may not be typical

## **ACKNOWLEDGEMENTS**

This project is funded in part through contributions by Canada and the Province of Ontario under the Canada-Ontario Research and Development (CORD) Program, an initiative of the federal-provincial-territorial Agricultural Policy Framework designed to position Canada's agri-food sector as a world leader. The Agricultural Adaptation Council administers the CORD Program on behalf of the province.

Funding was also provided by the Ontario Sugar Beet Growers Association, the Ontario Ministry of Agriculture and Food Sustainable Production System Program, and the University of Guelph.

The cooperation of the following growers and industry personnel is greatly appreciated:

- Wayne Martin and his group at the piling yard
- Mark Lumley (Tiger harvester)
- Brian Fox and his harvest group (Artsway harvester)
- George Bos, Dwayne Ferguson and William Shenk (Vervaet harvester)
- Ande Boekhorst
- Wayne VanDamme and his harvest group