

Dry Soil Removal Project

Project Results of de-dirting trials on field harvesters and washing lines



Tim Brook, P.Eng. & John Van de Vegte P.Eng.
Ontario Ministry of Agriculture, Food and Rural Affairs

Bridget Visser, HMGA Water Project

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Presentation Overview

- Purpose of Project
- Preliminary work
- Types of Dry Soil Removal
- Methodology
- Soil load of harvested vegetables
- De-dirtting Project Results
- Recommendations



Purpose of Project

- Measure the amount of soil on root vegetables, as harvested
- Determine the effectiveness of various dry soil removal techniques
 - Harvesters
 - Washing Lines

Purpose of Project

- **Economic and Environmental Benefits:**
 - ↓ soil leaving the field with harvested vegetables
 - ↓ soil on vegetables prior to washing
 - ↓ solids and phosphorous in washwater
 - ↓ amount of water needed to wash vegetables
 - ↓ the size and cost of washwater treatment systems

Preliminary Work

- **Connection to HMGA Water Project** (2014-2017)
 - Working on washwater treatment equipment and technology
 - Reducing water use and soil loading is important to reduce the size of washwater treatment system



Preliminary Work

- **OMAFRA Kick Start Project** (2015-2016)
 - Developed a testing procedure to measure the effectiveness of de-dirting equipment
 - Determined how much soil can be removed from vegetables using various de-dirting methods
 - Determined how much less water is needed to wash vegetables after various de-dirting methods



Preliminary Work

- **De-dirtting Project** (2016-2017)
 - Survey of existing dry removal technologies used in the Marsh
 - Secured funding through Environment Canada
 - Secured in-kind contribution and support from co-operator growers/packers, University of Guelph Muck Crop Research Station and OMAFRA



Types of Dry Soil Removal

- Bumpers
- Finger Tables
- Scrappers
- Hedgehogs

Bumpers

- Installed under the harvest belts
- Designed to jostle or 'bump' the produce as it moves up the belt to the knives
- Can be rods or fingers, stationary or rotating



Finger Tables

- Series of rotating shafts
 - containing sets of rubber fingers
 - rotates and tumbles the produce
- Soil and other loosened material falls through the openings onto field or into collection system



Finger Tables - Video



Finger Tables - Video



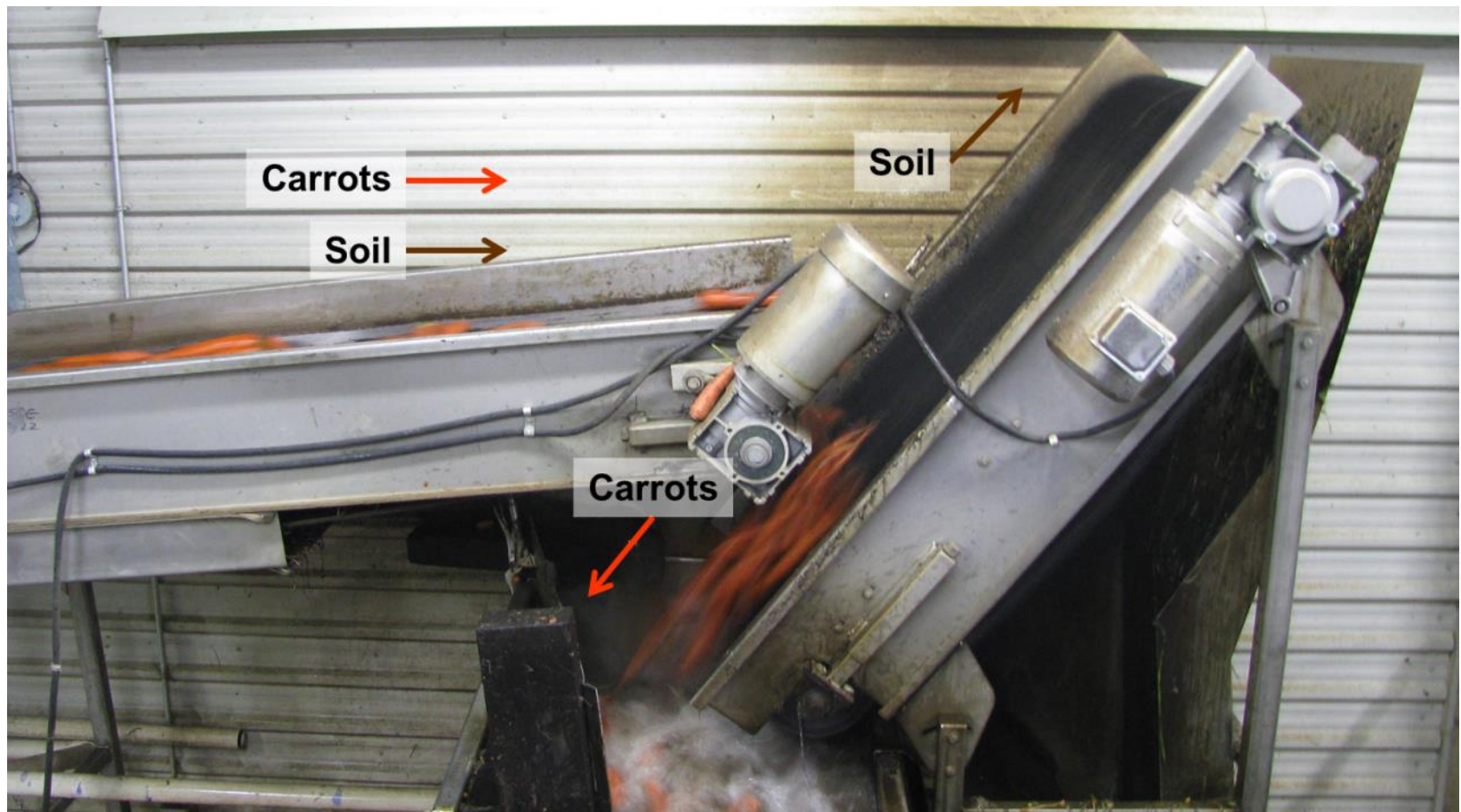
Scrappers

- Rotating metal bars with paddles
- Located beneath finger tables
- Clear built-up soil and debris from the fingers



Hedgehog

- A conveyor system that remove soil, vegetation and other debris



Hedgehog

- Hedgehog on a harvester
- Can be used with air to enhance removal



Hedgehog - Video



Methodology

- Bushels of produce were collected:
 - as harvested and/or from storage in pallet boxes
 - after each de-dirting system
- Each bushel was tagged and weighed



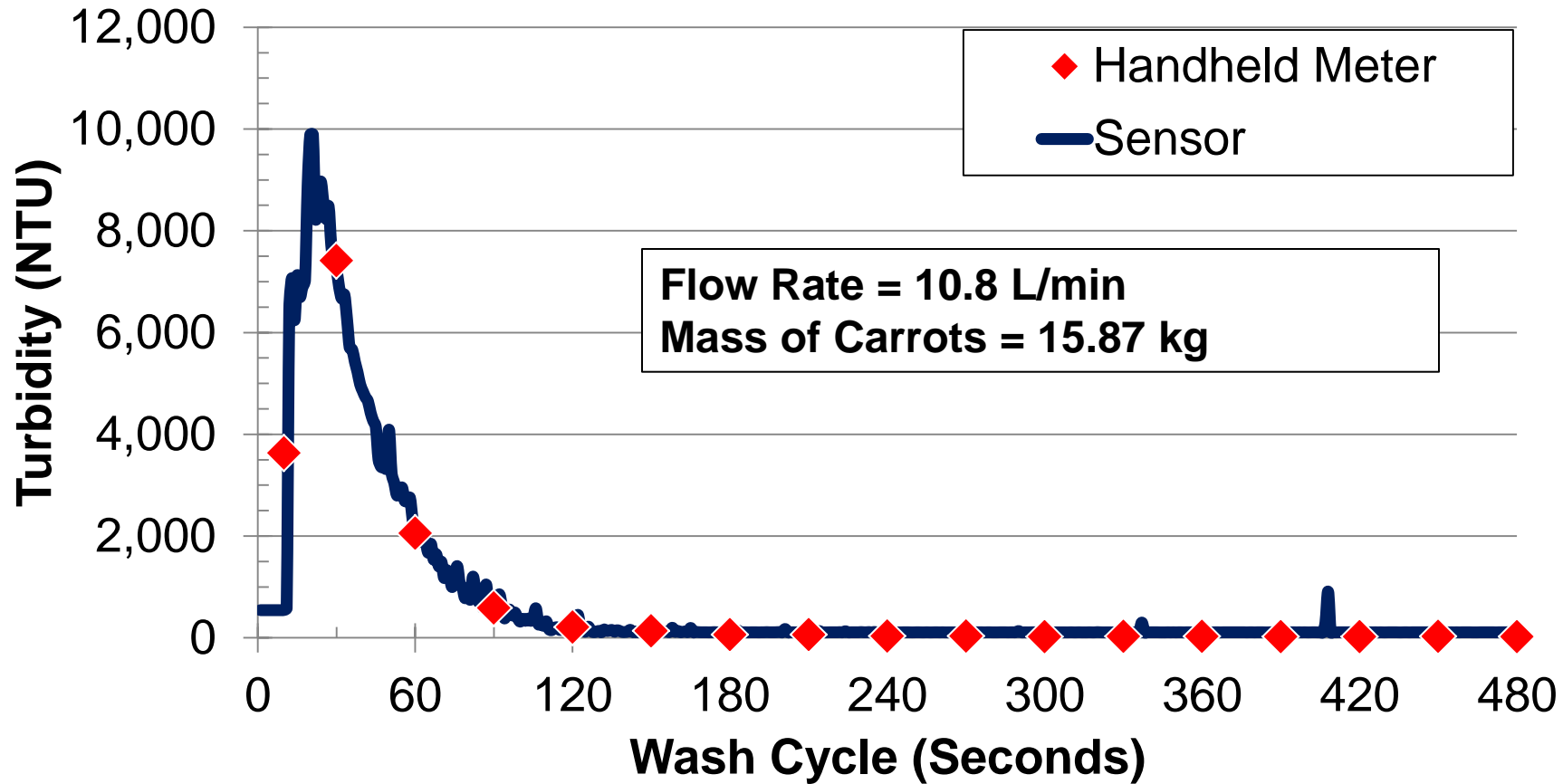
Methodology

- Each bushel was washed for 8 minutes
- Water flow rate/volume, turbidity and other water quality parameters were monitored

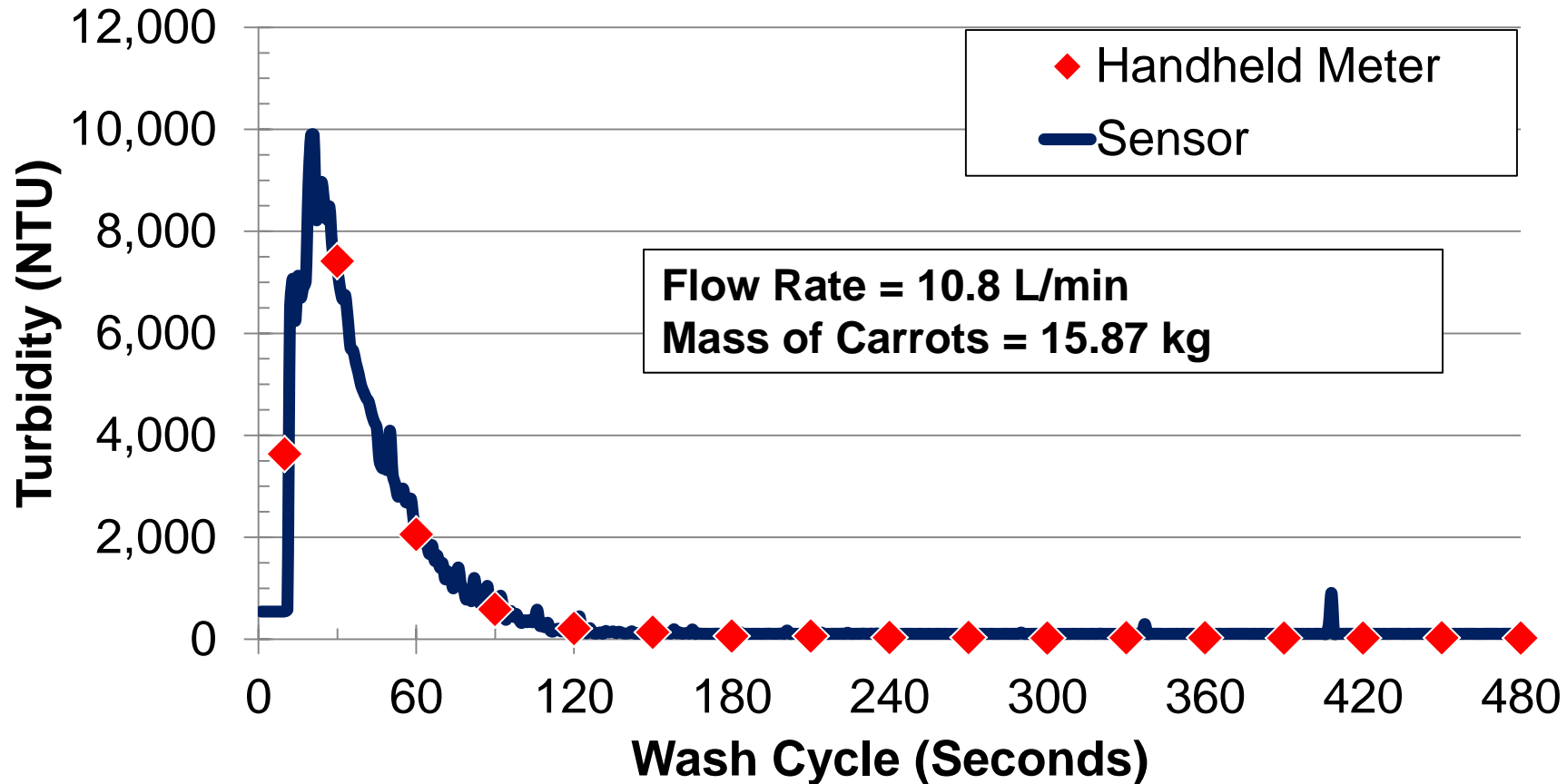


Parameter	Frequency	Method of Analysis
Turbidity	1 second interval	Sensor
Turbidity	At 10s, 30s (30s intervals)	Handheld Meter
TSS, TP, TKN & CBOD₅	At 30s, 60s and 120s	Laboratory Analysis

Methodology



Methodology



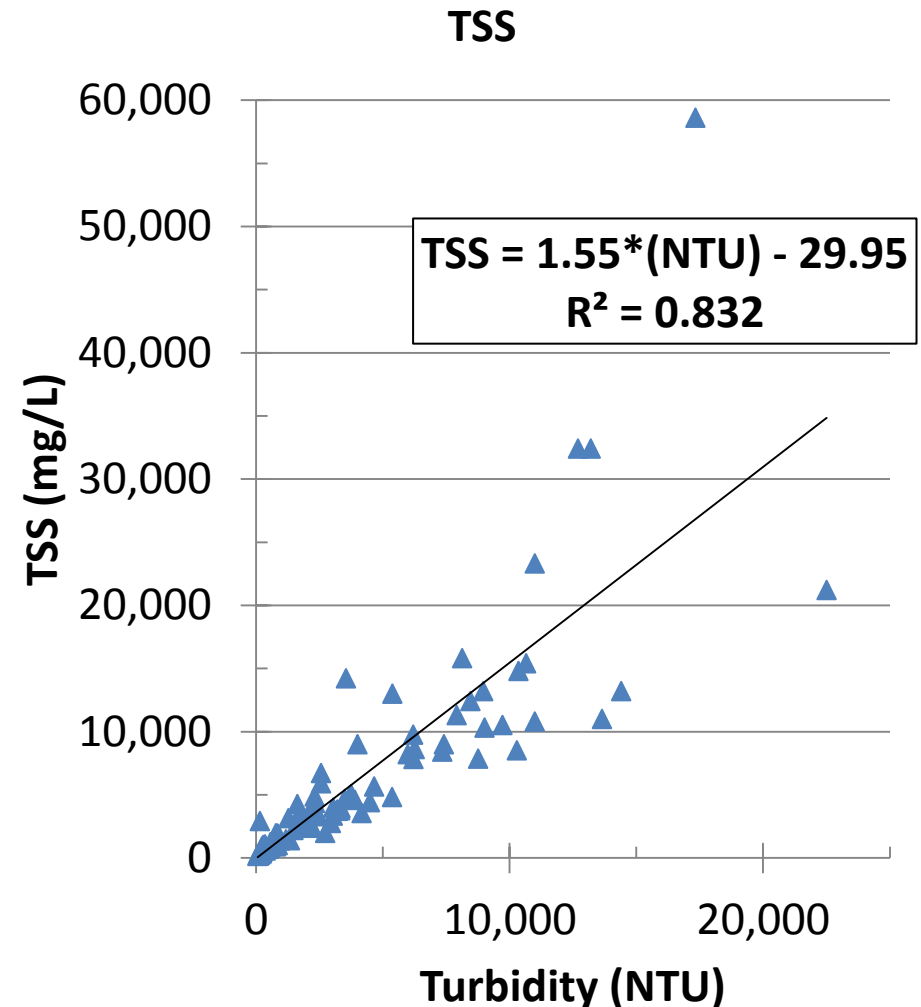
Determining Required Water Use

Clean Carrots at 120 seconds

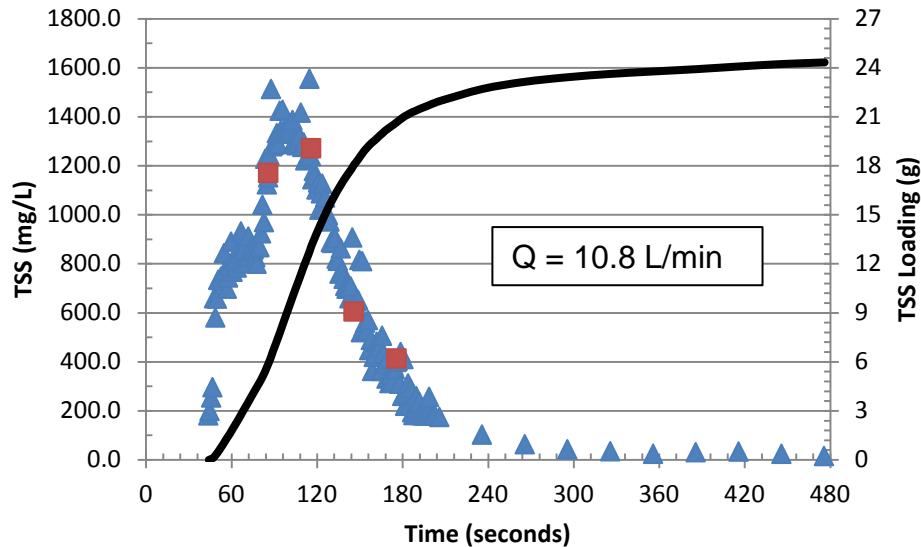
$$\begin{aligned} \text{Water Used} &= 10.8 \text{ L/min} * 120/60 \text{ min} / 15.87 \text{ kg} \\ &= 1.36 \text{ L/kg} \end{aligned}$$

Methodology

- Laboratory sample results for TSS, TP, TKN and CBOD₅ were correlated to turbidity
- TSS and TP had strong correlations
- TKN and CBOD₅ had weak correlations
- The correlations were used to estimate the concentrations of parameters based on turbidity data

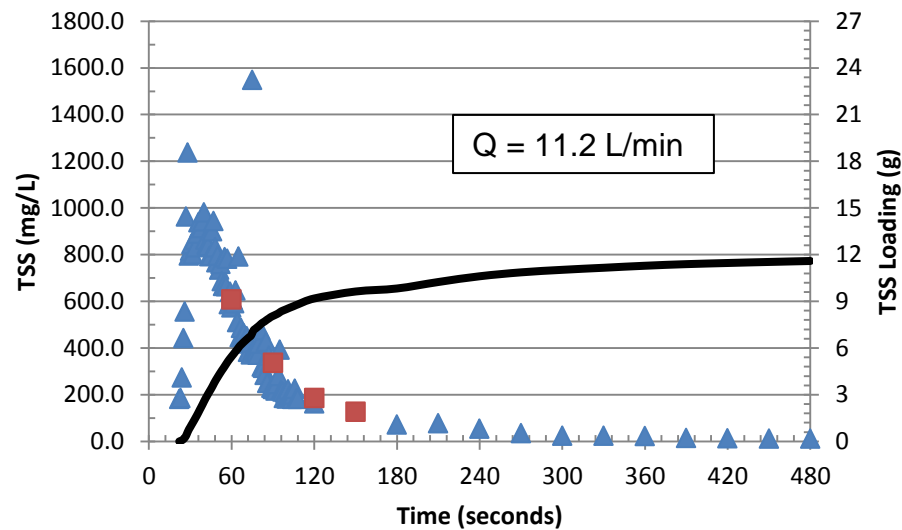


TSS Concentration and Loading



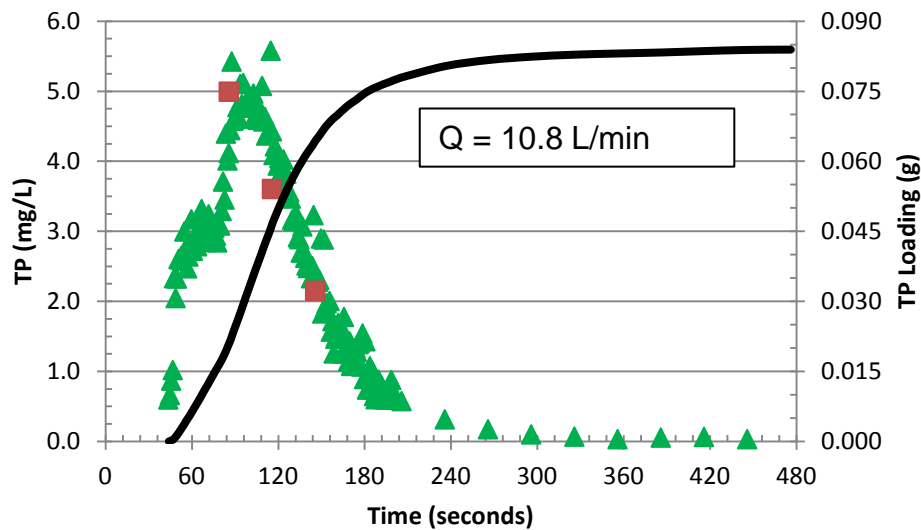
▲ TSS - Calculated ■ TSS - Laboratory — TSS - Loading

TSS Concentration and Loading



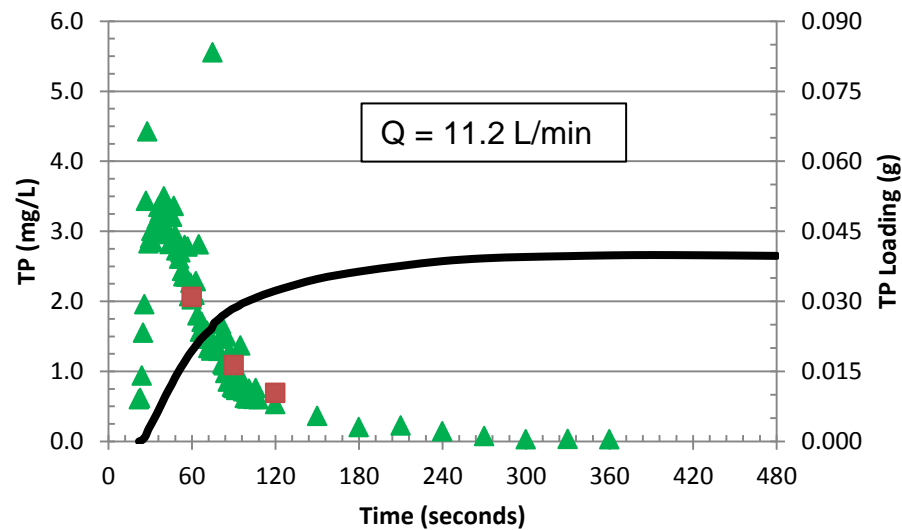
▲ TSS - Calculated ■ TSS - Laboratory — TSS - Loading

TP Concentration and Loading



▲ "TP - Calculated" ■ TP - Laboratory — TP - Loading

TP Concentration and Loading



▲ "TP - Calculated" ■ TP - Laboratory — TP - Loading

Methodology

- Compare the results of as harvested bushels to the bushels collected after the various de-dirting techniques.
- For example:

Parameter	As Harvested	Bumpers & 2 Finger Tables	Reduction (%)	Reduction (g/kg)
TP (g/kg)	0.04	0.01	77	0.03
	0.05	0.01	81	0.04
	0.04	0.01	76	0.03
Average	0.05	0.01	78	0.04

Soil Load of As Harvested Vegetables

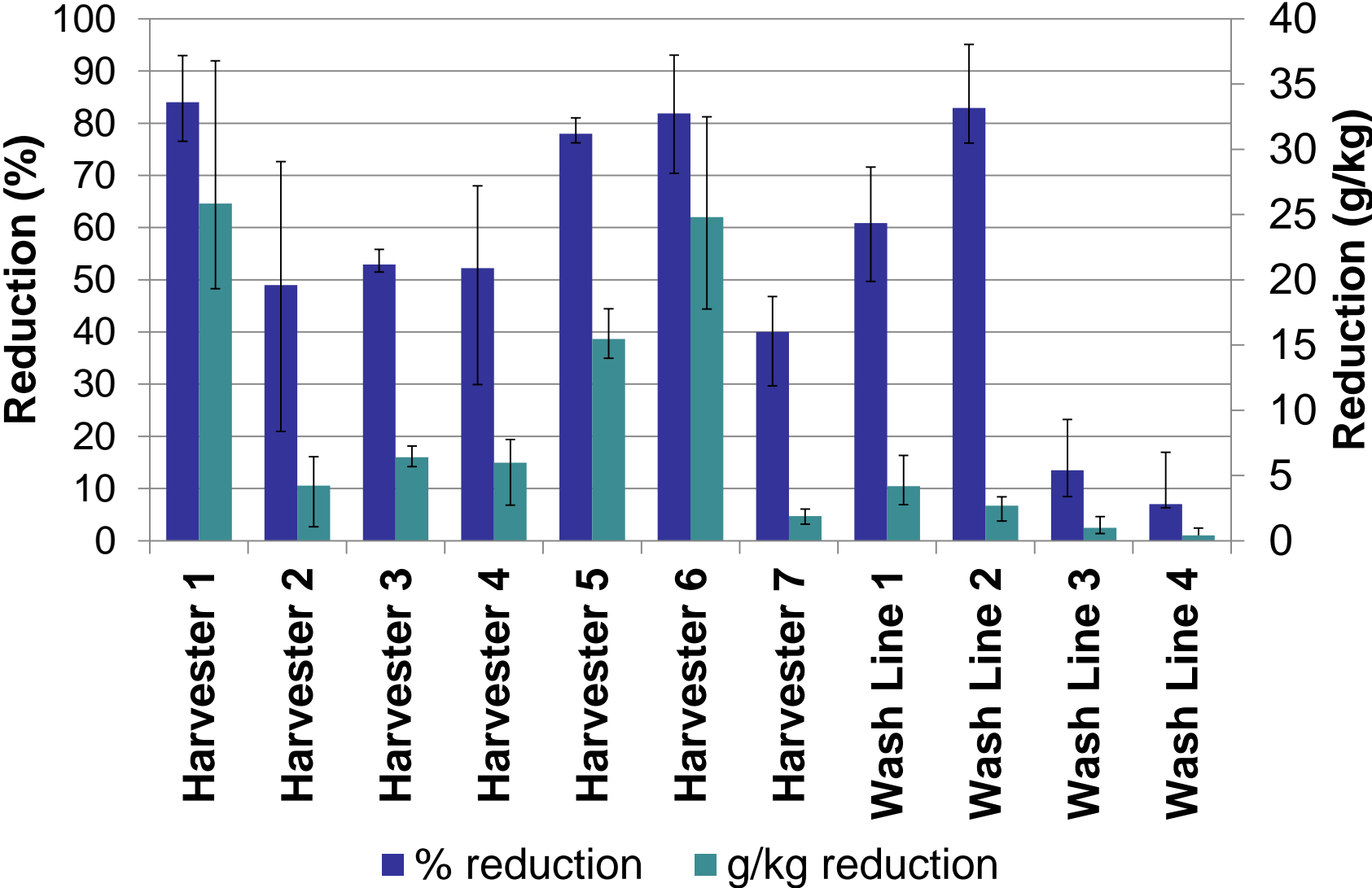
Parameter	Muck			Mineral		
	Min	Avg	Max	Min	Avg	Max
TSS (g/kg)	9.1	18.3	39.6	4.3	4.7	5.2
TP (g/kg)	0.03	0.05	0.14	0.012	0.013	0.014
TKN (g/kg)	0.2	0.6	1.1	0.037	0.040	0.043
CBOD ₅ (g/kg)	0.29	0.37	0.45	0.23	0.25	0.26
Water use (L/kg)	2.5	3.8	6.8	1.6	1.7	1.9



Trials

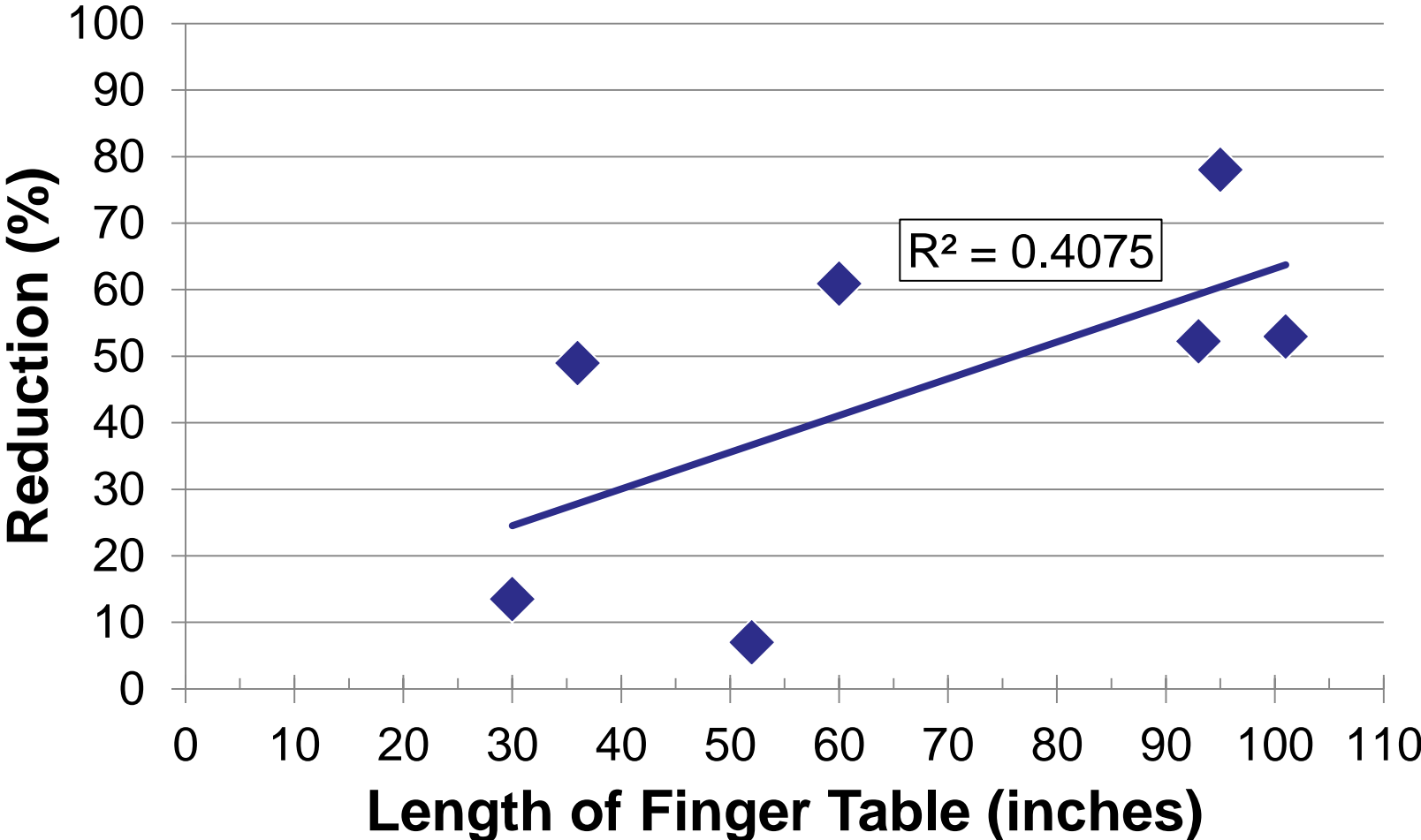
	Technology
Harvester 1	Bumpers only
Harvester 2	1 Finger Table
Harvester 3	Bumpers & 2 Finger Table with Scrappers
Harvester 4	Bumpers & 2 Finger Tables (average soil moisture of 57.3%)
Harvester 5	Bumpers & 2 Finger Tables (average soil moisture of 27.7%)
Harvester 6	Bumpers & Hedgehog
Harvester 7	Bumpers & Hedgehog (Mineral soil)
Wash Line 1	1 Finger Table
Wash Line 2	Flume
Wash Line 3	1 Finger Table (Mineral soil)
Wash Line 4	1 Finger Table (Mineral soil)

Results: TSS

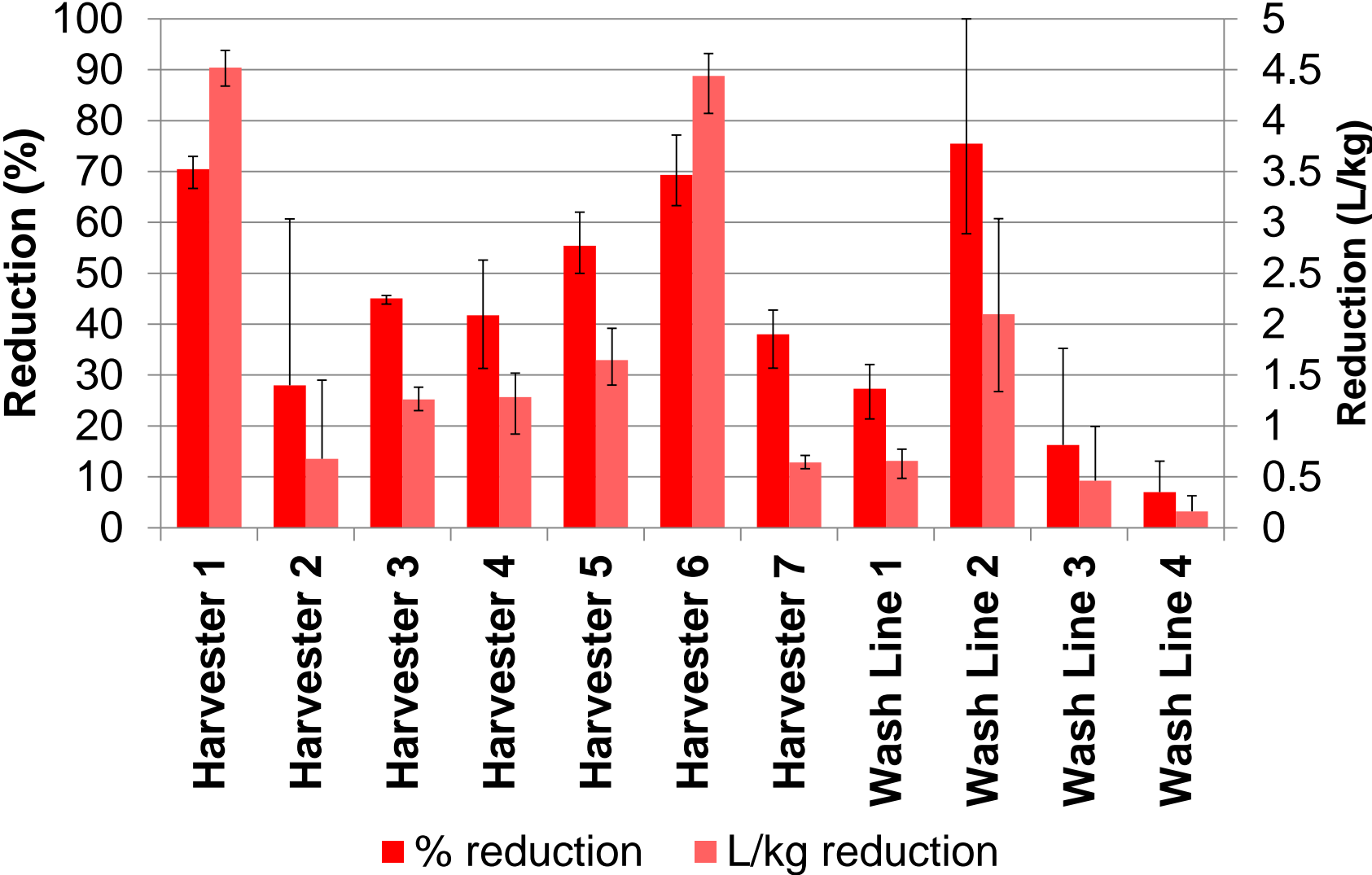


Results: TSS

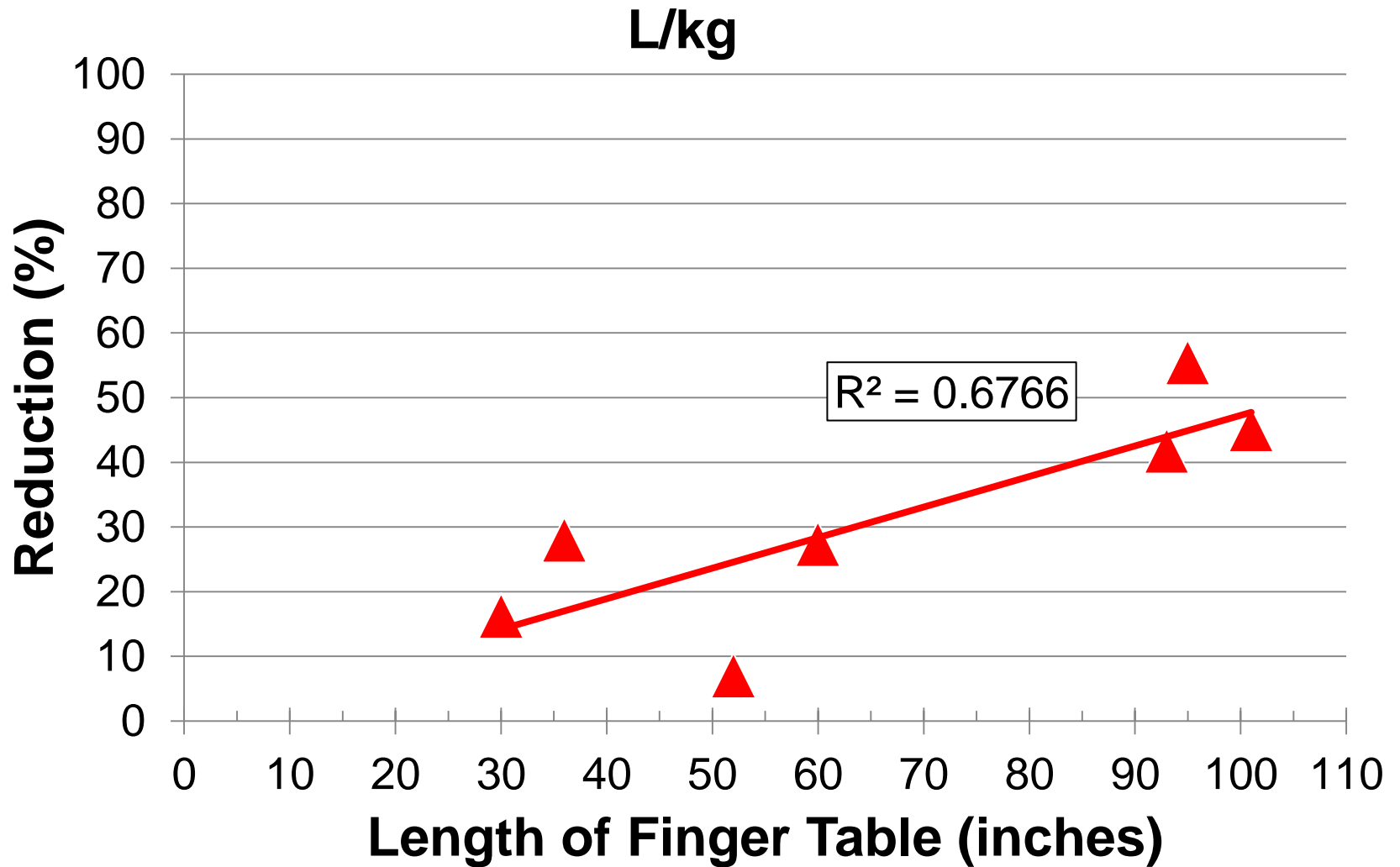
TSS



Results: L/kg

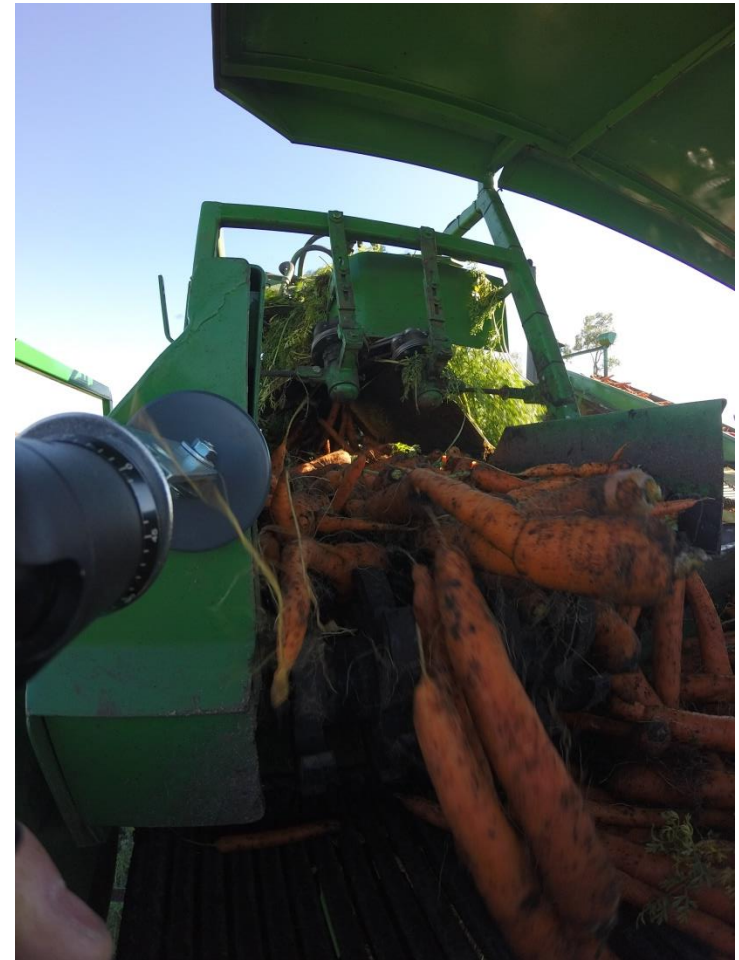


Results: L/kg



Findings: Harvesters

- De-dirtting is a valuable tool: leave the soil in the field
- Bumpers can provide large results with small effort
- The best results came from using multiple methods
 - It is difficult to predict how much combining methods will increase efficacy
- Soil moisture has an impact on the results



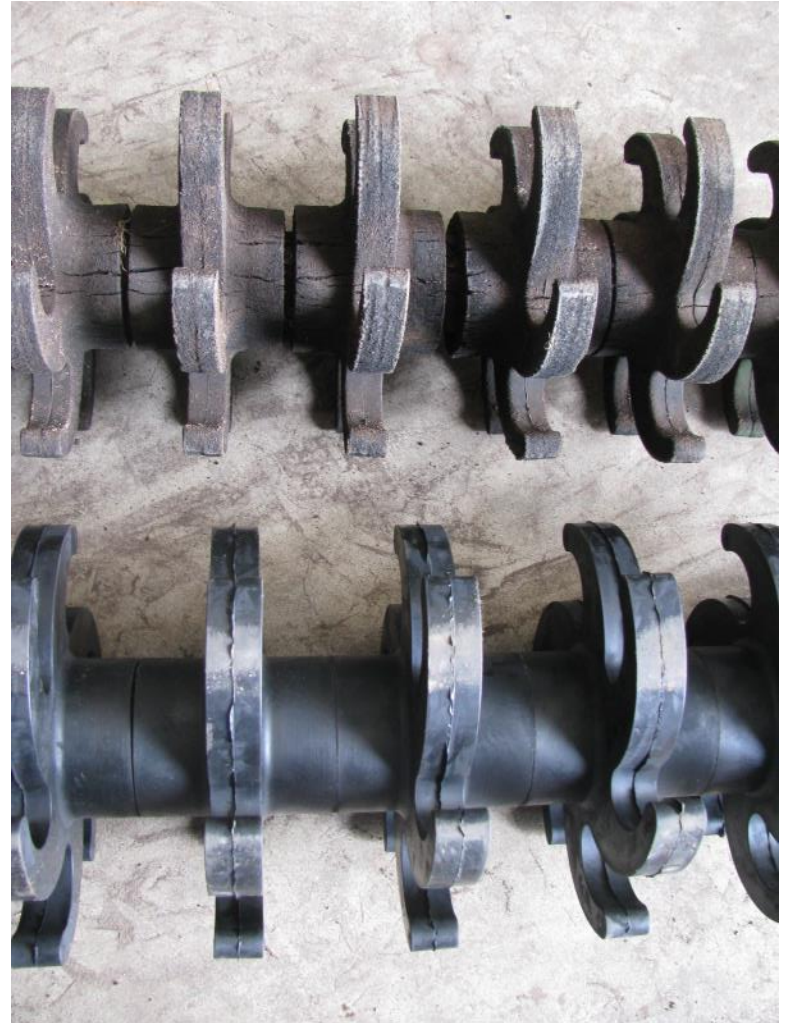
Findings: Washing Lines

- Dry soil removal should be completed regardless of de-dirting in the field
- Evaluate the amount of soil on produce prior to washing as it will impact the amount of water needed
- Fluming does not replace dry soil removal



Recommendations

- Replace aging equipment for optimal results
- Watch the speed; need sufficient contact time
- Place equipment out of range of splash back from tanks
- Observe consistently to make adjustments
- Ensure equipment is being fully utilized



Acknowledgements

- Co-operator Growers/Packers
- Holland Marsh Growers' Association Water Project
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- Nottawasaga Valley Conservation Authority
- Ontario Ministry of Agriculture, Food and Rural Affairs

