TETHERED CTL IN WESTERN OREGON

Productivity, cost and environmental impacts of steep slope harvesting in western Oregon.

Presenter: Preston Green[1]
Research Team: Francesca Belart[1], Woodam Chung[1], Stephen Fitzgerald[1], Ben Leshchinsky[1], Brett Morrissette[1], John Sessions[1], Jeff Wimer[1], John Garland[2]

[1]Oregon State University
College of Forestry

[2]Garland & Associates

Oregon State University

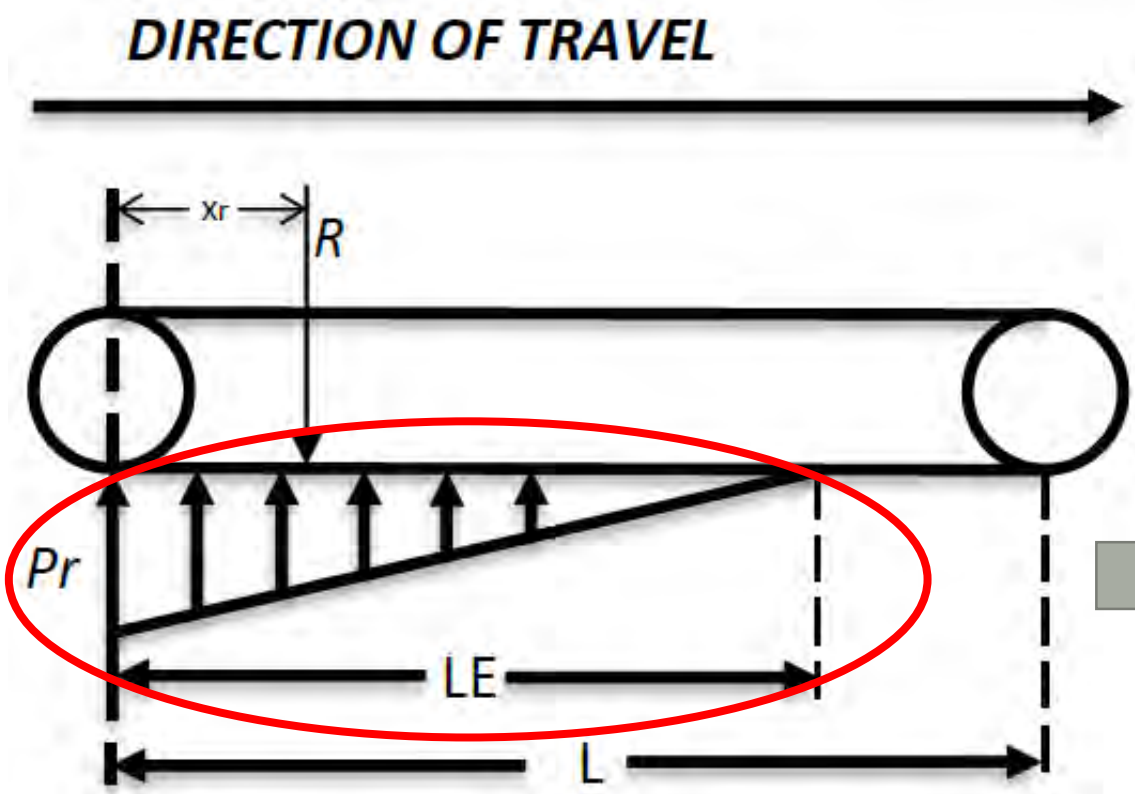
Steep Slope Harvesting

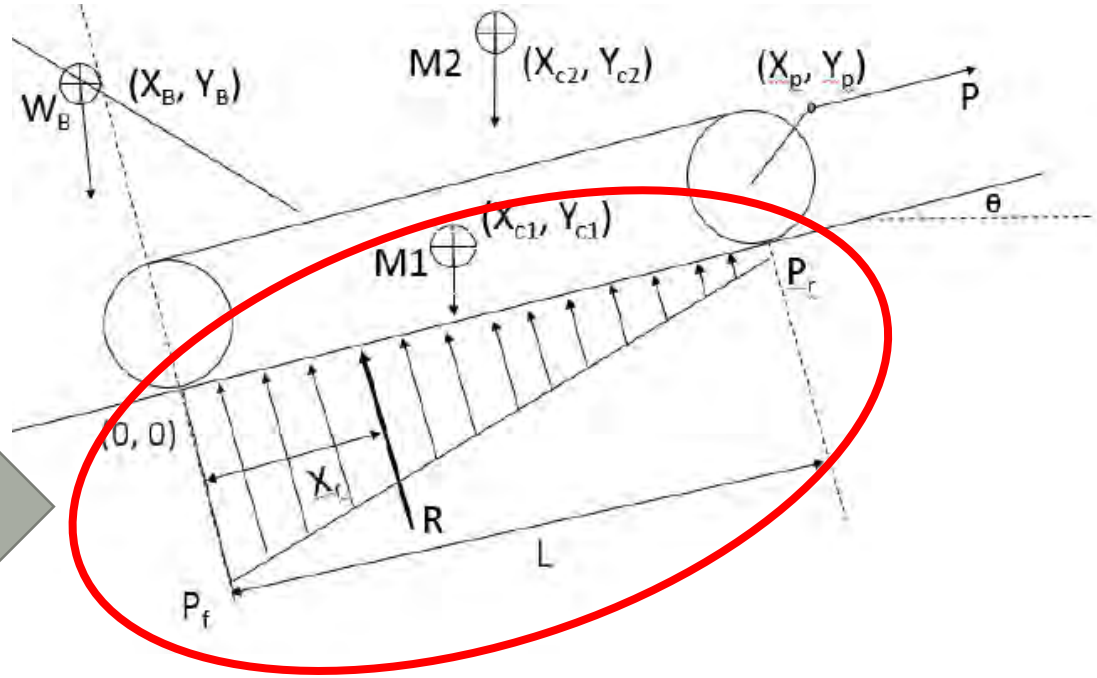
- Research Introduction (NIOSH Project) and Goals
- Theory Interlude
- Study Overview
- Methodology, Results and Discussion
  - Dry Bulk Density, Penetration Resistance
  - Productivity and Cost
- Visual Impacts
- Take-away Messages, Management Implications

NIOSH Research Introduction & Goals

- Motivations:
  - Logging is “difficult, dirty, dangerous, and declining”
  - Logging is the first step in an industry that generates over $5.2 billion in revenue for Oregon alone
  - Workforce, mechanization, political environment are all drivers of change
- Research Arms & Goals:
  - Assessing practical and physiological response of logging workers
  - Assessing environmental impacts of various steep-slope harvesting systems
  - Measure shift-level productivity of felling and yarding as part of worker risk exposure
  - Development of guidelines and design criteria for new logging systems

Soil impacts are dictated by…





Images courtesy of FE 470 Class Notes


…And soil type!

Research Project Overview

- Study to asses soil impacts as well as productivity and cost
- “Quick Draw” harvest unit
- Thinning on Oregon State University Research Forest
- Unassisted and cable-assisted Ponsse[1] Bear and Elephant King
- Private harvesting contractor

[1]Mention or depiction of machines or trade names does not constitute endorsement by Oregon State University or any agency of the federal government.

Photos courtesy of Dr. Woodam Chung

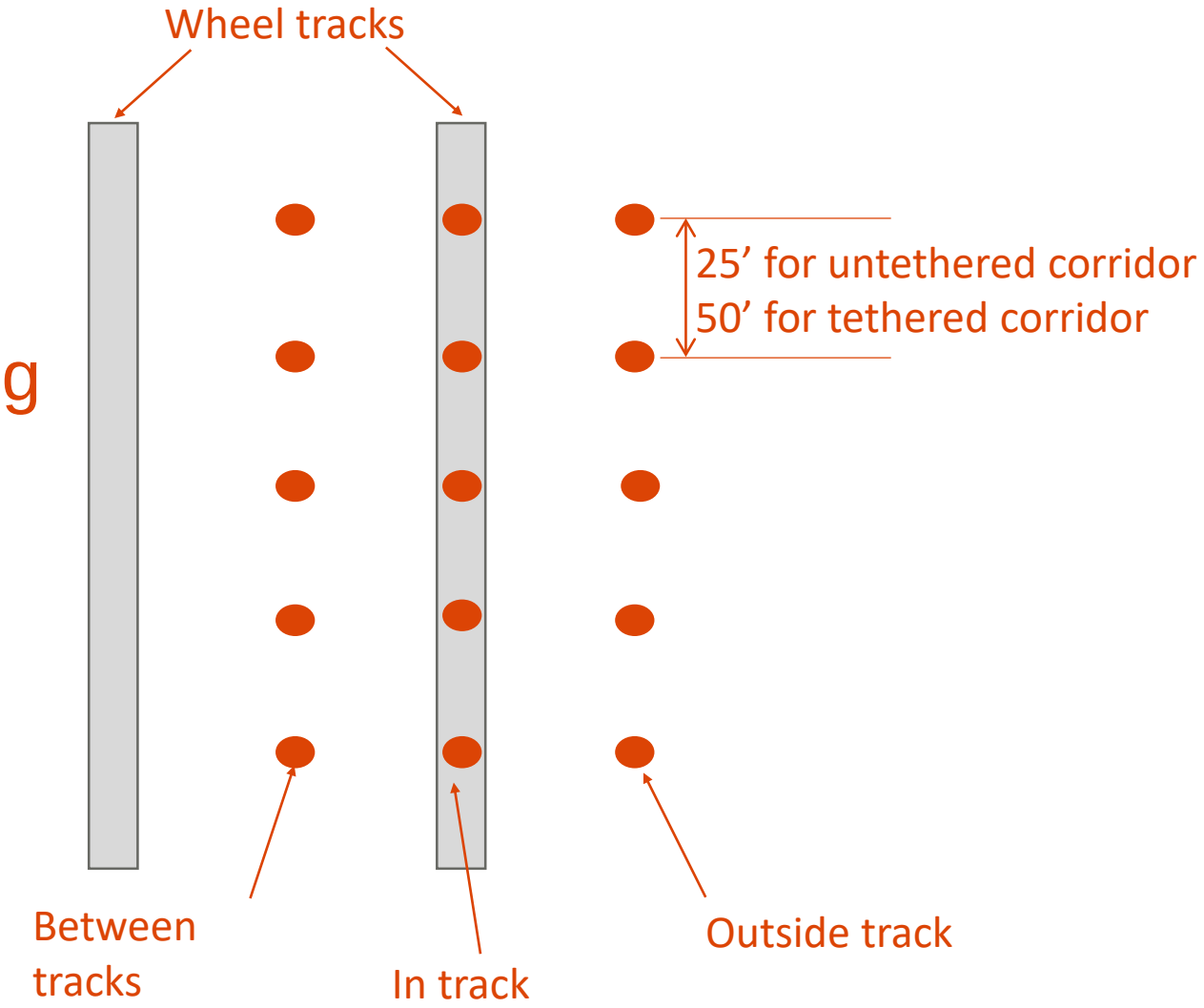
Research Project Overview

- Predominantly Douglas-fir
  - 7-18” DBH, 108’ tall cut trees; initial density ~118 TPA; cut from 175.5 ft^2/ac to 122.8 ft^2/ac (52.5 ft^2/ac cut)
- Clay soils, dry operating conditions
  - Research done in August 2017

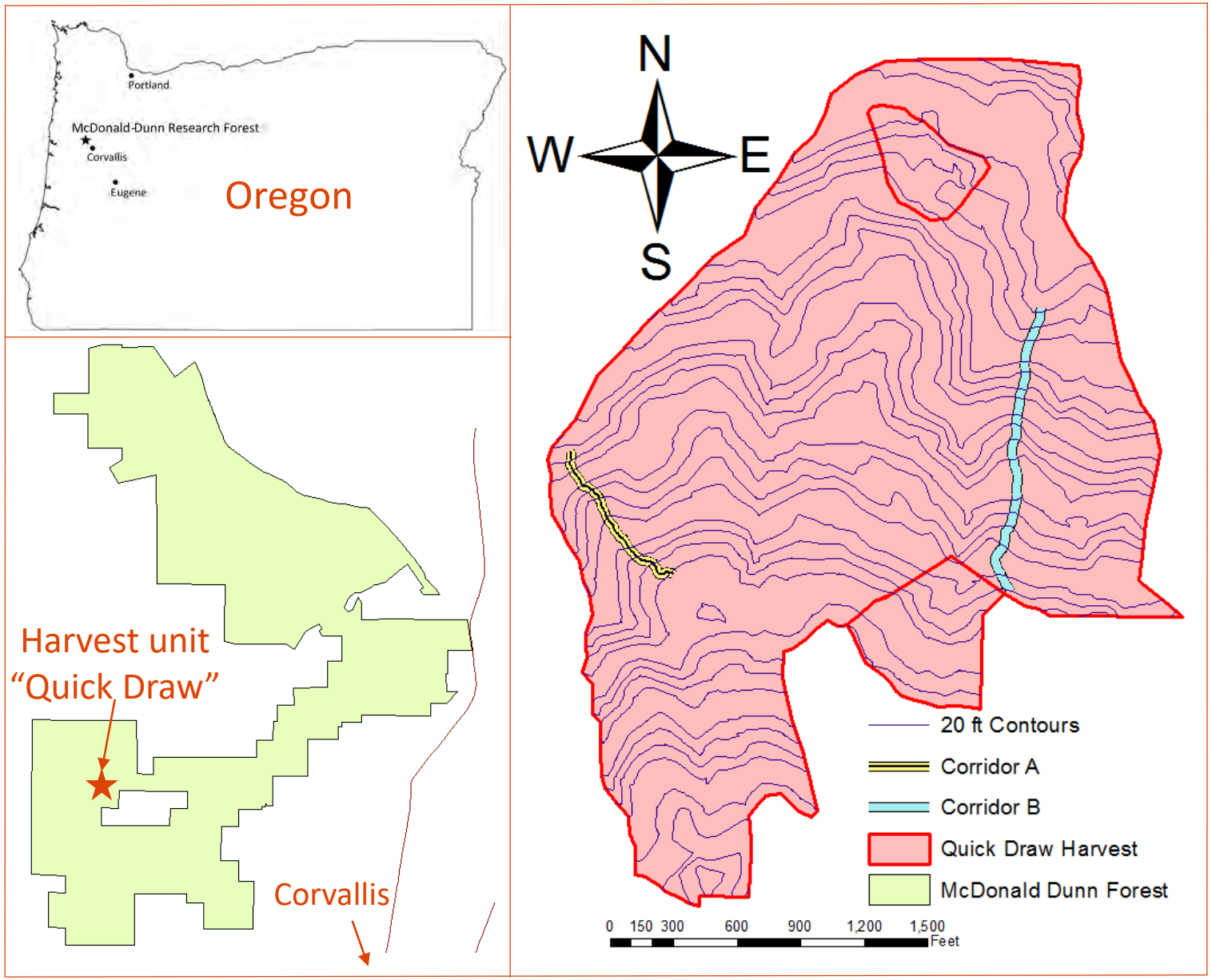
Photos courtesy of Dr. Woodam Chung

Methodology, Environmental Impacts

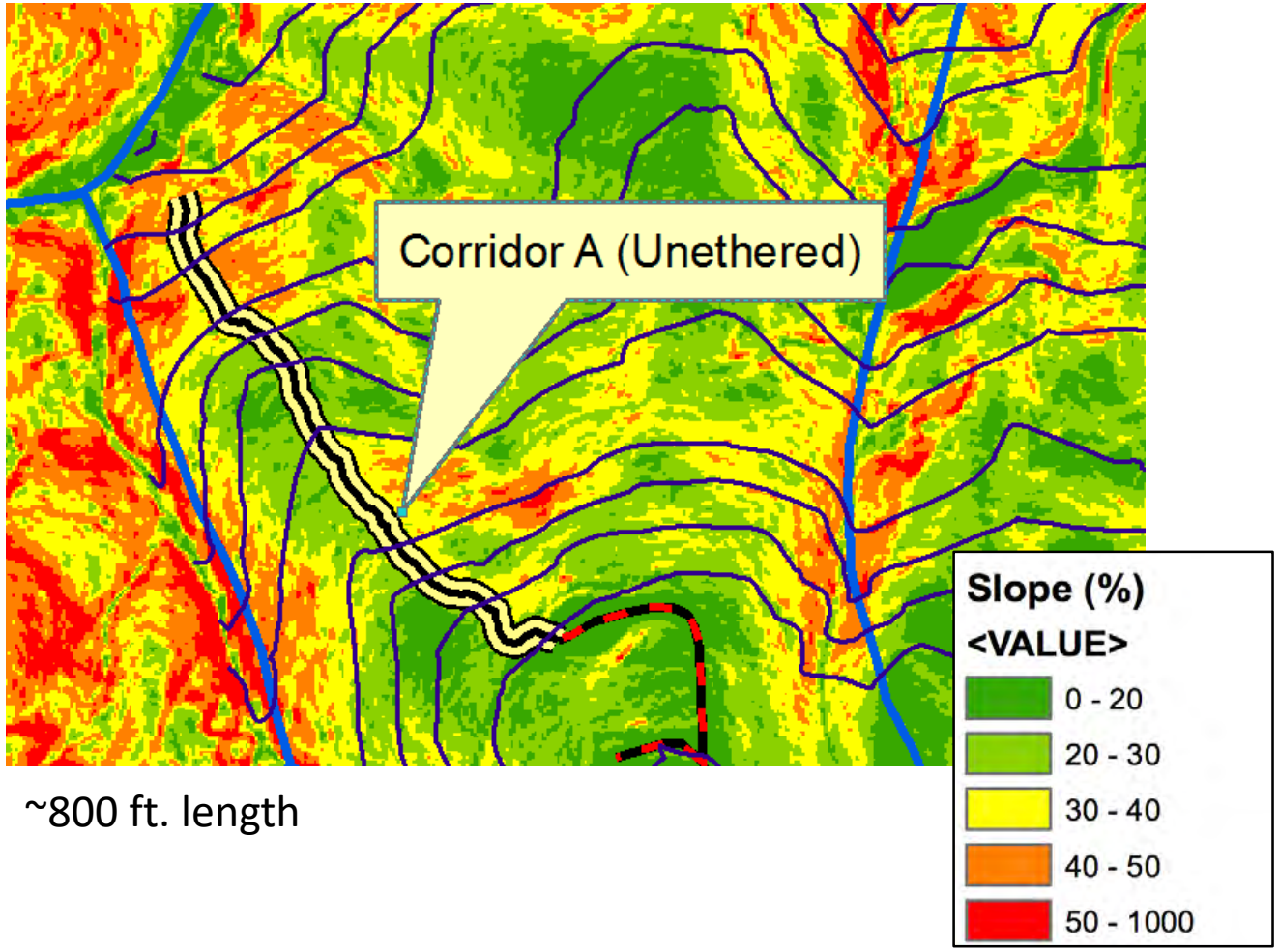
- Paired corridor approach
- Fixed sampling before harvest, after harvesting, after forwarding
- Surficial and at-depth measurements taken
  - Dry bulk density and penetration resistance



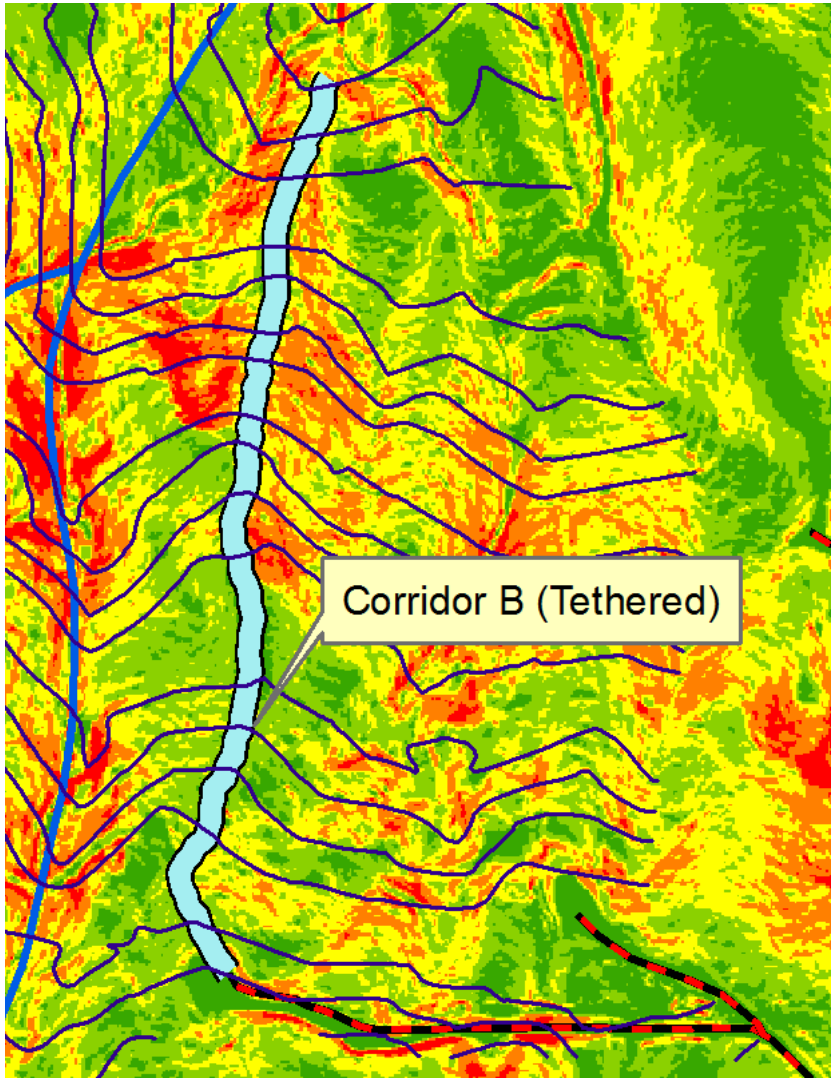
Harvest Unit



Harvest Unit



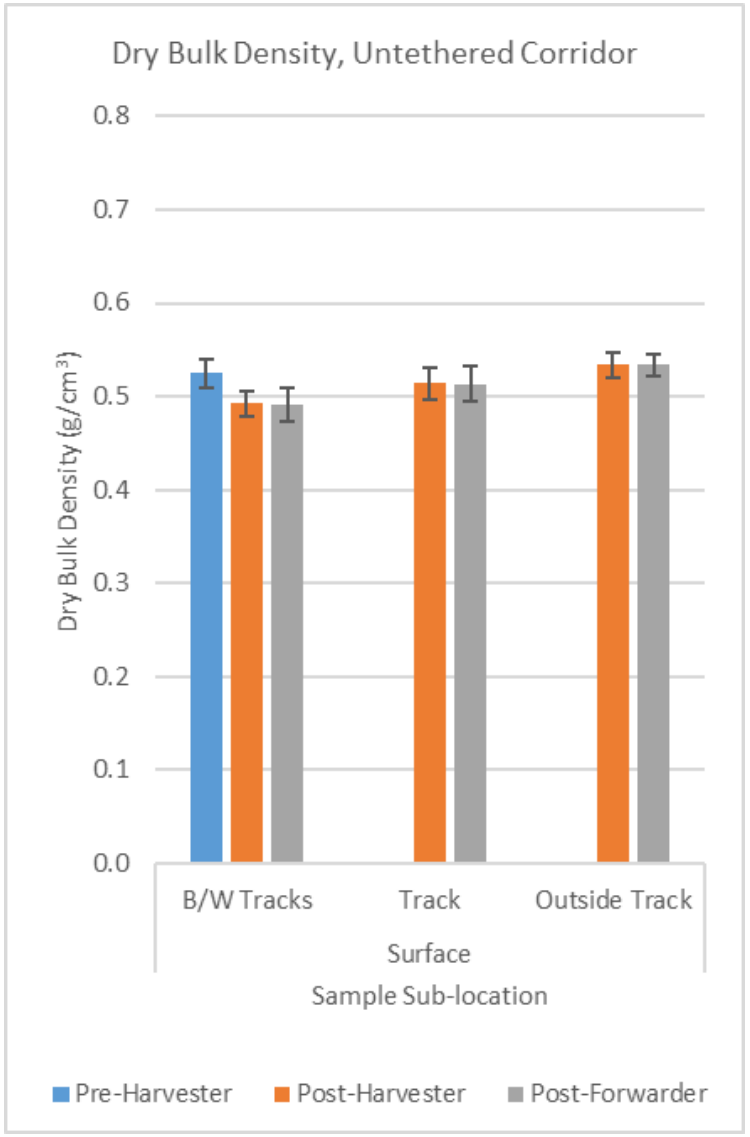
~800 ft. length

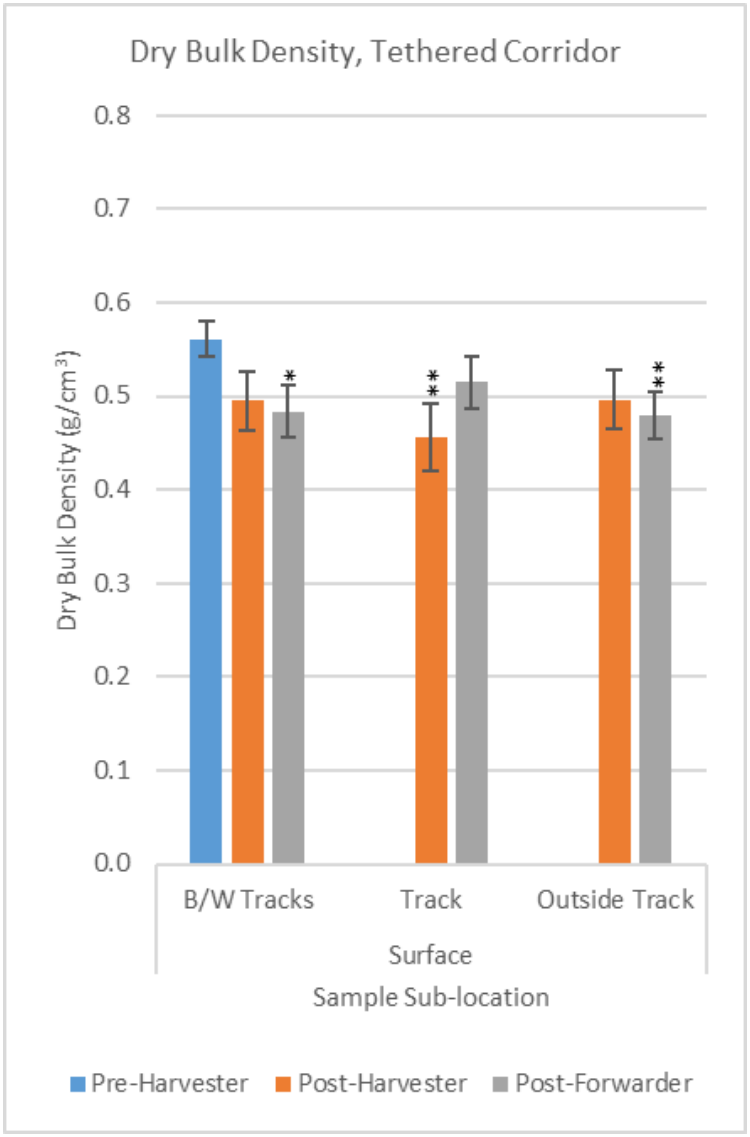


~1,450 ft. length

Results

Dry Bulk Density


Dry Bulk Density, Untethered Corridor
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Dry Bulk Density (g/cm³)
B/W Tracks
Track
Outside Track
Surface
Sample Sub-location
Pre-Harvester
Post-Harvester
Post-Forwarder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Dry Bulk Density (g/cm³)
*
**
**
B/W Tracks
Track
Outside Track
Surface
Sample Sub-location
Pre-Harvester
Post-Harvester
Post-Forwarder

Results

Penetration Resistance

Static Cone Penetrometer

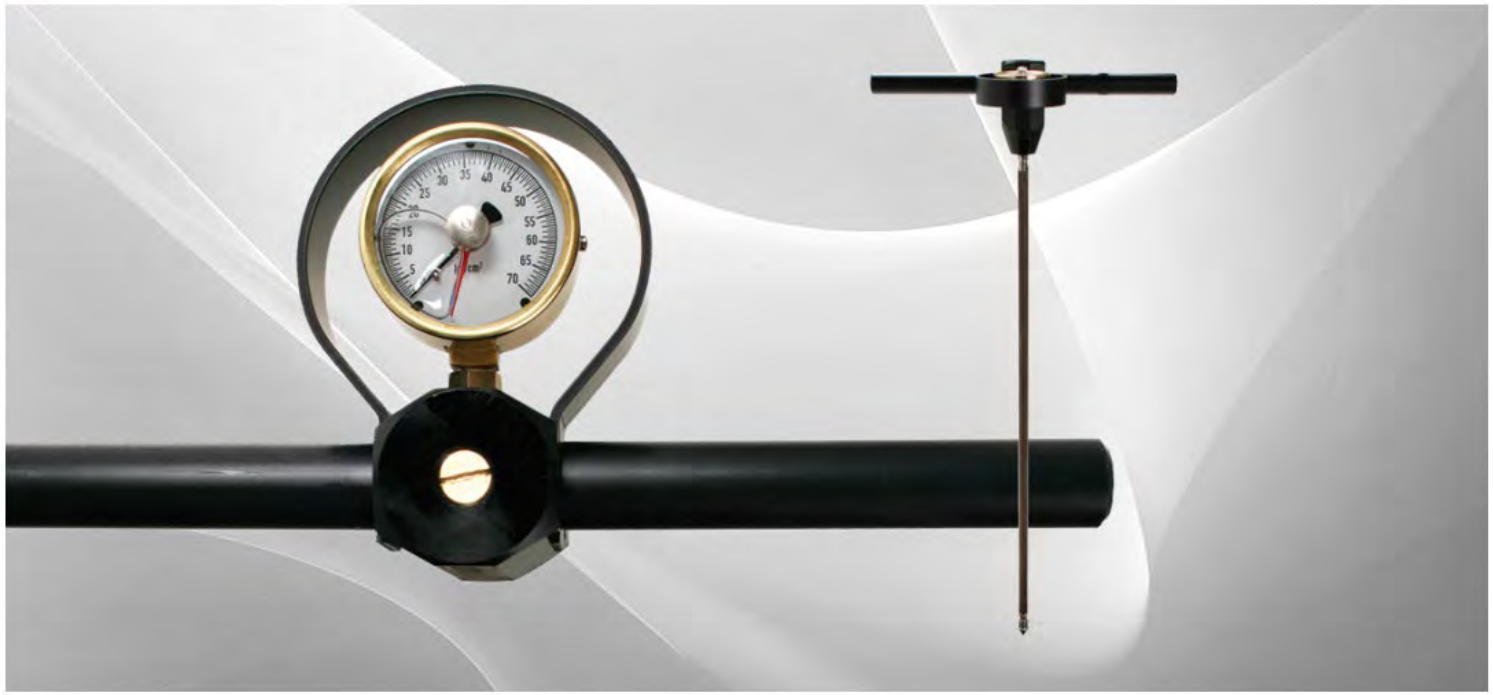
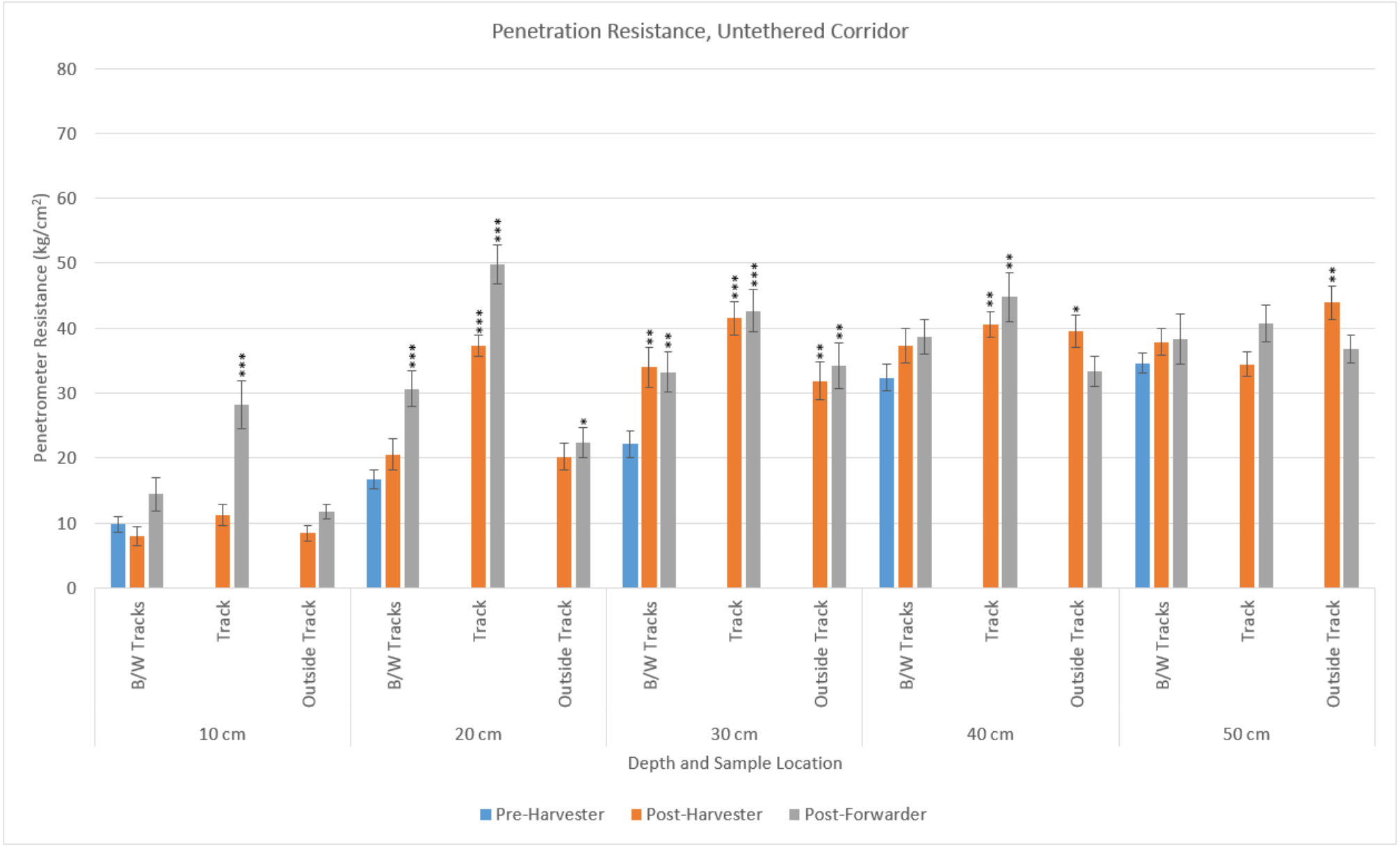
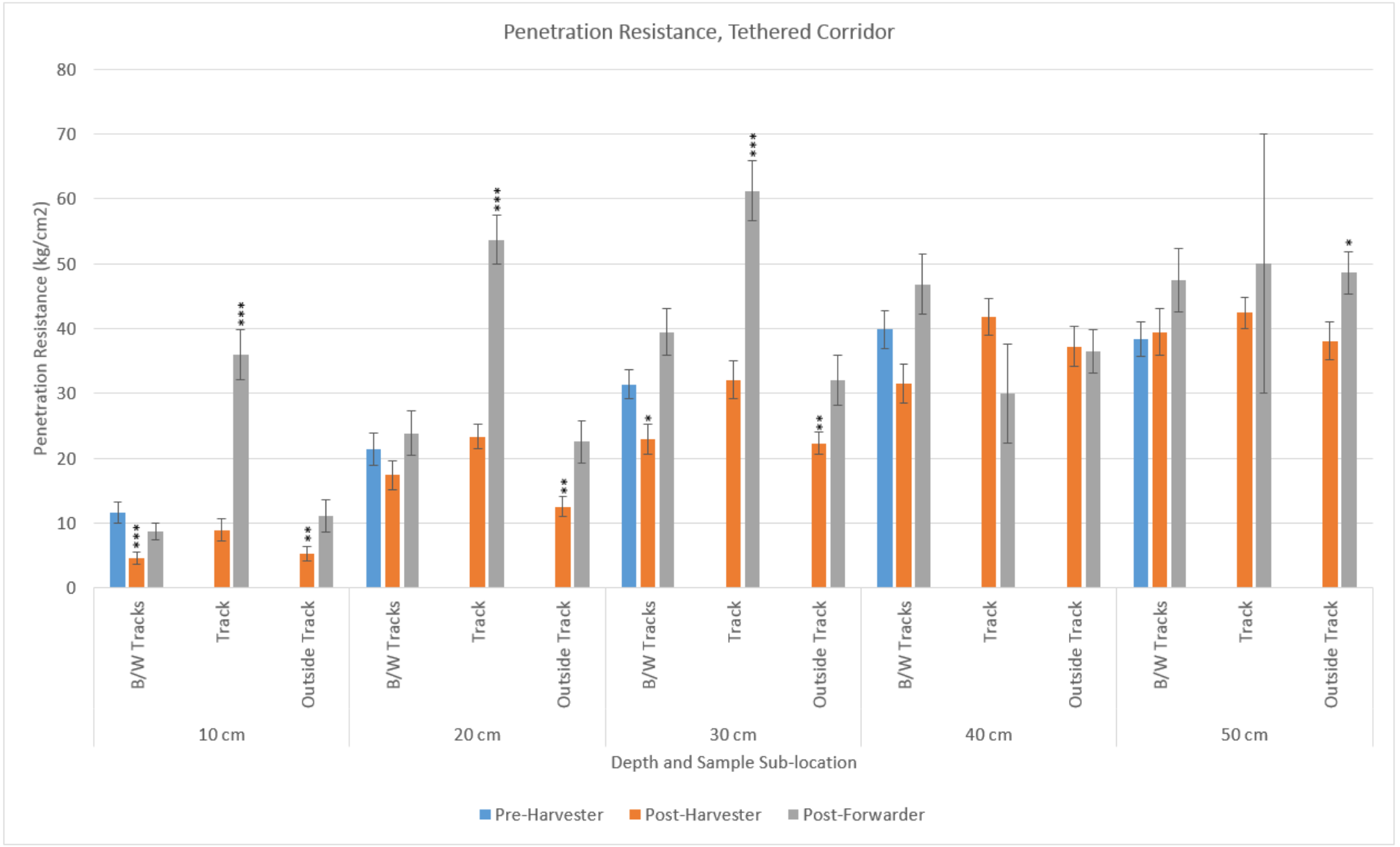


Photo from Humboldt Manufacturing website (www.humboldtmfg.com)


Penetration Resistance, Untethered Corridor
Penetrometer Resistance (kg/cm²)
80
70
60
50
40
30
20
10
0
B/W Tracks
Track
Outside Track
10 cm
20 cm
30 cm
40 cm
50 cm
Depth and Sample Location
Pre-Harvester
Post-Harvester
Post-Forwarder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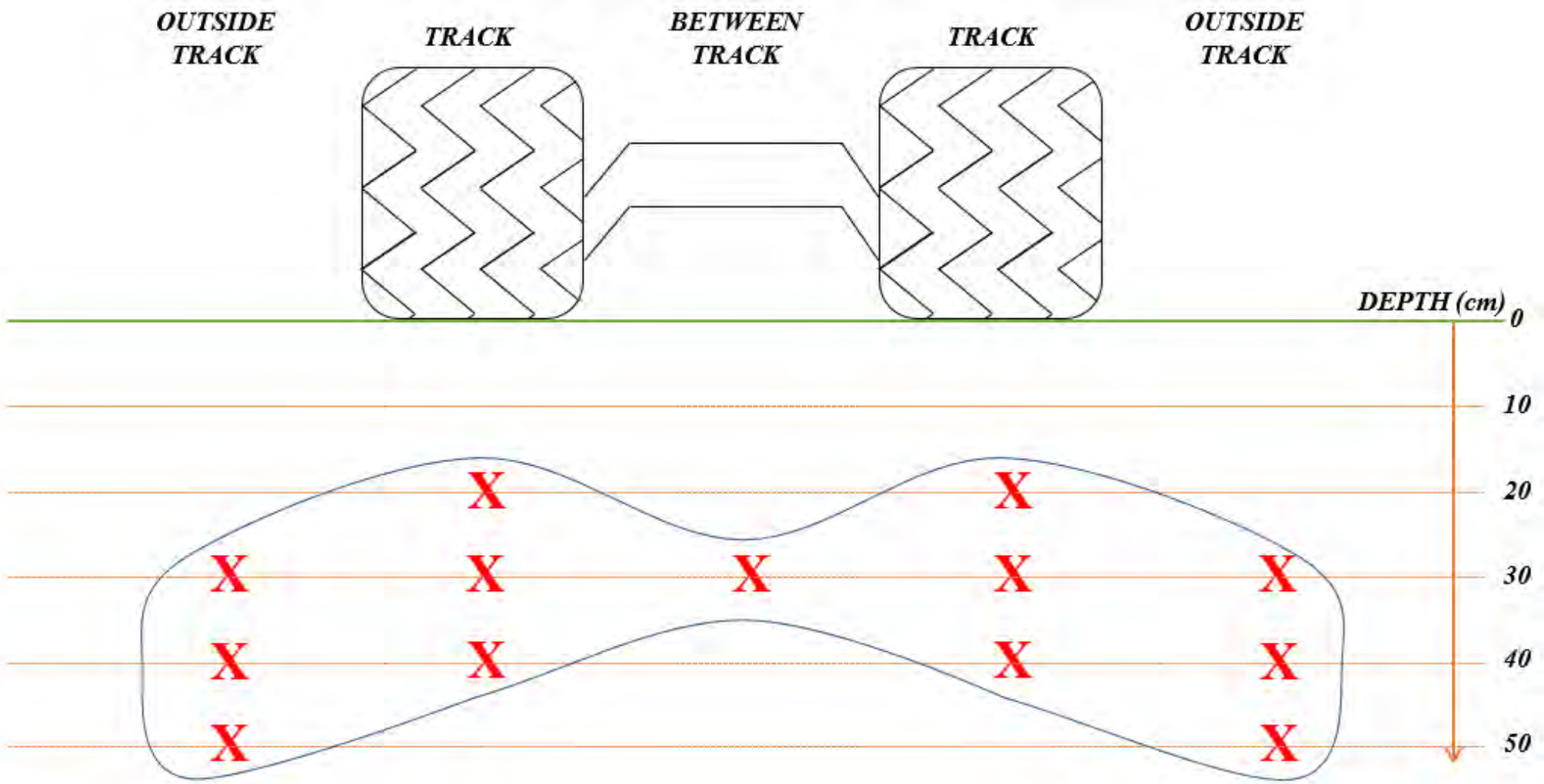
Depth and Sample Sub-location
Pre-Harvester
Post-Harvester
Post-Forwarder

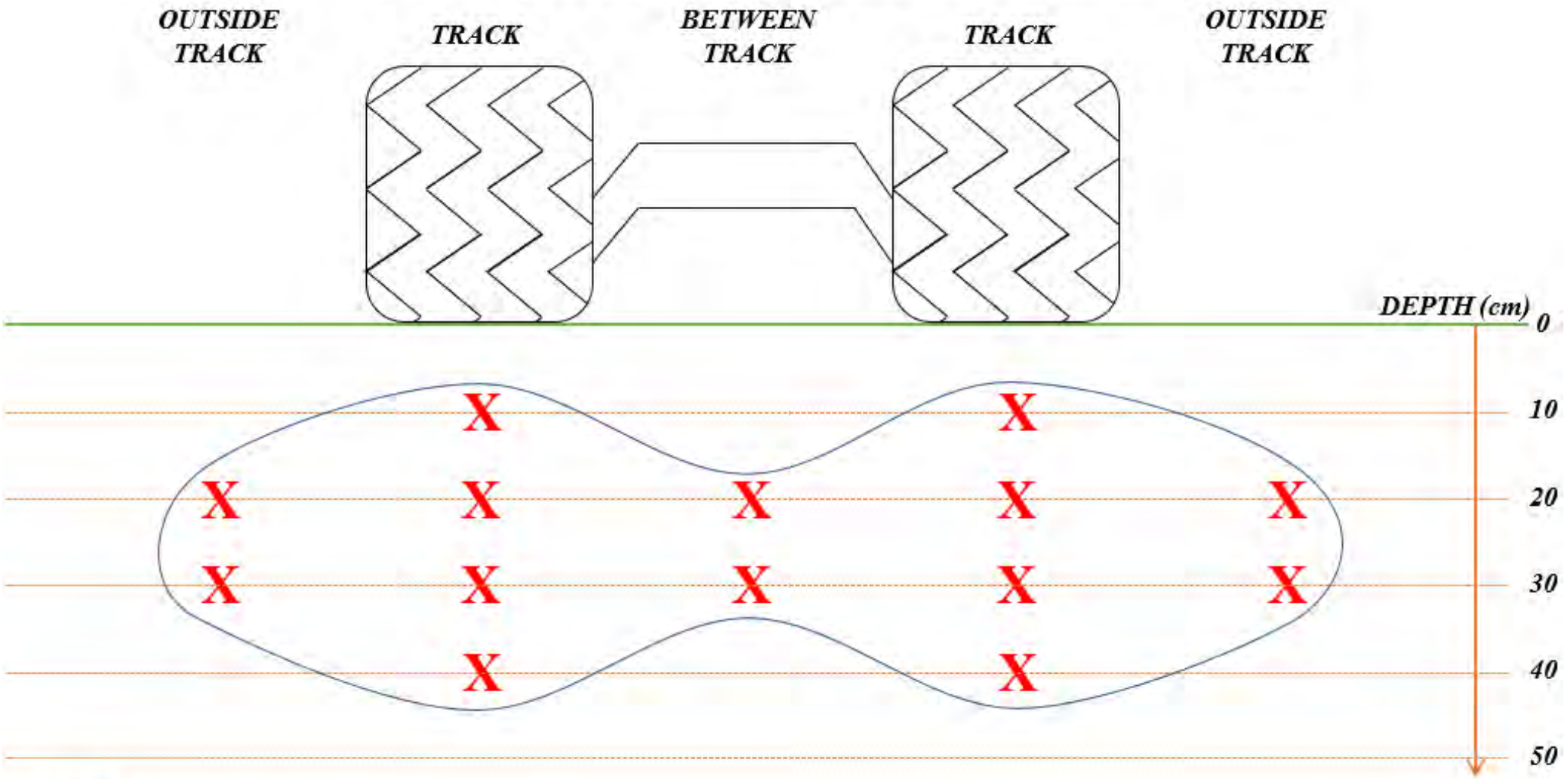
UNTETHERED, POST-HARVESTER



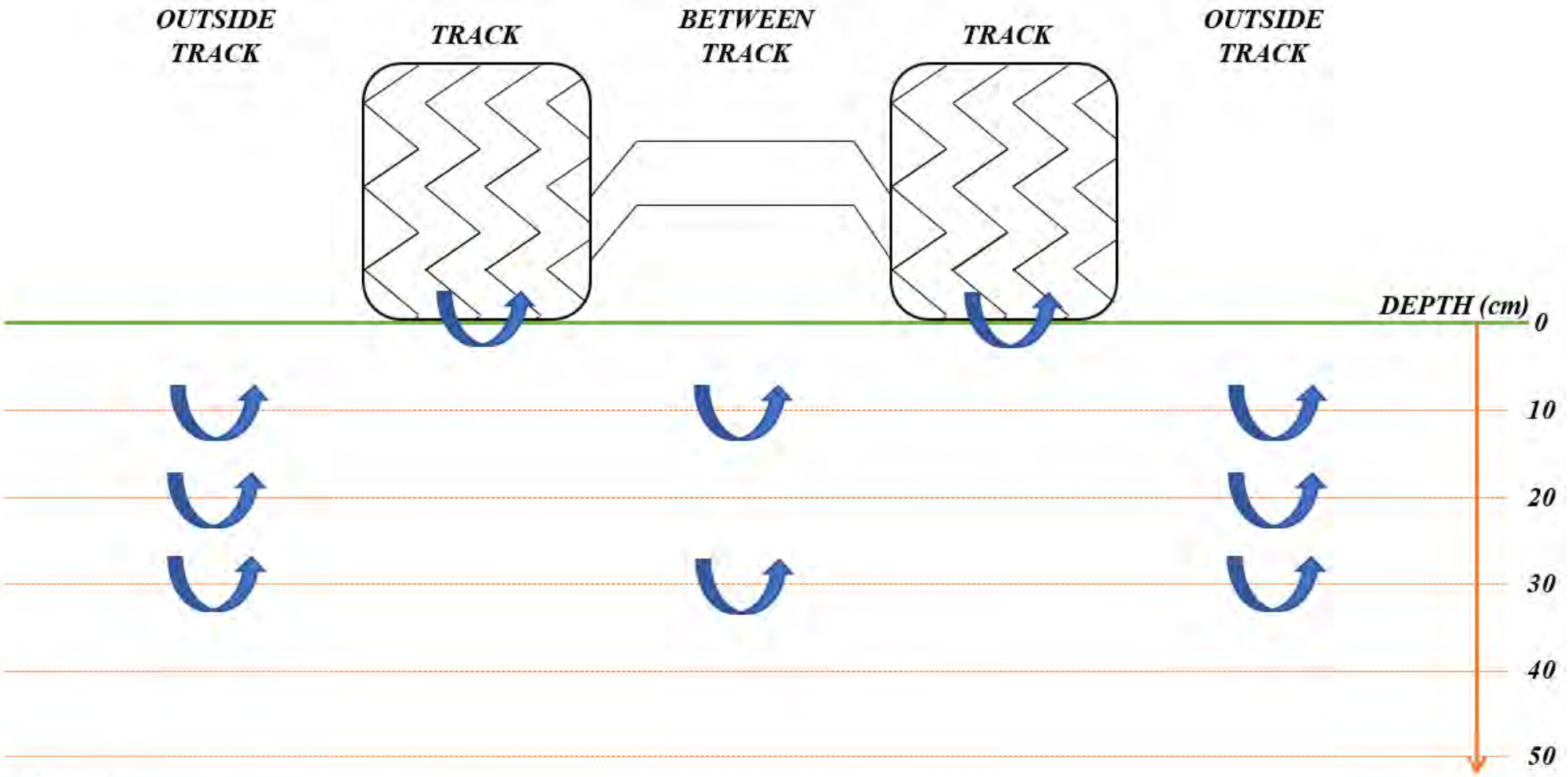
Legend:

X = statistically significant ***increase***.

UNTETHERED, POST-FORWARDER



TETHERED, POST-HARVESTER

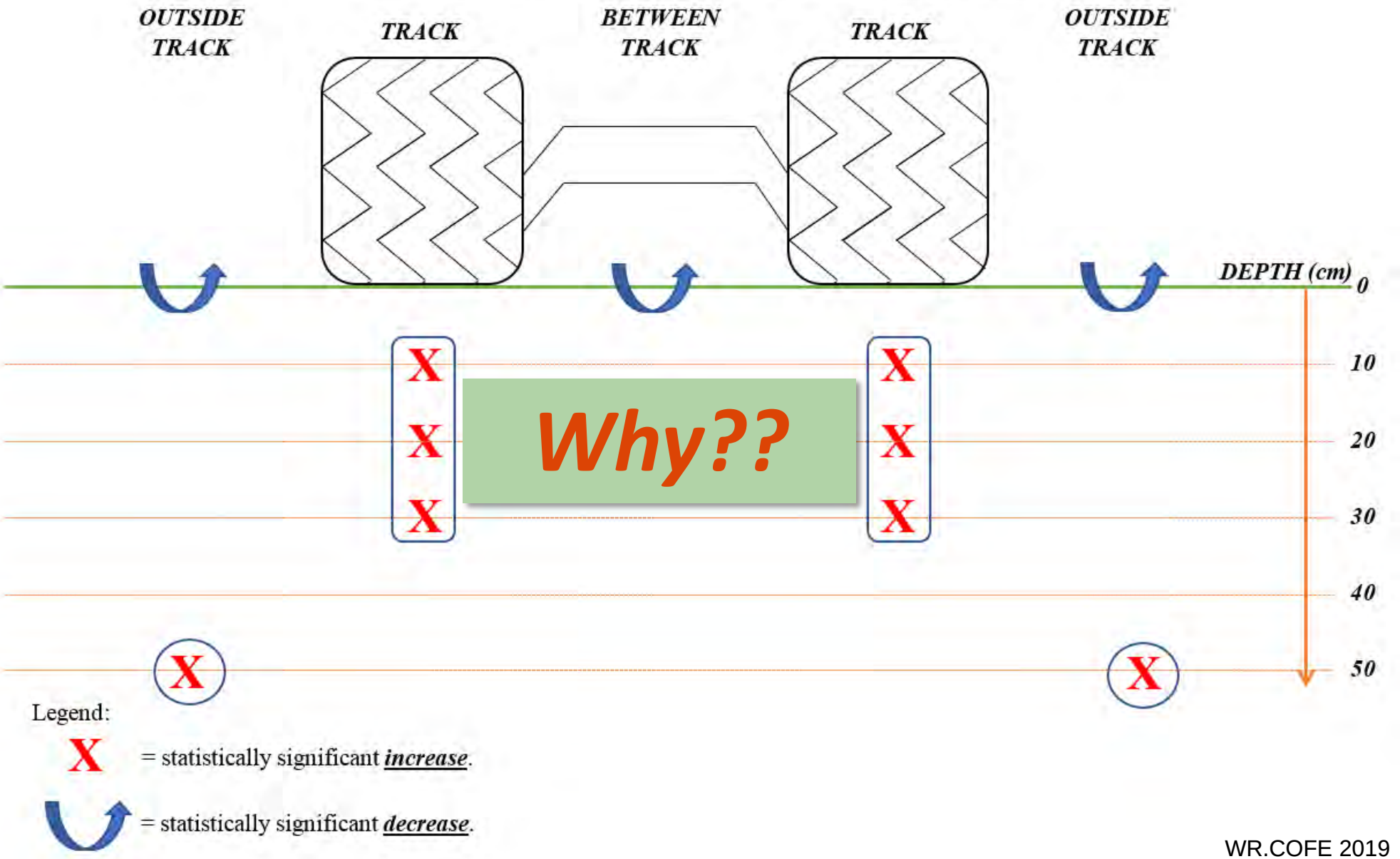


Legend:

X = statistically significant ***increase***.

= statistically significant ***decrease***.

TETHERED, POST-FORWARDER

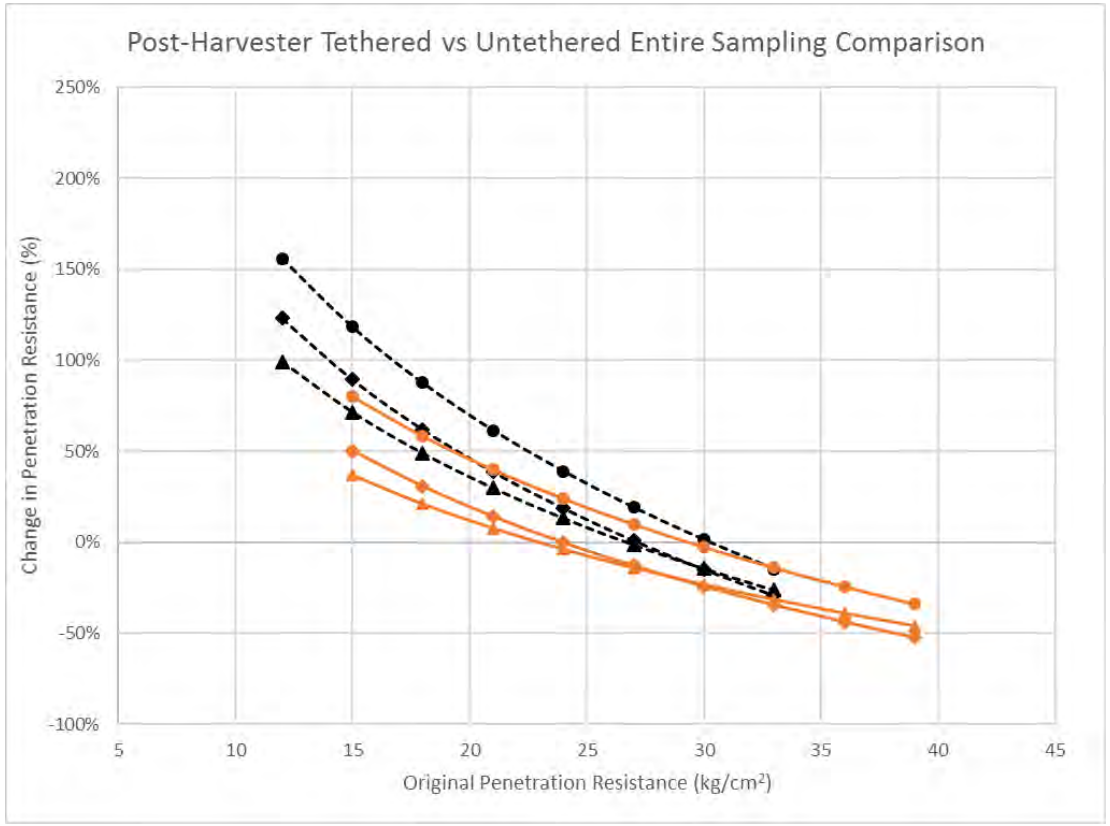


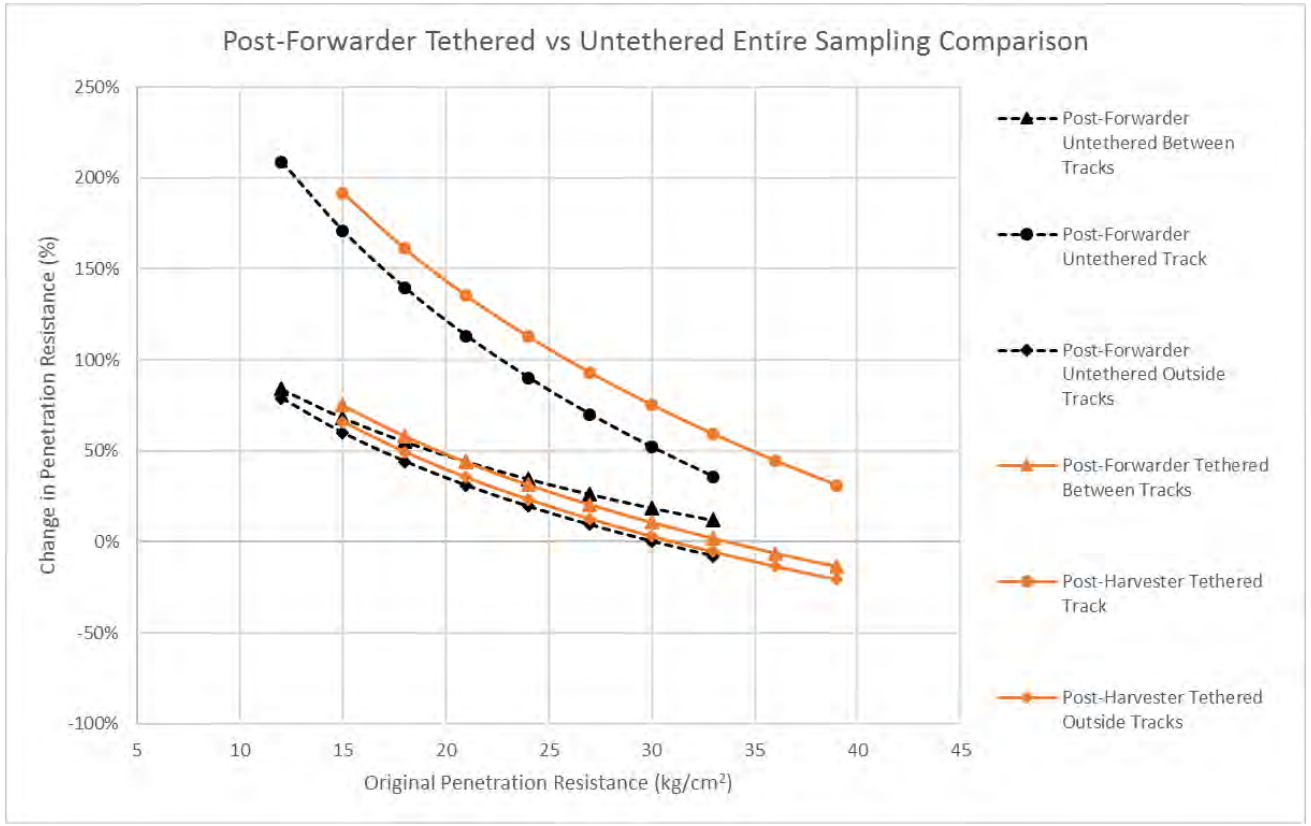
Why?

- Original soil condition
  - Looser materials contract, while denser materials expand
- Corridor A (untethered) soil was about 20% looser than corridor B (tethered) soil. Significant!

- Slope? No.
- Passes? No.

- Original soil condition
  - Looser materials contract, while denser materials expand





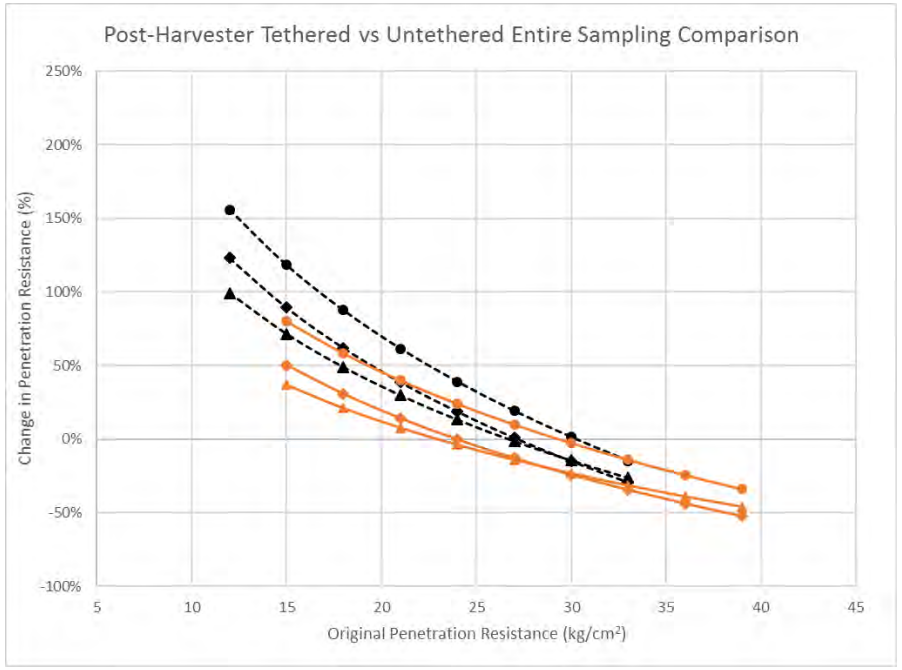
- Original soil condition
  - Looser materials contract, while denser materials expand

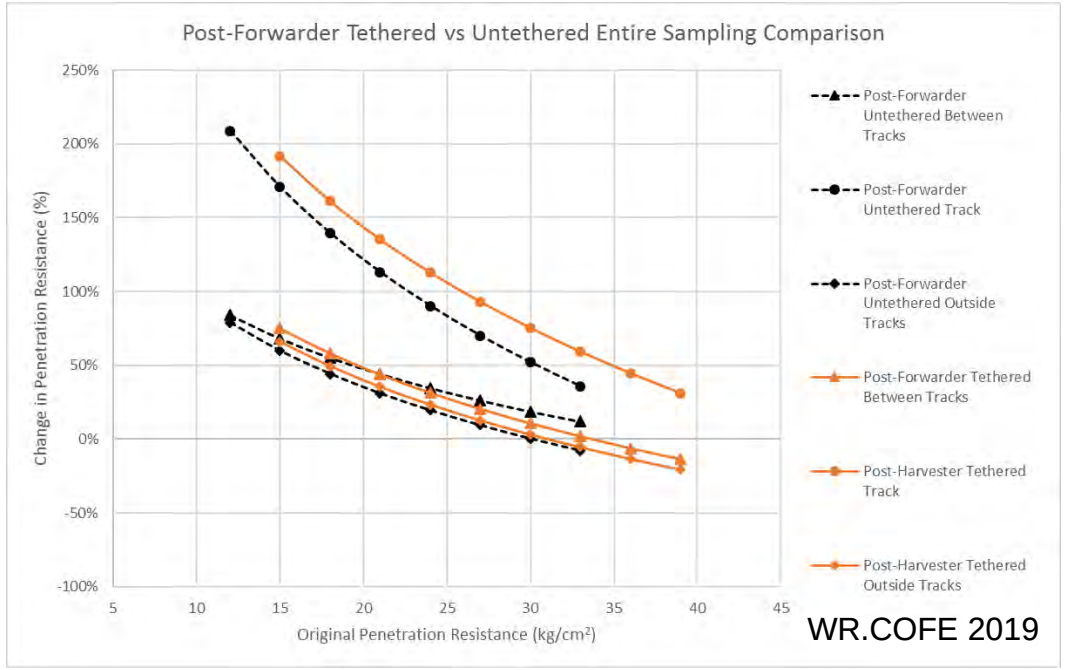
Post-Harvester

Rank	Location	% Change
1	Untethered Track	51%
2	Untethered Outside Track	30%
3	Untethered Between Tracks	22%
4	Tethered Track	7%
5	Tethered Between Tracks	-15%
6	Tethered Outside Track	-17%

Post-Forwarder

Rank	Location	% Change
1	Untethered Track	106%
2	Tethered Track	89%
3	Untethered Between Tracks	41%
4	Untethered Outside Track	27%
5	Tethered Between Tracks	18%
6	Tethered Outside Track	11%

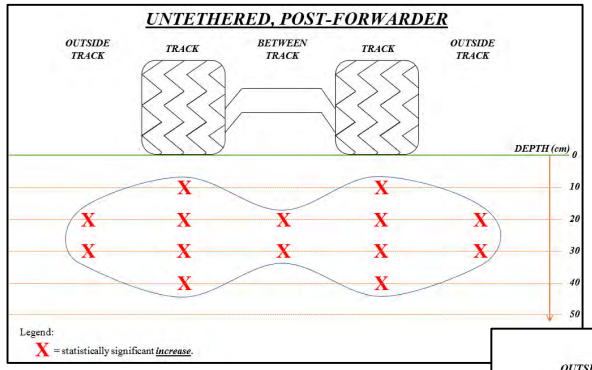




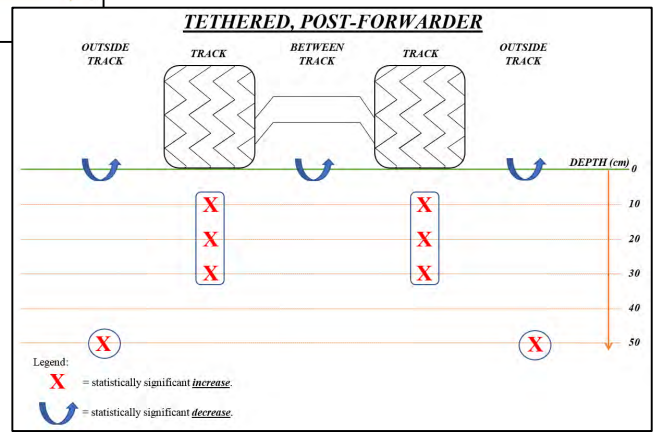
Soil Discussion

Horizontal benefits

- Controlled ‘track wander’
- Less significant ground coverage!

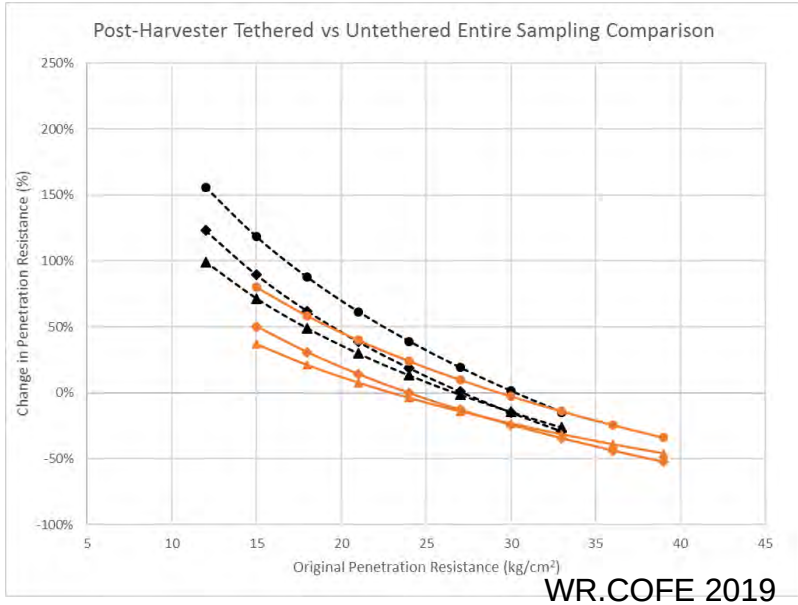


versus…



Vertical benefits

- Reduces maximum ground pressure → reduces shear displacement (maintaining soil profile) → enables more passes to reach densification



Productivity & Cost

Methodology, Harvesting & Forwarding Productivity

- Detailed time study of unassisted & cable-assisted harvester & forwarder via paper/stopwatch and video recording
- GPS tracking of machines to determine precise movement distances
- Tree size (dbh) observed from harvester display in cab

Photos courtesy of Dr. Woodam Chung

Harvesting & Forwarding Productivity

- Machine costs generated via publicly available cost models
- Harvesting/forwarding productivity models generated through regression techniques
- “Coupled” versus “uncoupled” system to show productivity ranges
- 19 ft^3/log measured at roadside after forwarding

Coupled System Productivity

Machine	MBF/PMH	Utilization	MBF/SMH	System Productivity (MBF/SMH)	U_F%
Untethered Harvester	25.7	80%	20.5	6.4	25%
Untethered Forwarder	8.0	80%	6.4		80%
Tethered Harvester	17.6	75%	13.2	7.1	40%
Tethered Forwarder	9.5	75%	7.1		75%

Coupled System Cost

	Costs Per SMH						
Machine	Fixed	Variable	Operator	TOTAL	(per MBF)	System ($/SMH)	Unit Cost ($/MBF)
Untethered Harvester	$133.55	$43.80	$42.30	$219.65	$34.38	$535.09	$83.75
Untethered Forwarder	$135.40	$137.73	$42.30	$315.43	$49.37		
Tethered Harvester	$144.77	$79.53	$42.30	$266.61	$37.60	$600.50	$84.70
Tethered Forwarder	$146.54	$145.06	$42.30	$333.89	$47.09		

Uncoupled System Productivity

Machine	MBF/PMH	Utilization	MBF/SMH	Machine Productivity (MBF/SMH)	U_F%
Untethered Harvester	25.7	80%	20.5	20.5	80%
Untethered Forwarder	8.0	80%	6.4	6.4	80%
Tethered Harvester	17.6	75%	13.2	13.2	75%
Tethered Forwarder	9.5	75%	7.1	7.1	75%

Coupled System Productivity

	Costs Per SMH						
Machine	Fixed	Variable	Operator	TOTAL	(per MBF)	System ($/SMH)	Unit Cost ($/MBF)
Untethered Harvester	$133.55	$140.70	$42.30	$316.55	$15.42	$597.07	$59.33
Untethered Forwarder	$116.93	$121.29	$42.30	$280.52	$43.91		
Tethered Harvester	$144.77	$147.72	$42.30	$334.79	$25.42	$635.69	$67.86
Tethered Forwarder	$128.95	$129.65	$42.30	$300.89	$42.44		

Harvester Productivity Difference: Why?

- Different harvester operators…
- Tethered operator stopped more frequent

- Narrower operating window while operating to maintain lead with tether, or to avoid sidehill on steeper slopes?

Visual Impacts

Photos courtesy of Dr. Woodam Chung

Post-Harvester

Post-Harvester

Post-Forwarder

Take-Away Messages, Management Implications

- ***Soils are complex, site conditions are important! Wet, dry, clay, sand, etc…***
- Horizontal and vertical benefits through careful implementation of cable-assistance
- Financially practical
- As we develop steep-slope technology, where are our new opportunities for improvement?
  - Operator training/ability
  - Machine maintenance/design
  - Regulatory environment

THANK YOU! QUESTIONS?

PRESTON GREEN

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Photo courtesy of Dr. Woodam Chung

2019 Western Region COFE Seminar – Improving Forest Harvesting Operations

COFE Western Region

Improving Forest Harvest Operations

January 17, 2019 • Eugene, OR

Agenda

Start Date: January 17, 2019
Location: Valley River Inn, Eugene, OR
THEME: *IMPROVING FOREST HARVESTING OPERATIONS*

Click on any presentation title below to view a pdf of the presentation.

8:15 *Introduction to WR.COFE & Seminar* – **Jeff Wimer**, Chair, WR.COFE & Forest Engineering, Resources and Management Dept., College of Forestry, Oregon State University

SESSION 1: Logging – Steep Slope

8:30 *Tethered Cut-to-length in Western Oregon: A Multi-objective Case Study* – **Preston Green**, Graduate Student, Forest Engineering, Resources and Management Dept., College of Forestry, Oregon State University

9:00 *Tethered logging in Southwest Oregon: A Research Perspective* – **Woody Chung**, Forest Engineering, Resources and Management Dept., College of Forestry, Oregon State University

9:30 *Tethered Logging in Southwest Oregon: A Landowner Perspective* – **Brennan Garrelts**, Lone Rock

10:00 *Peterson Cat update*

10:10 BREAK (Refreshments Provided)

10:40 *Pape' Machinery Update*

10:50 *Grapple Yarding Through the Years* – **Austin Weber**, Weber Logging and Construction Inc.

SESSION 2: Workforce Issues

11:20 *Planning the 2020 Workforce: Growing Our Forest Contract Capacity* – **Rex Storm**, Associated Oregon Loggers

About the Conference

WR.COFE is a regional chapter (western United States and British Columbia) of the COUNCIL ON FOREST ENGINEERING (COFE). COFE is an international professional organization formed to foster the development of forest engineering in industry, government, and education in order to promote the best methods of managing and operating forests, both private and public. COFE serves the forestry profession by disseminating technical information about forest engineering. For more information, see the COFE website at: www.cofe.org

11:50 *Triad Machinery Update*

12:00 LUNCH (Provided)

12:40 *ANNOUNCEMENTS:* Ticket Raffle, OSU Student Scholarship Awards – Jerry Sedlak Memorial Scholarship

13:10 *Blount International Update*

SESSION 3: New Technology

13:50 *Modern Machinery Update*

14:00 BREAK (Refreshments Provided)

14:20 *Fire Fighting on Federal Land* – **Mike Robinson**, Coos Forest Protective Association

SESSION 4: Technological Innovation in Forestry

14:50 *Computer Vision for Real-Time Tree Detection and Measurement* – **Woody Chung**

SESSION 5: Roads

15:20 *Rock Economics* – **Scott Hoffine**, Roseburg

15:50 *Road Construction in Forest Activities: The Safety Issues Related to Road Construction* – **Larry Fipps**, Oregon Occupational Safety and Health Administration

16:20 *Wrap-Up and Evaluation* – **Jeff Wimer**

Upcoming Conferences And Workshops

2020 North American Forest and Conservation Nursery Technology Webinar Series: FREE

Start Date: August 5, 2020
End Date: September 23, 2020
Conference Location: Webinar Series

Western Forestry & Conservation Association
4033 SW Canyon Road
Portland, OR 97221