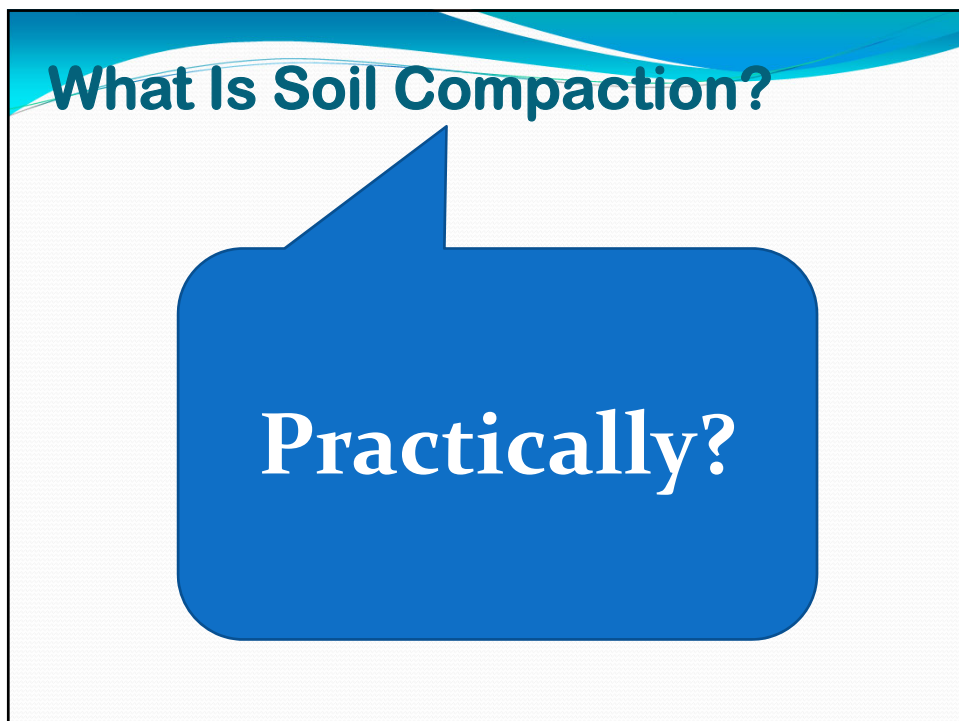


Conquering the Complexity of Compaction!

OSU Precision U
Jan. 8th, 2020

Ian McDonald, OMAFRA







What Is Soil Compaction?

A Management Decision

1. Timing of field operations
2. Type of field operations (freq + aggression)
3. Weight and configuration of equipment
4. Crop selection and rotations
5. Return of organic amendments
6. Soil management

We Decide!

This slide has a blue wavy header. The title 'What Is Soil Compaction?' is in a dark blue, sans-serif font. Below the title is the section header 'A Management Decision' in a bold, dark blue, sans-serif font. Underneath is a numbered list of six items, each in a blue, sans-serif font. At the bottom right, there is a blue speech bubble with the text 'We Decide!' in a white, bold, sans-serif font. The speech bubble has a tail pointing towards the list item 'Return of organic amendments'.

Let's Beat Soil Compaction!



1. Build Better Soils
2. Avoid Wet Soils
3. Bigger Tires
4. Lower Tire PSI
5. Use Inflation/Deflation Systems
6. Better Tires
7. More Tires/Axles
8. Less Passes
9. Control Traffic
10. Lower Load Weights

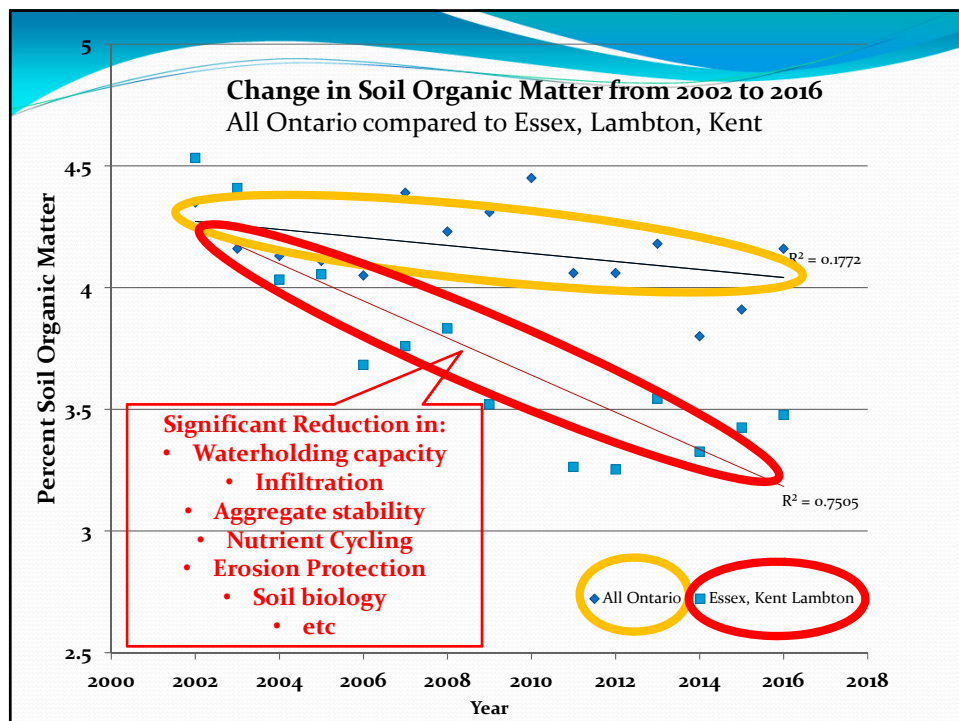


Why Do We Care About Soil Compaction?

Why Do We Care About Soil Compaction?

Results in:

- Decreased water infiltration
- Reduced water holding capacity
- Reduced root growth and rooting depth
- Increased soil erosion
- Reduced nutrient uptake
- Reduced water and soil quality
- **Increased input cost**
- **Reduced YIELD!**



Why More Elgin SCIA Compaction Day Aug 8, 2019

FARMSMART PRESENTS:

COMPACTIONSMART

WE ALL HAVE IT, LET'S MANAGE IT!

Friday, January 20, 2017
RIM Park,
Manulife Financial Sportsplex,
Forbes Hall, 2001
University Ave. E., Waterloo, ON




Scott Shearer John P. Fulton
Food, Agricultural and Biological Engineering, The Ohio State University

COMPACTION ACTION

www.ifap.com



Compaction Video Series:
[Compaction Action Day Overview](#)

- [1. Tires vs Tracks](#)
- [2. Tire Pressure and Compaction](#)
- [3. Skinny vs Wide Tires](#)
- [4. Control Traffic on Your Fields](#)
- [5. Farmers Talk: Ken Nixon and Shawn Schill](#)
- [6. Matthias Stettler on Compaction](#)

Data Results

Please Note — It's important to read both of documents below to correctly interpret the results.

Understanding Soil Compaction
Interpreting Data Results

Dundas SCIA Compaction Day Aug 29, 2019

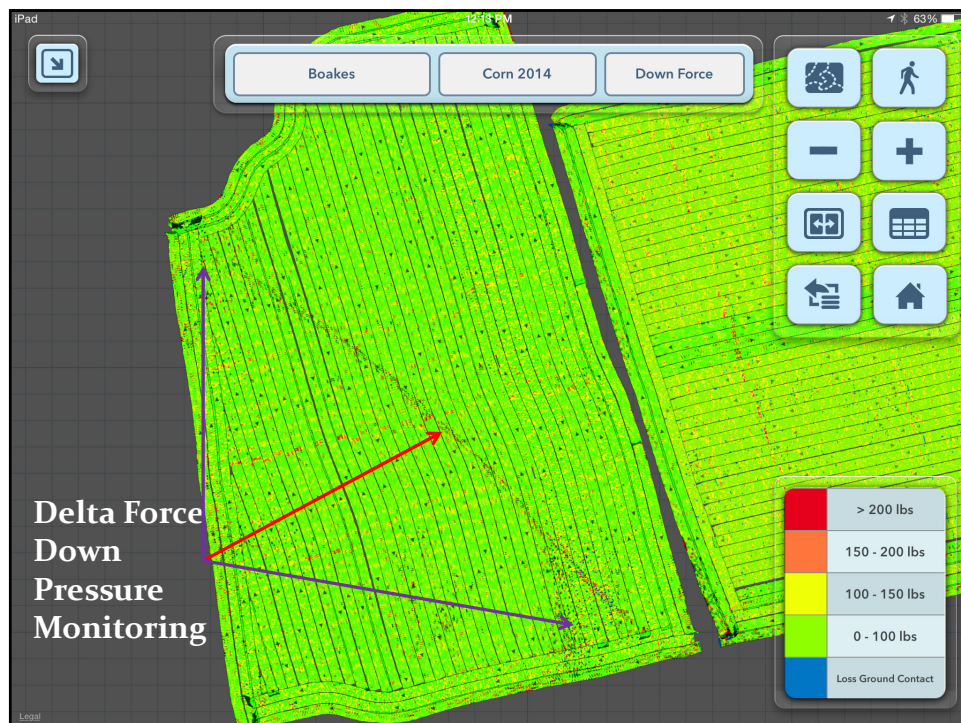
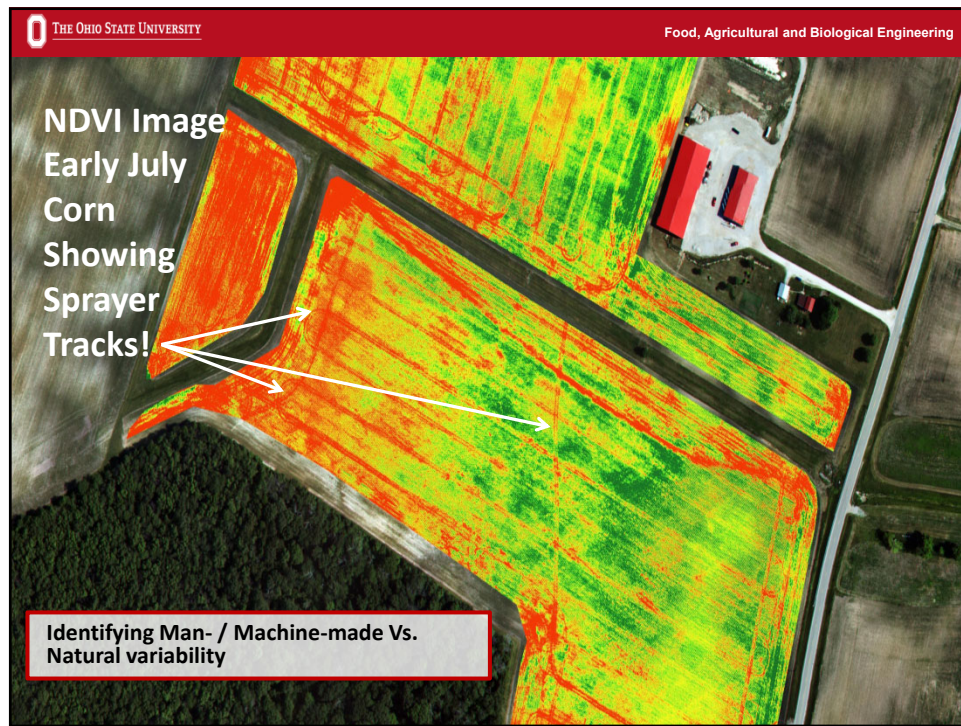




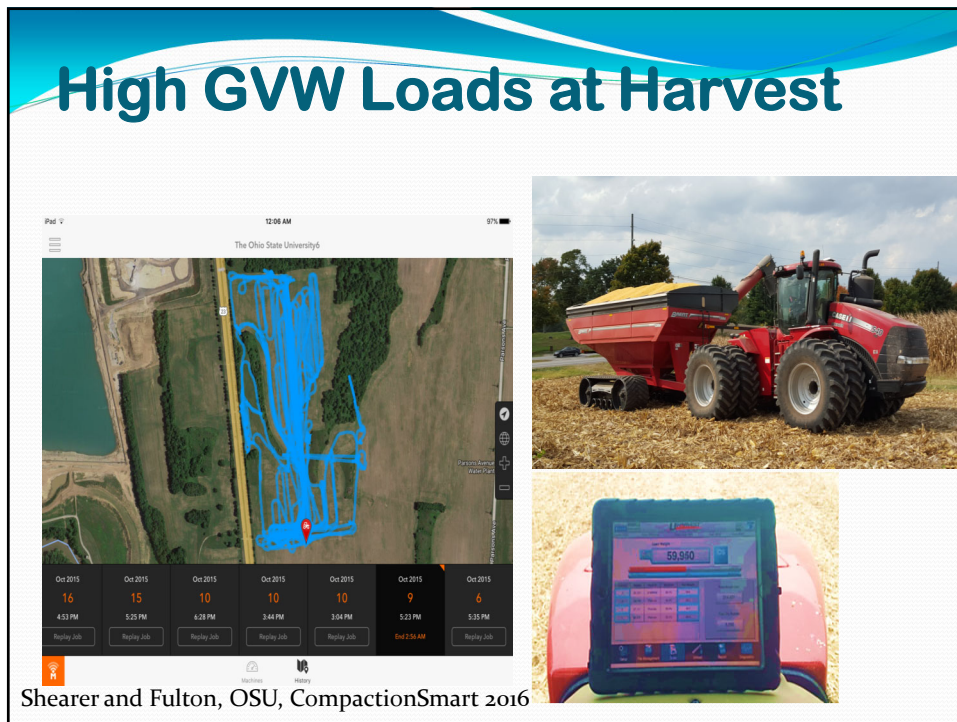
Equipment Axle Loads

Common Field Equipment Axle Loads		
Equip. Type	Axle Load (ton)	Limit on
4WD tractor, 200hp		axle
4WD tractor, 325hp		toy
4WD tractor, 530hp		built
Terragator Rear Axle		ts ok
Manure Tanker 4,200 gal		onto a
Manure Tanker 7,200 gal		em”?
Combine 12 row	24	recommendation is <10
Grain Buggy 720 bu	22	ton/axle
Grain Buggy 1200 bu	35-40	

**Matthias Stettler
Bern Univ suggests
the #'s should be
<5t/axle and <15 psi
inflation pressures
in field!**



High GVW Loads at Harvest



Why is Soil Compaction so Complicated?

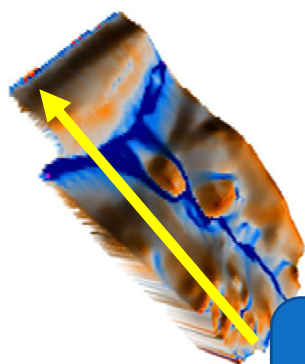
Phenomenon of Cyclic Loading

On most implements:

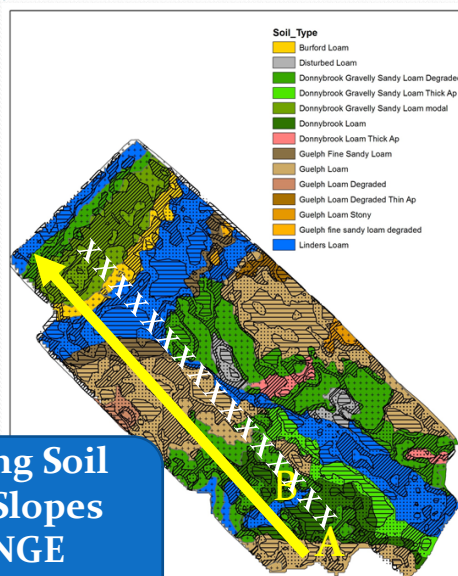
- Axle Weight changes dramatically and continuously during operation.
- Always increasing or decreasing
- The change is usually linear



Why is Soil Compaction so Complicated?



Changing Soil
Types, Slopes
CHANGE
Soil Moisture!



Why is Soil Compaction so Complicated?

- Cyclic Loading
- Variation in field landscape (soil and elevation)

Why is Soil Compaction so Complicated?

- Cyclic Loading
- Variation in field landscape (soil and elevation)
- Compaction occurs in wheel strips and we harvest in bigger widths so the impact gets “hidden”!
- The impact is occurring underground which is much less visible to us, even the above ground response may not reveal the true whole system impact!
- **THEREFORE – extremely difficult to determine COMPACTION COST!**

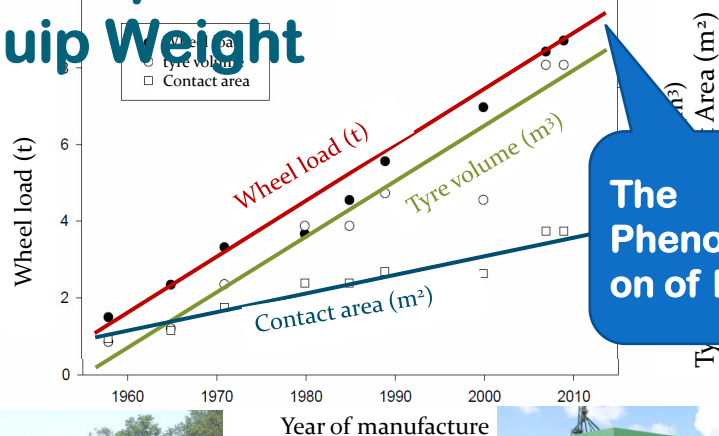
Why is Soil Compaction so Complicated?

The “causal” equation!

$$SC = aM \times bFR \times cSM \times dSMD \times TST \times TP \times eSH \times fTX$$

- M – Mass
 - FR – Frequency (# Of Passes)
 - SM – Soil Moisture
 - SMD – Soil Moisture @ Depth
 - TST – Tire Size & Technology
 - TP – Tire Pressure
 - SH – Soil Health
 - TX – Soil Texture
- And a,b,c,d,e,f are coefficients*

Consequences of Increased Equip Weight



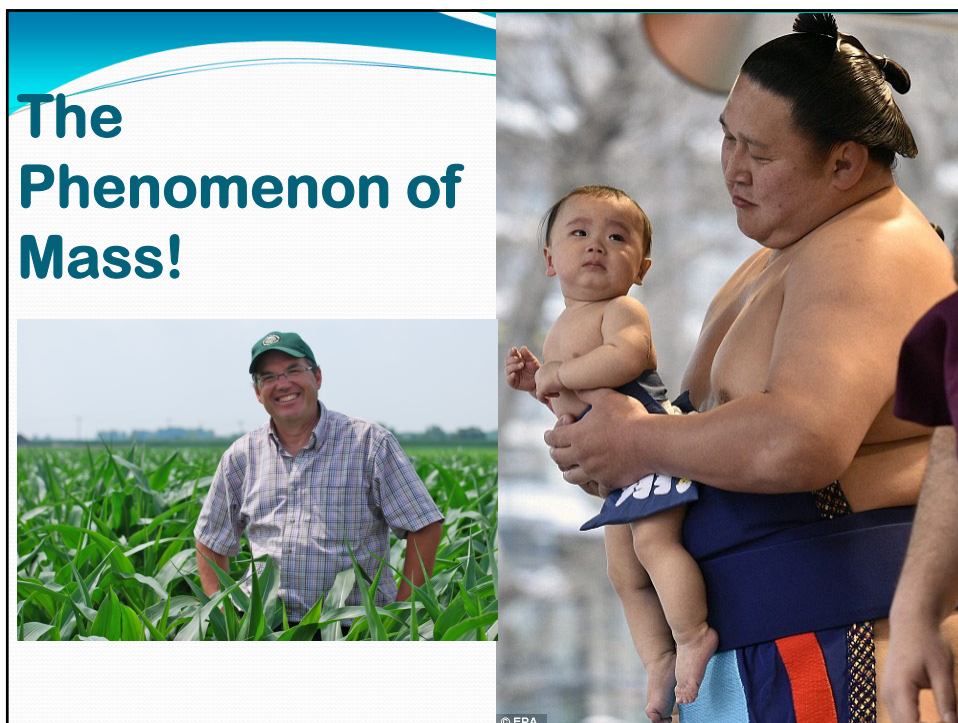
The Phenomenon of Mass!



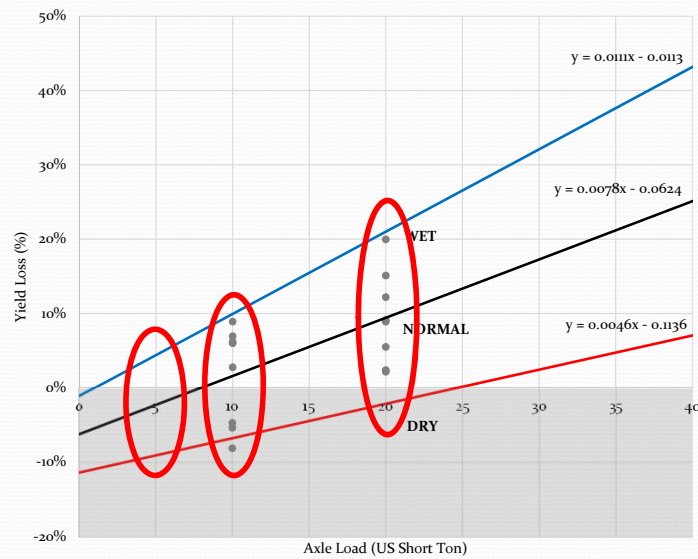
Year of manufacture

Source: Per Schjøning,
Aarhus University, DK





Yield Loss vs. Axle Load – Corn



Shearer and Fulton, OSU, CompactionSmart 2016

What Matters in Soil Compaction?

- Mass – total load
- Pressure – how load distributed (contact patch)
- Soil Moisture – higher H₂O > higher compaction potential

What Have We Been Doing in Ontario?

- **CompactionSmart**
 - **Field events**
 - **Articles**
- **Presentation's**
- **Research**

Ontario Big Compaction Events

- 2017 FarmSmart CompactionSmart
- 2017 IFAO Compaction Action
- 2018 Northeast, Halton, Maizex
- 2019 Dundas and Elgin Local SCIA Compaction Day's
- 2020
 - Tracks and Tires Aug 21
 - NA Manure Expo Aug 27
 - East Central Regional SCIA Compaction Day Sep 2

**>1200
farmers
to field
events!**

Compaction Fighting Tools

Why?



The collage illustrates the problem of soil compaction and the tools used to combat it. The top right shows a person using a hand tamper. The bottom left shows a close-up of a tire tread. The bottom right shows a hand holding a clump of compacted soil. The center features a mechanical soil compaction tool with a pressure gauge.

Tires: Size, Volume and Technology

Speed!

If You Aren't Optimizing You Are Losing!

- Safety
- Tire wear and failure
- Fuel economy
- Soil Compaction
- Crop Damage
- Increased Input Costs
- Decreased returns




The speedometer shows a needle pointing to 40 mph. The dashboard also displays other information, including a tire size of 520/70 R34 148D TL and a MSPN of 29601.


Why is Tire Pressure so Important?

- 40 vs 20 vs 10 vs 8 psi
 - 40 > 38 = 2 psi = 5%
 - 2 psi; No "Big Deal" right?
 - 50% reduction
 - 50% reduction
 - 2 psi = 20% reduction
- Increase contact patch
- Distribute the load

Why Are We Where We Are Today?



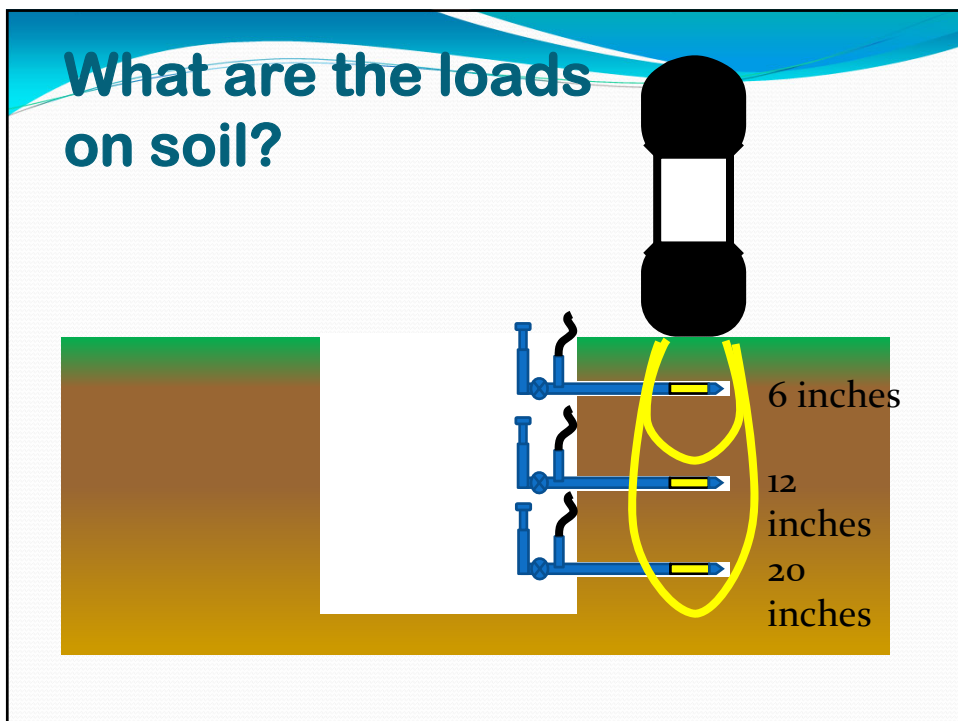
Jake Kraayenbrink – Agribrink



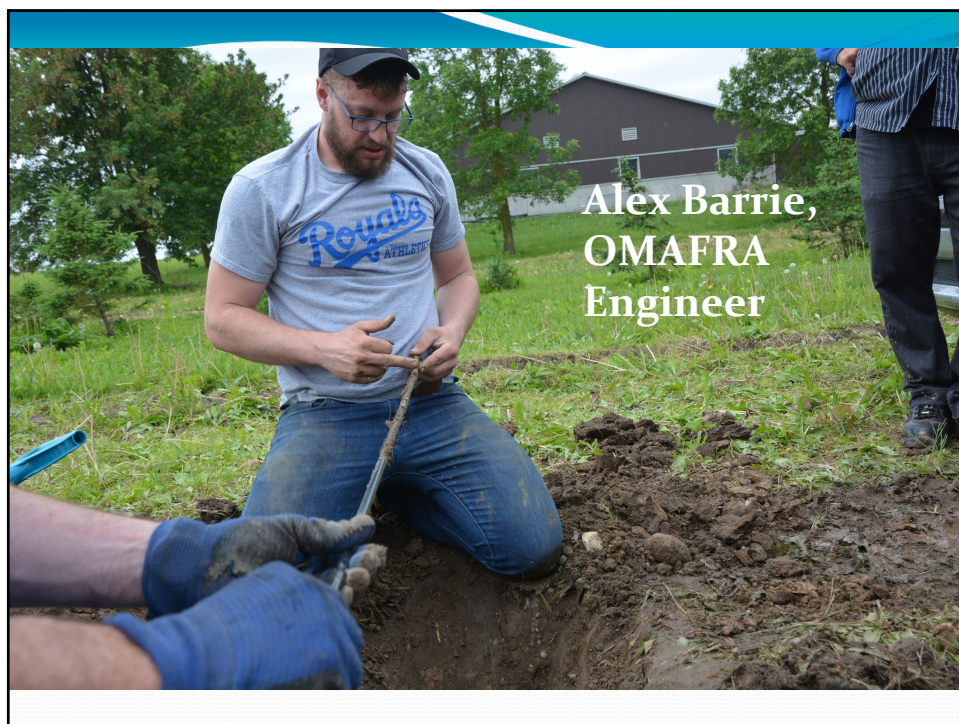
Matthias Stettler – Bern Univ.

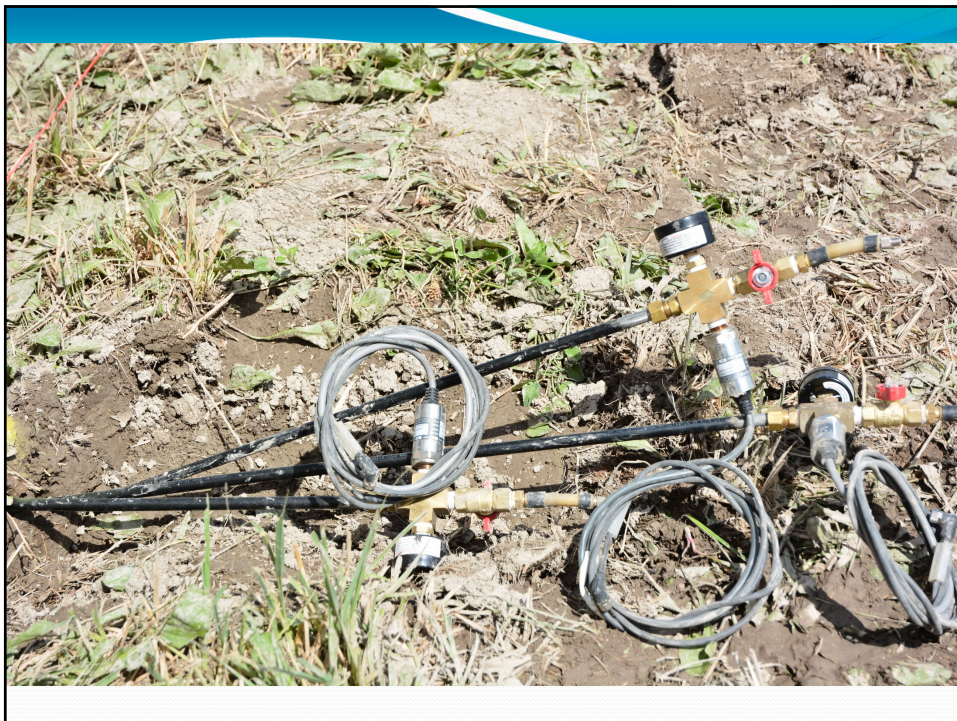


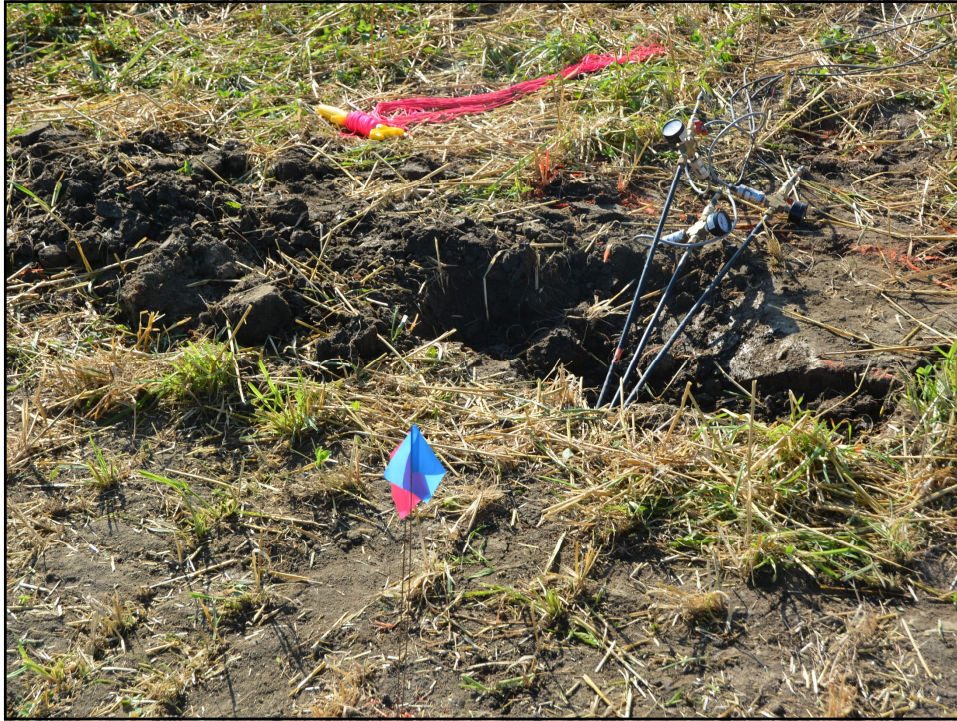




















Soil Strength

Soils are extremely variable, but the average “safe stress limit” is considered as:

≈14.5 psi (1 Bar) for topsoil

≈7.25 psi (0.5 Bar) for subsoil

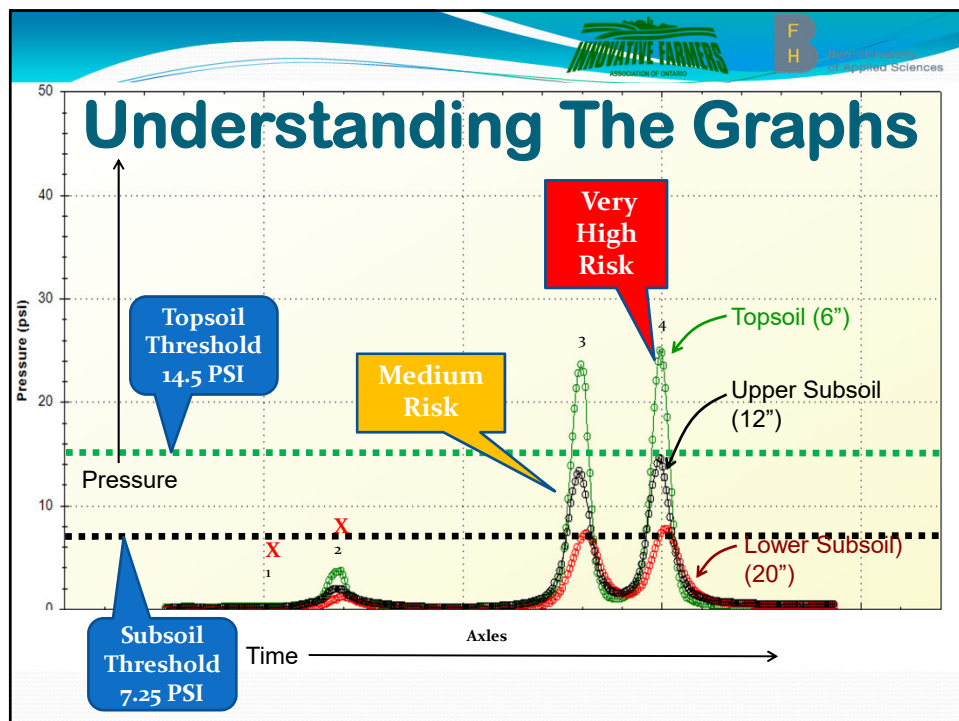
We are not measuring
COMPACTION!

Assessing **PRESSURE** Exerted
by the Load to depth of 6, 12,
20”!

PRESSURE is a
PROXY for Soil
Compaction!

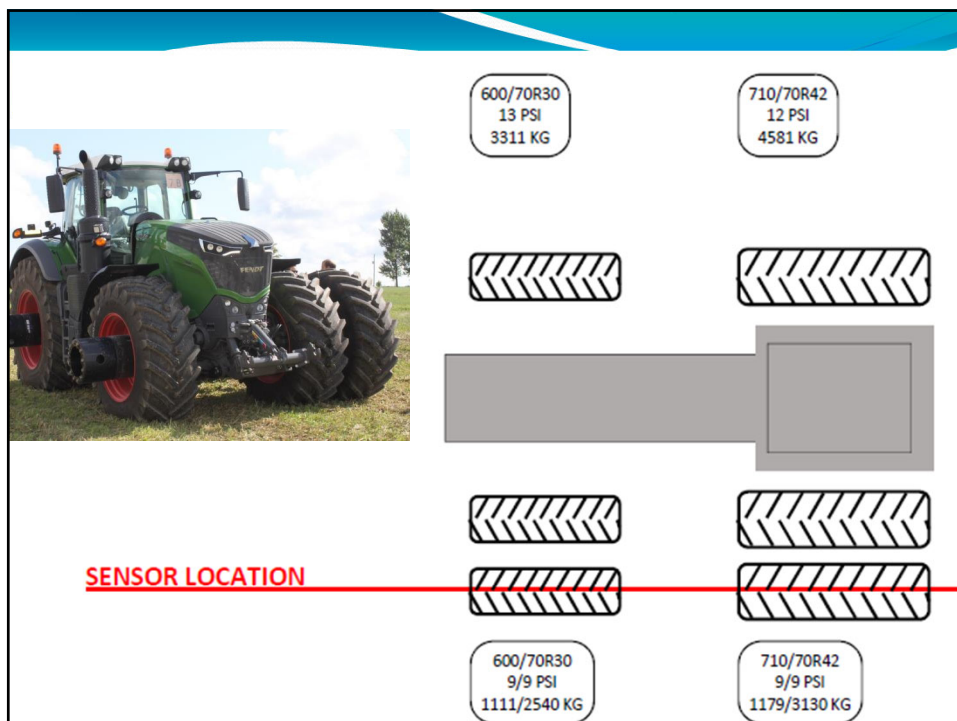
The “Results”!

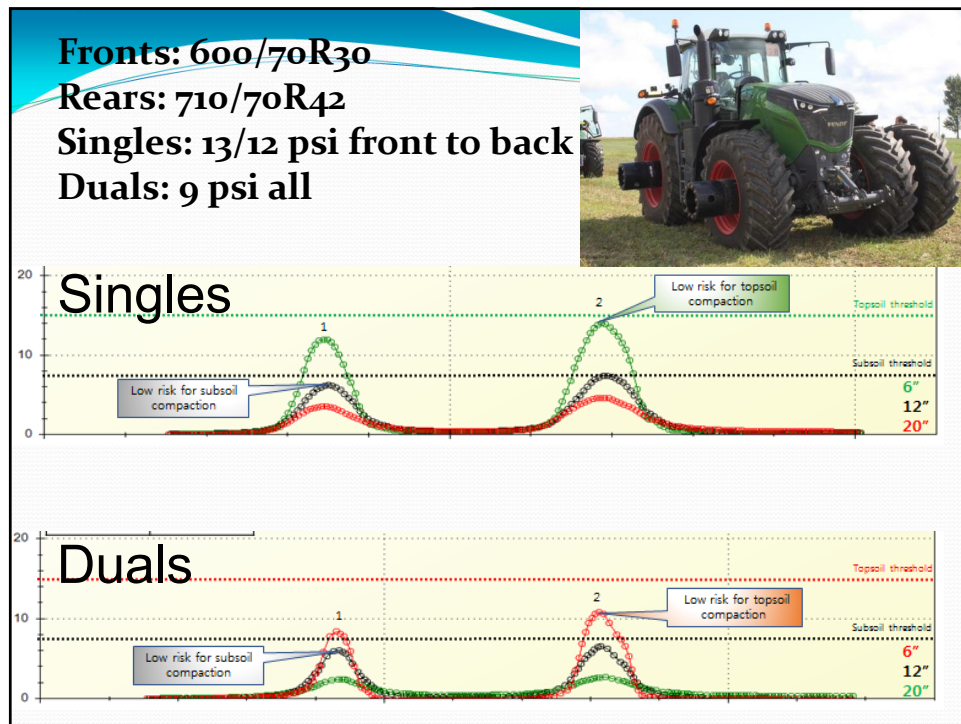
- This is somewhere between “demonstration” and “research”!
- Comparisons can be made within a site (soil type, moisture), but even at a site we have equipment going over 3-5 sensor installations
- The trends found are maintaining across sites/soils but the absolute values change!

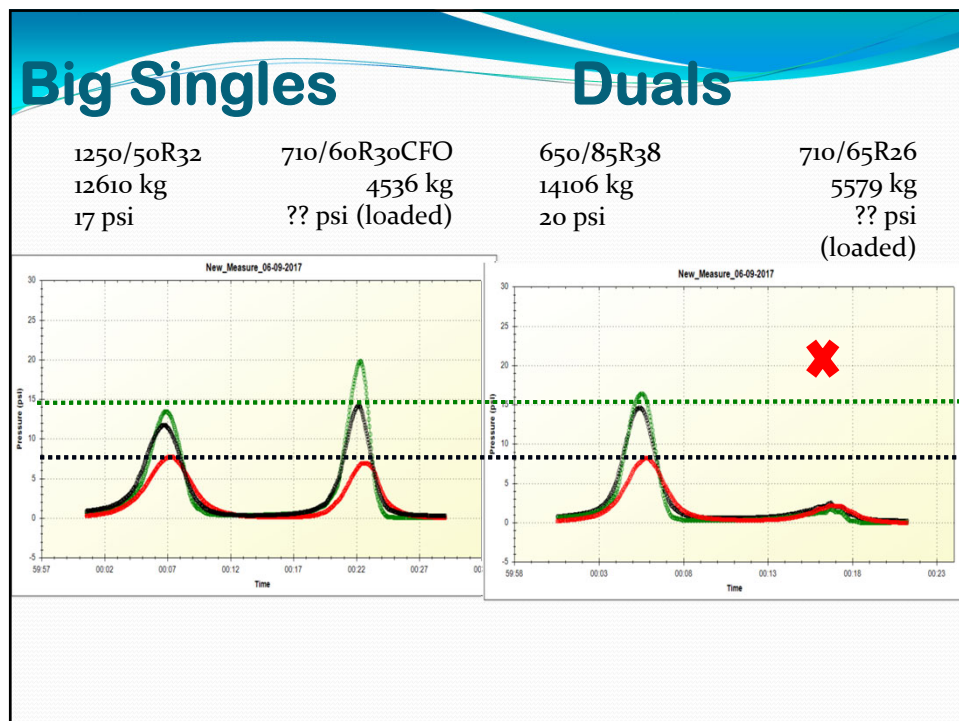
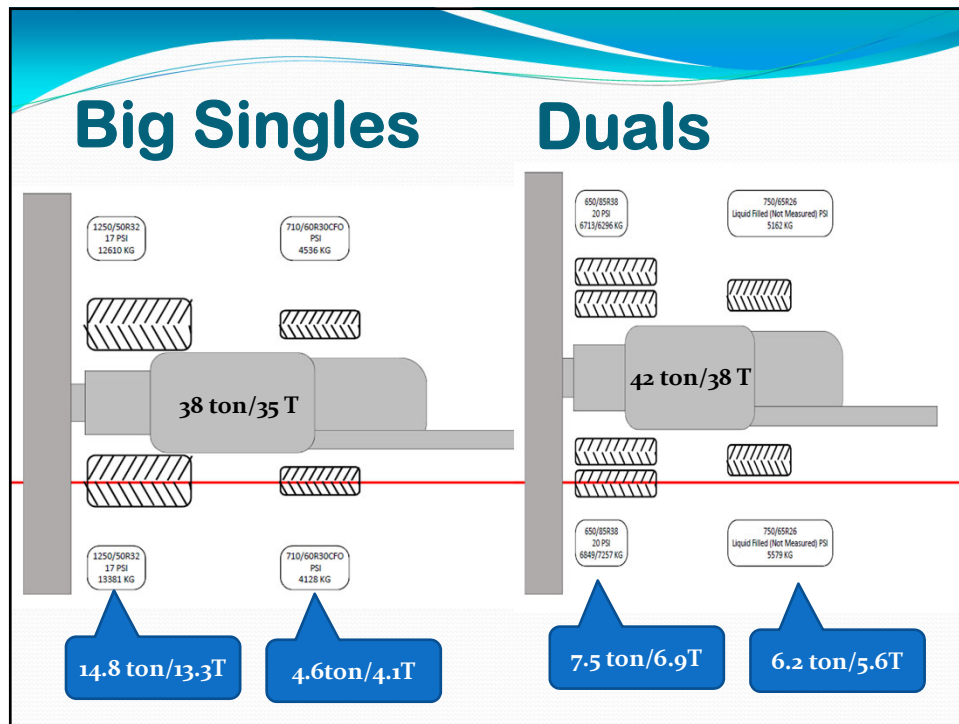


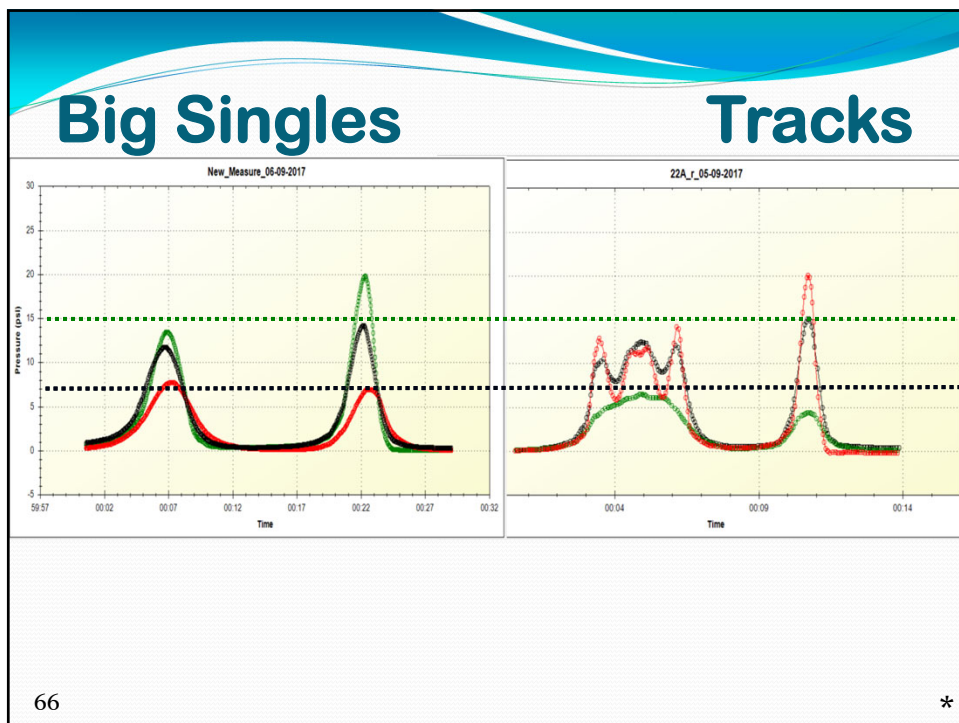
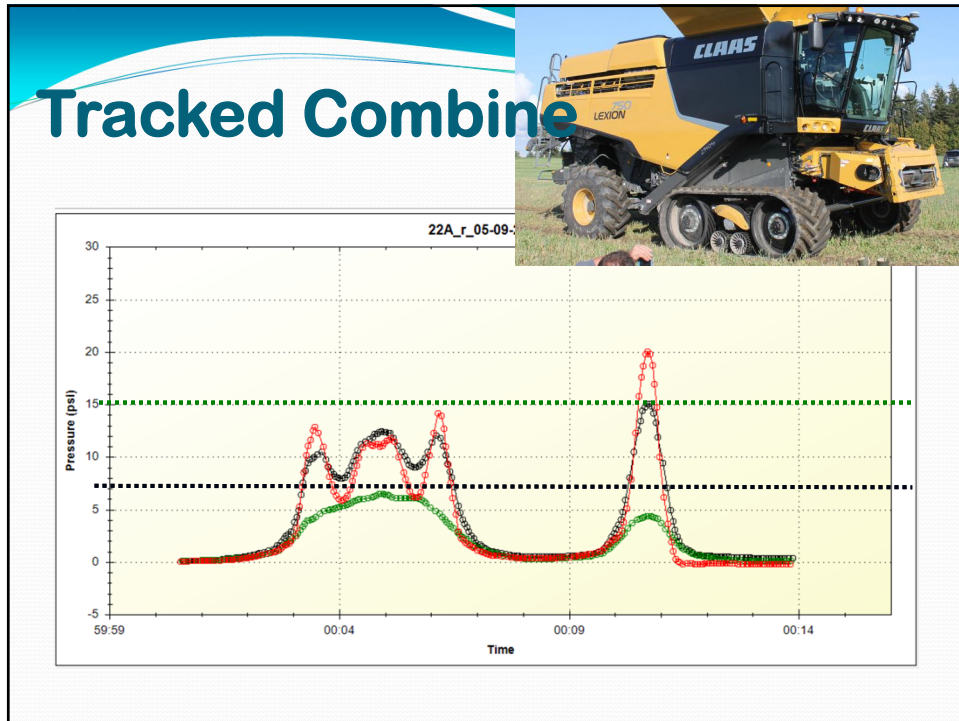
The “Results”!

Configuration!







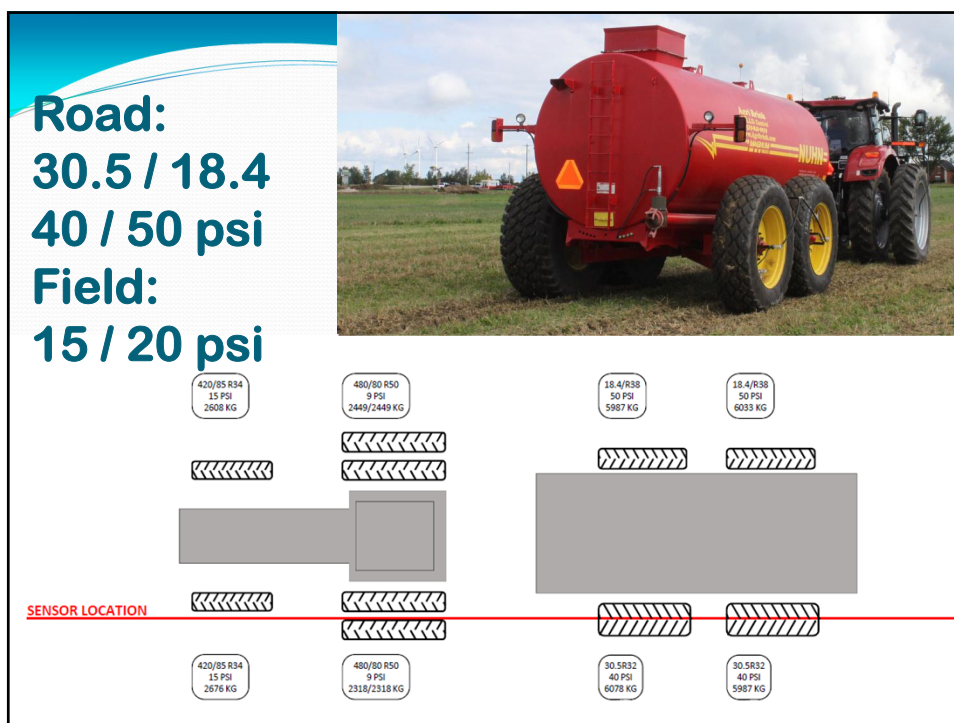


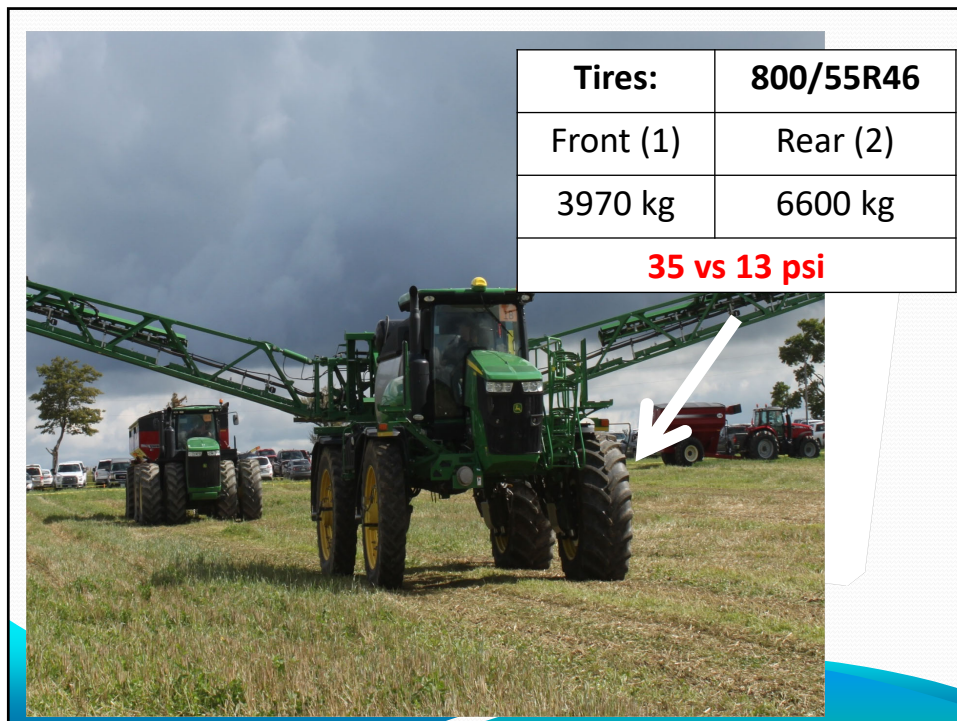
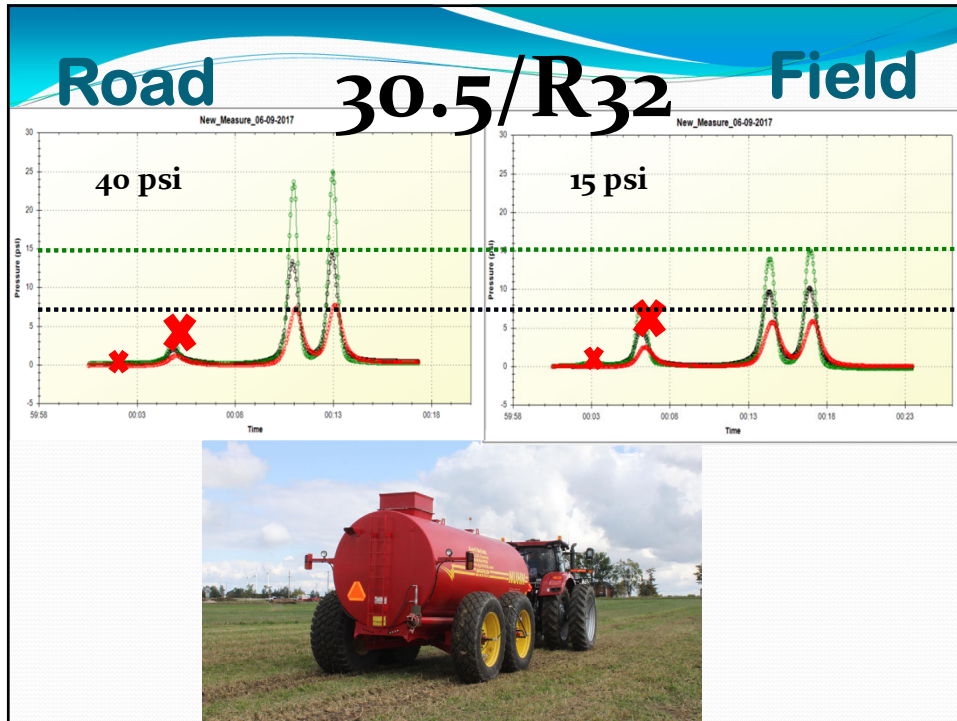
The “Results”!

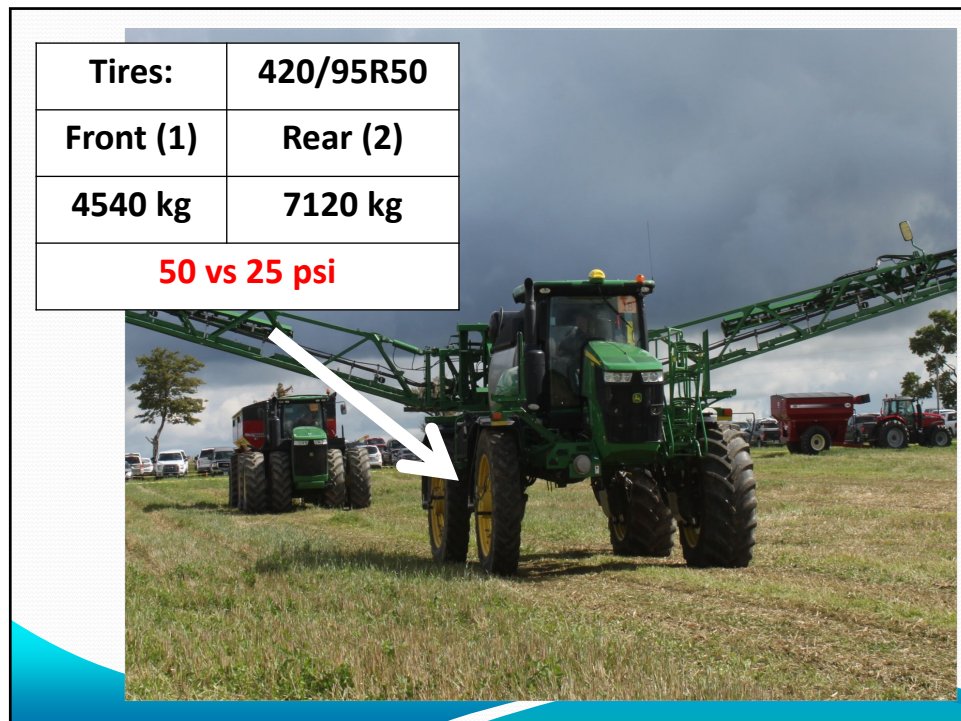
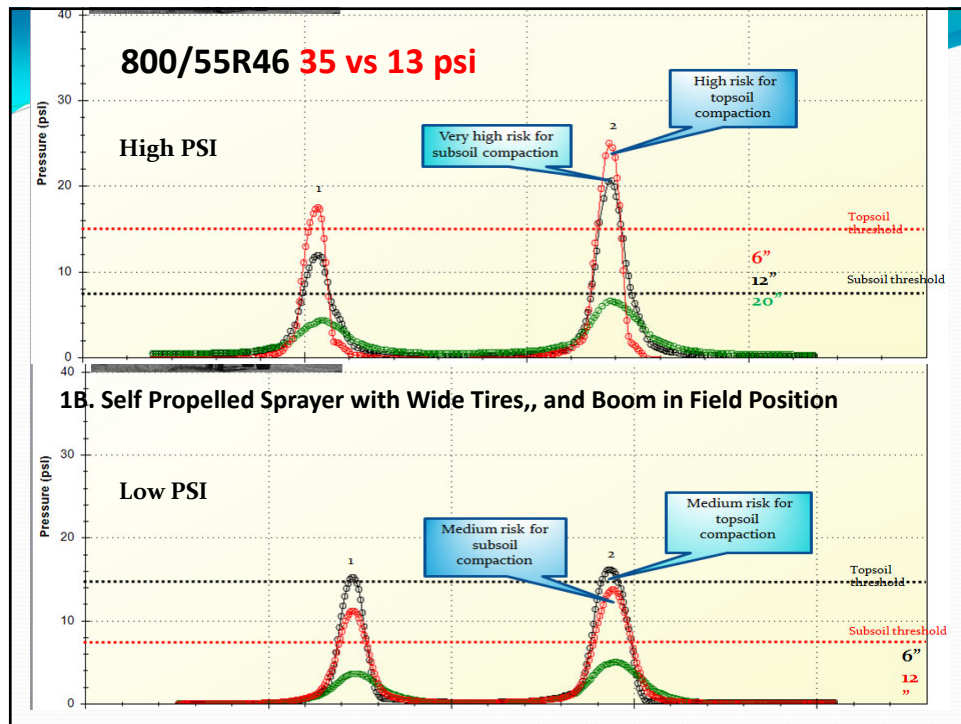
Pressure!

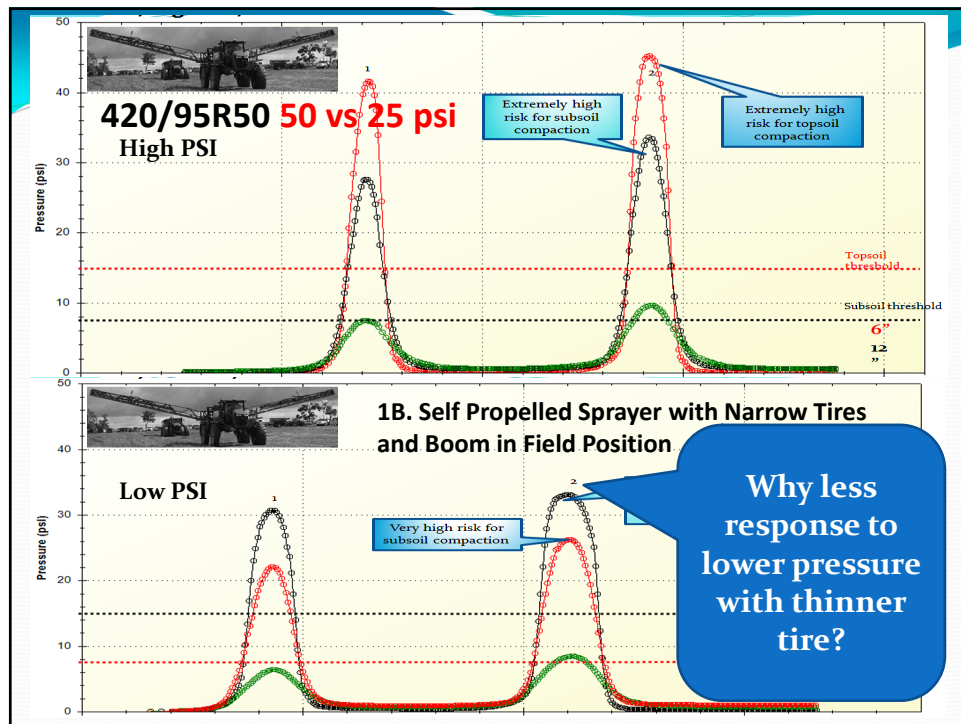
CTIS!

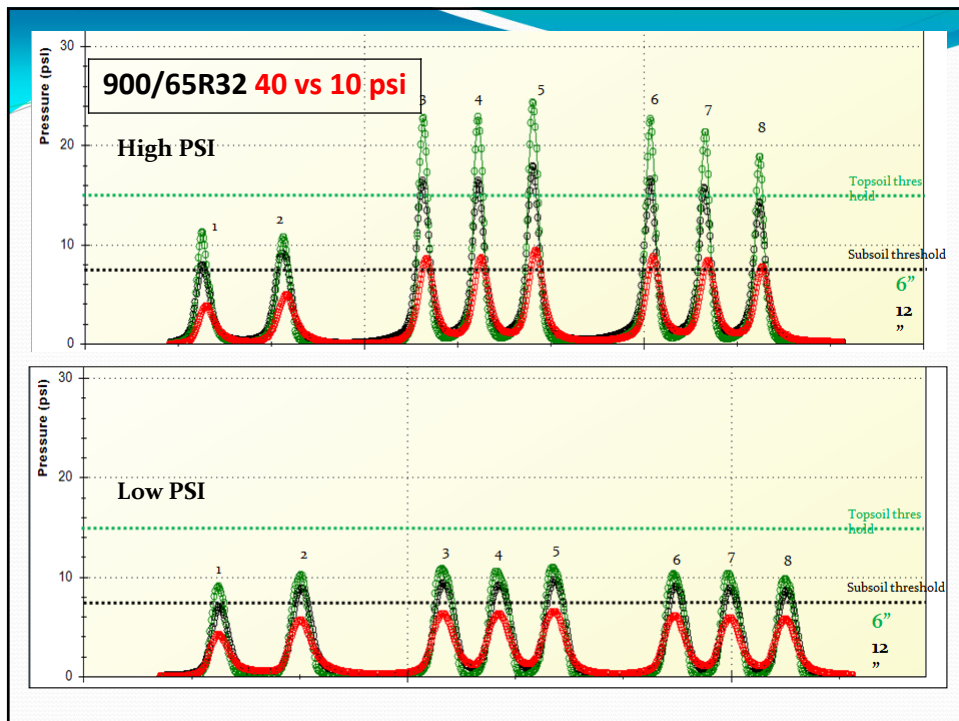
(Central Tire Inflation Systems)









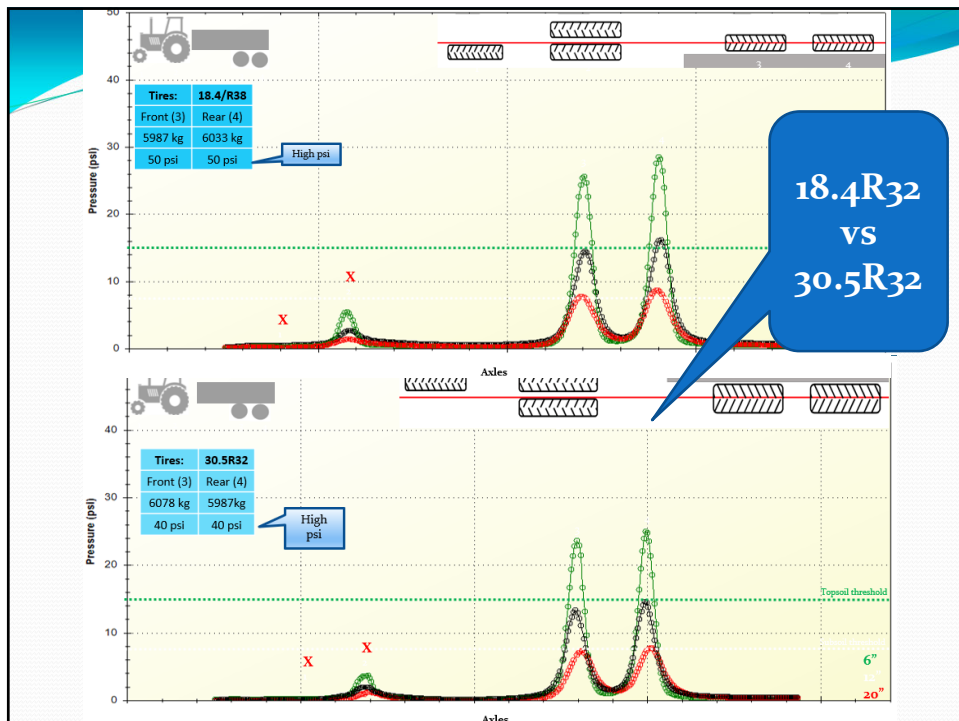
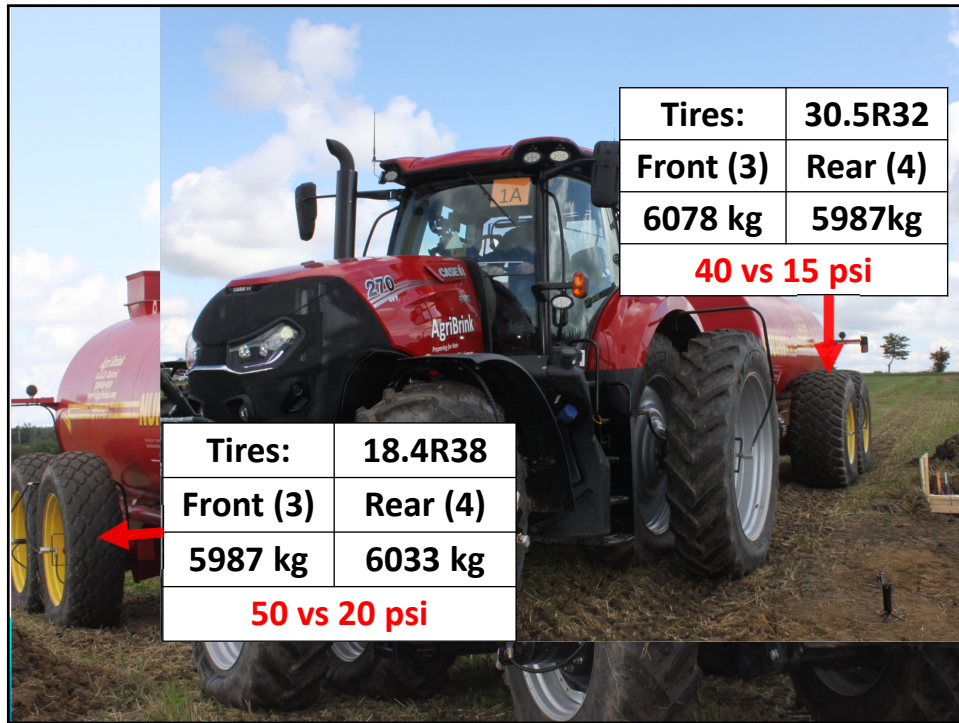


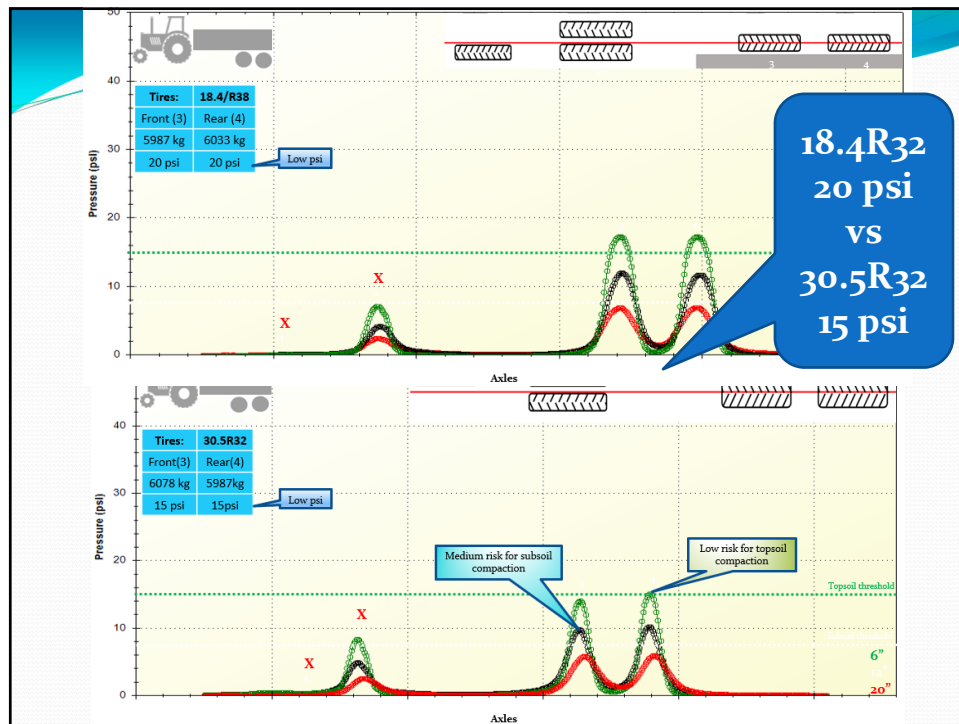
Tire Pressure

- Average doesn't cut it!
- If you have to run the roads, for safety, tire wear, load carrying, you have to go with high pressure
- In the field this will “kill” you!
- If 40 psi road, and 10 psi field is the requirement/possibility, 20 psi is a LOSE-LOSE proposition!
- Why invest so many dollars in equipment that you don't optimize?
- We need to consider CTIS for road/field scenarios!

The “Results”!

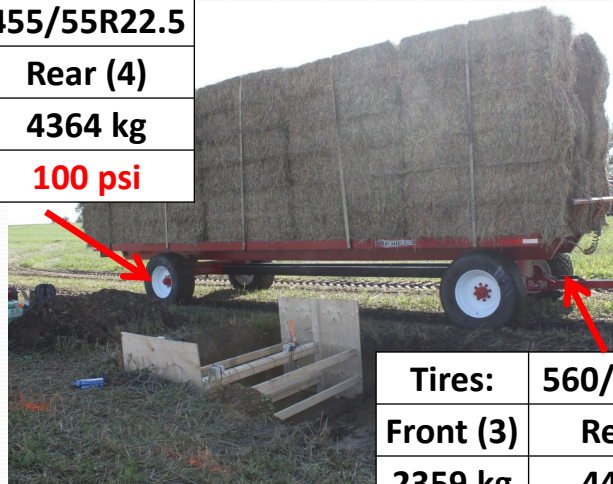
**Tire Size and
Tech!**





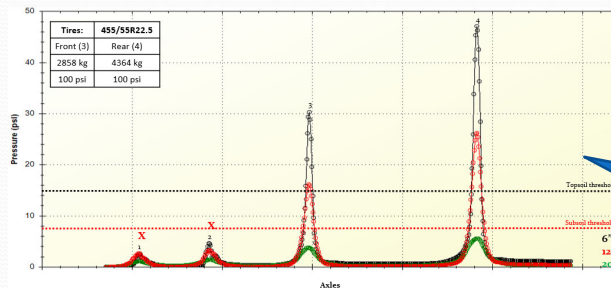
Large Bale Wagon

Tires:	455/55R22.5
Front (3)	Rear (4)
2858 kg	4364 kg
100 psi	100 psi

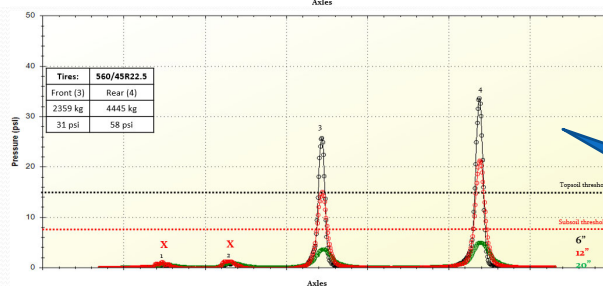


Tires:	560/45R22.5
Front (3)	Rear (4)
2359 kg	4445 kg
31 psi	58 psi

Large Bale Wagon



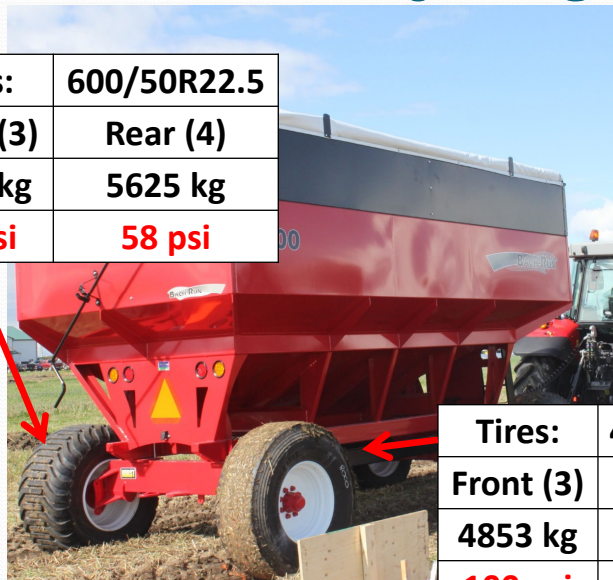
100 psi



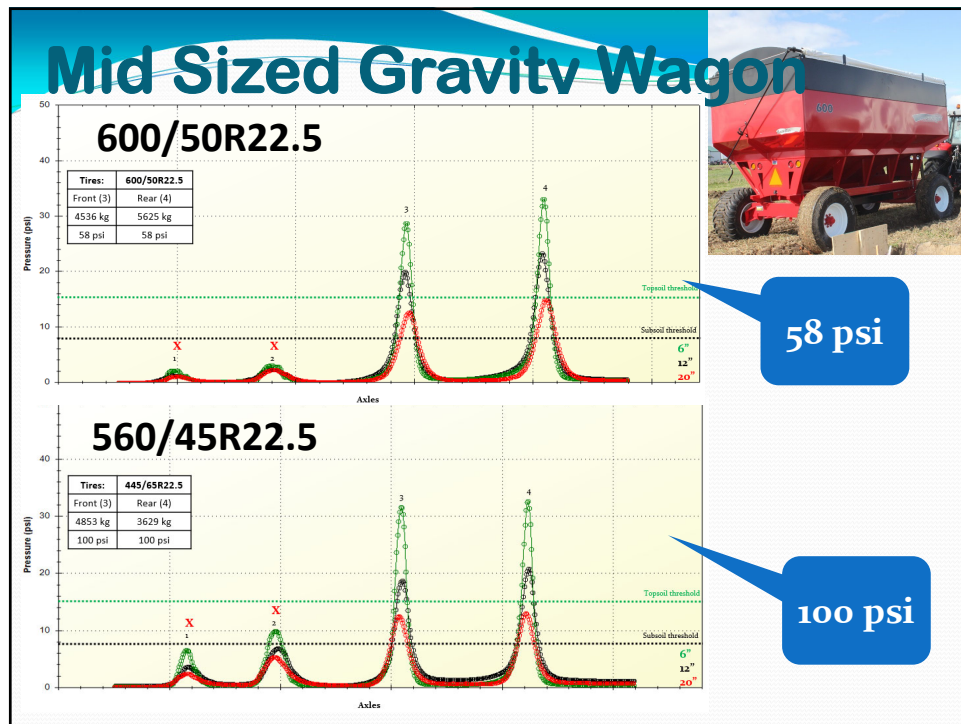
31 / 58
psi

Mid Sized Gravity Wagon

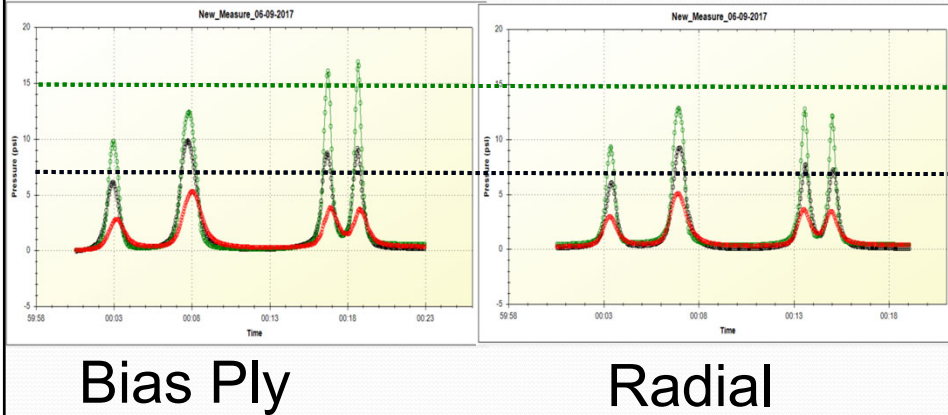
Tires:	600/50R22.5
Front (3)	Rear (4)
4536 kg	5625 kg
58 psi	58 psi



Tires:	445/65R22.5
Front (3)	Rear (4)
4853 kg	3629 kg
100 psi	100 psi

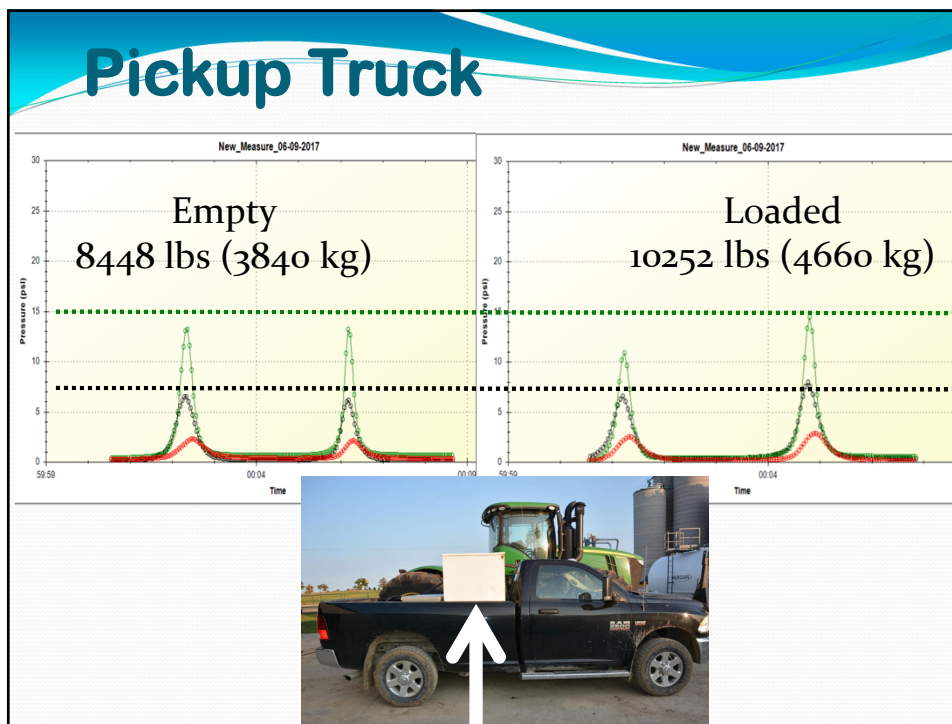


Bias Ply vs Radial Tire (Big Square Baler)



87





How do farm implements “weigh up” on Compaction?

Bad			Better
<ul style="list-style-type: none"> • Hay wagons • Gravity wagons • SP Sprayers 	<ul style="list-style-type: none"> • Balers • Hay Equipment • SP harvesters 	<ul style="list-style-type: none"> • Grain Carts • Manure Spreaders • Combines 	<ul style="list-style-type: none"> • Tractors (regardless of size) • Combines • Pickups

**Tire Tech and Inflation
Pressure Choices vs
Weight alter category!**

Let's Beat Soil Compaction!



1. Build Better Soils
2. Avoid Wet Soils
3. Bigger Tires
4. Lower Tire PSI
5. Use Inflation/Deflation Systems
6. Better Tires
7. More Tires/Axles
8. Less Passes
9. Control Traffic
10. Lower Load Weights



Questions and Discussion

The End!

Ian McDonald
Applied Research Coordinator
Field Crop Unit, Ag Development Branch
OMAFRA
Rm 407 Crop Sci.
University of Guelph
GUELPH, ON., N1G 2W1
519.824.4120 x56707
Ian.mcdonald@ontario.ca
www.fieldcropnews.com
[@ian_d_mcdonald](https://twitter.com/ian_d_mcdonald)