Controlled Traffic Farming, On-farm Research and our new P management program

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Overview

I. **Introduction**

II. **Controlled Traffic Farming**

III. **On-farm Research**

IV. **P management**

V. Questions?

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I. Introduction

My Background

- Married with four children
- Owner/operator of third generation small grains farm
  - Located in SW Manitoba
  - 5000 ac wheat, soybeans, canola, dry beans
- Operate Agritruth Research Inc.
  - Independent agronomic research conducted on field-scale
- Post-secondary diploma, degree in Agronomy from University of Manitoba
- M.Sc in agronomy from Iowa State University
- I'm also a <u>SKEPTIC!</u>

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Our Current Cropping System

- No-till (20+ years)
- CTF (7 years)
- Moderate diversity
- Intensive on-farm research program drives system change

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II. Controlled Traffic Farming

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Controlled Traffic Farming defined

- **Controlled traffic farming (CTF) is a farming system built on permanent wheel tracks where the crop zone and traffic lanes are permanently separated**

- **CTF is currently the only <u>PERMANENT</u> solution to soil compaction**

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Why CTF?

1. Improvements in soil quality
2. Reductions in Greenhouse gas emissions
3. Increased yields
4. Reduced fuel consumption
5. Improvements in trafficability when wet
6. Facilitates on-farm research

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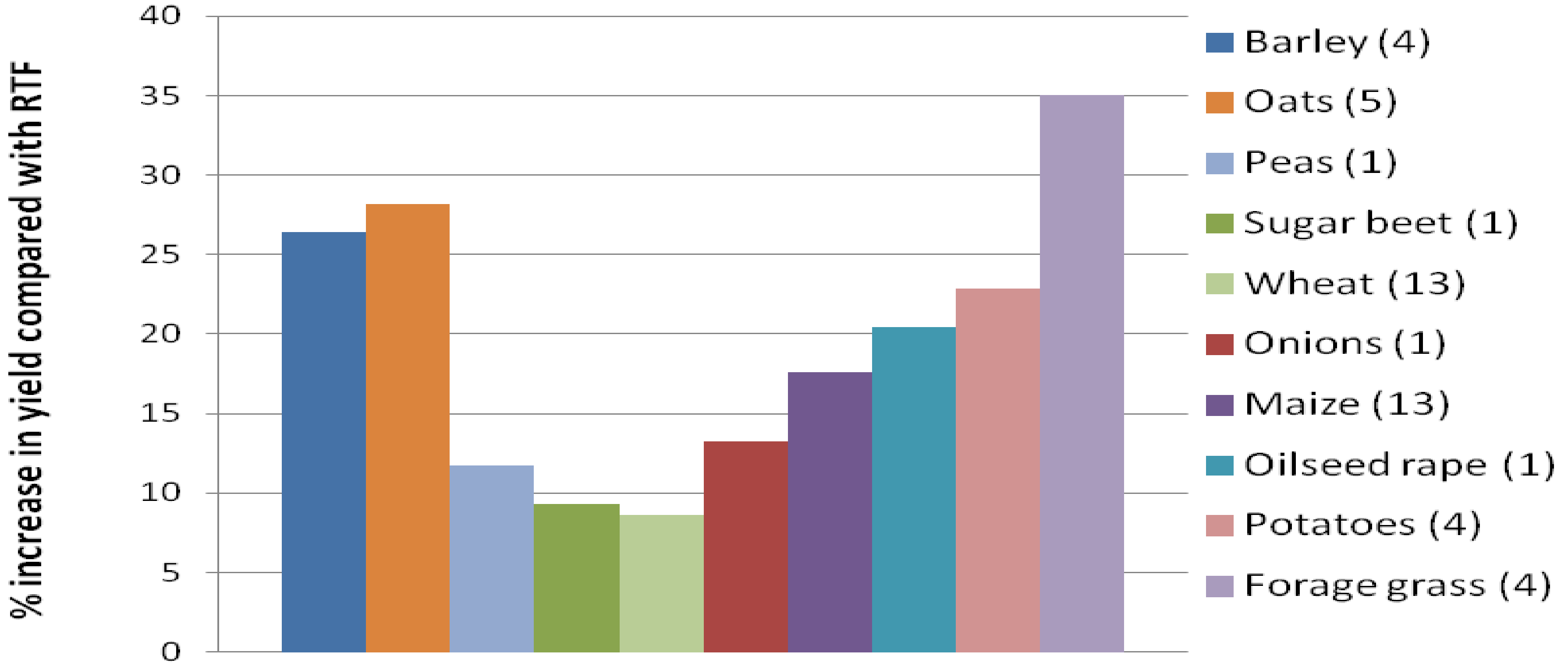
Crop yields increase

Percentage increase in yield by crop type under controlled compared with random traffic – data from around the world



From Chamen 2011

Numbers in brackets denote number of research results from which data were taken

CTF and Fuel Consumption

- **25% reduction** in fuel consumption in Australia in No-till systems (Dept. Ag. And Food Australia)
- **23.7% reduction** in fuel use with CTF in China (*Chen and Yang, 2015*)
- Draught requirements higher in trafficked soil by 30% (*Tullberg, 2000*)
- In tilled systems 35% reduction in fuel (Chamen)
- Fuel savings related to **increased tractive efficiency** and **reduced draught requirements**

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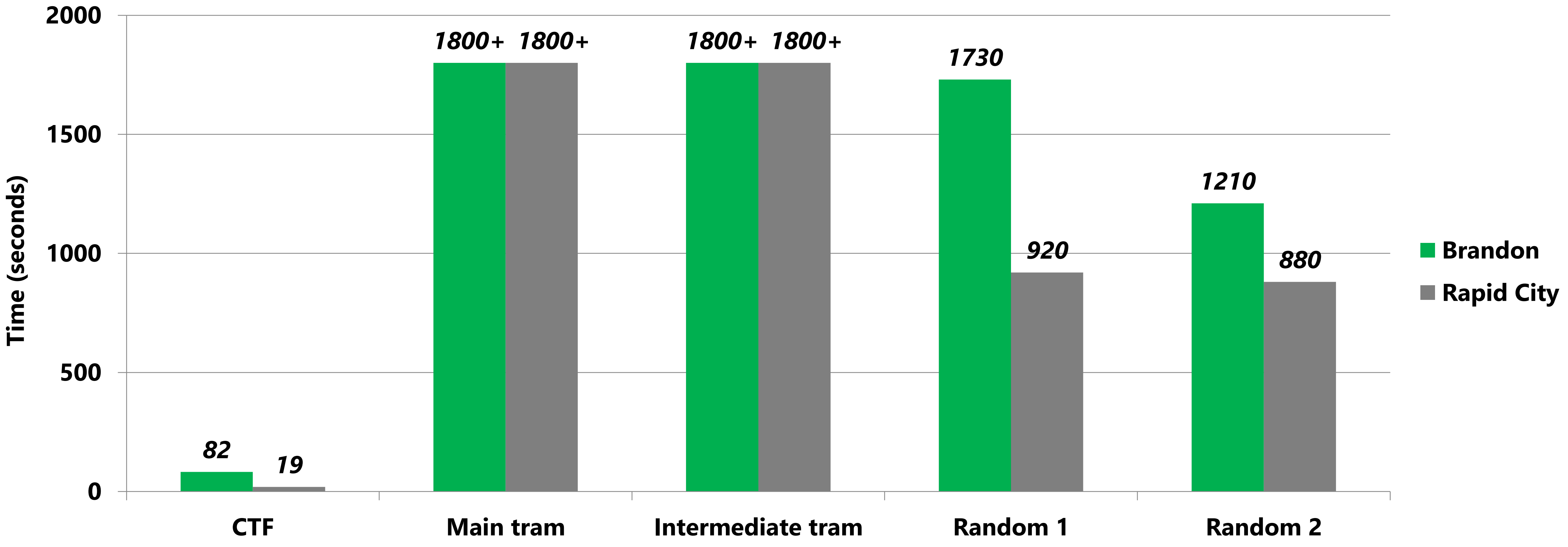
Infiltration rates

- Dramatic improvements in Infiltration with CTF
- Benefit in dry season
- Reduced risk of water erosion and non-point diffuse pollution (sediment, fertilizers, pesticides in waterways)

Time (seconds) to infiltrate 1" of water



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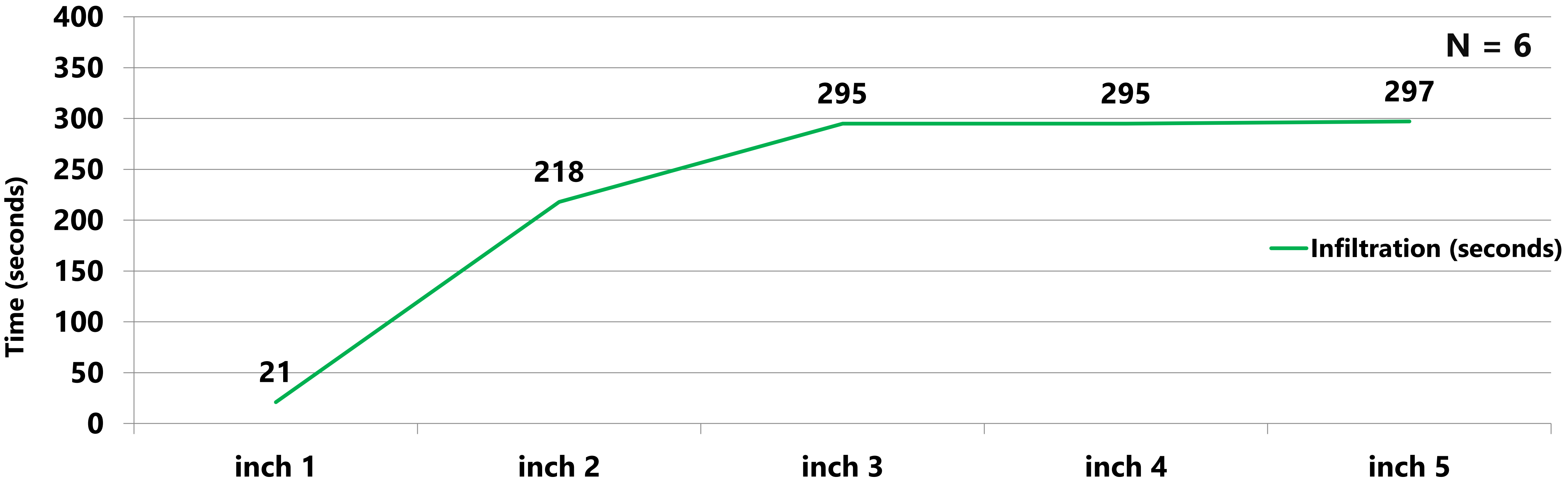
Infiltration of 5” (12.5cm) on Newdale Soil - CTF



Average time to infiltrate 5” on Newdale Soil at <u>Field Capacity</u> = ~ 19 minutes!!!

Earthworms = Infiltration!

N20 Emissions and CTF

- **Compaction ↑ likelihood and duration of elevated water-filled pore space (WFPS) & these elevated levels (>60%) closely associated with N20 emissions.** *(Lamers et al., 1986; Sexstone et al., 1988; Chamen et al., 1992b; Dobbie et al., 1999; Li et al., 2005b; Berisso et al., 2012).*

- **Non-trafficked soils retain pore structure and continuity that minimizes risk of increased WFPS above critical level of 60%.** *(Lamers et al., 1986; Sexstone et al., 1988; Chamen et al., 1992b; Dobbie et al., 1999; Li et al., 2005b; Berisso et al., 2012).*

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N20 Emissions and CTF

- **60% more emissions from a random traffic environment with 50% of field area trafficked annually.** (*Tullberg et al. 2011)*
- **2x more emissions from random traffic environment then CTF and effect likely higher with irrigation and higher nitrogen inputs** *(Tullberg et al. 2018)*
- **N20 production <u>67x higher</u> in compacted than uncompacted soil at field capacity** (*Beare et al. 2009*)

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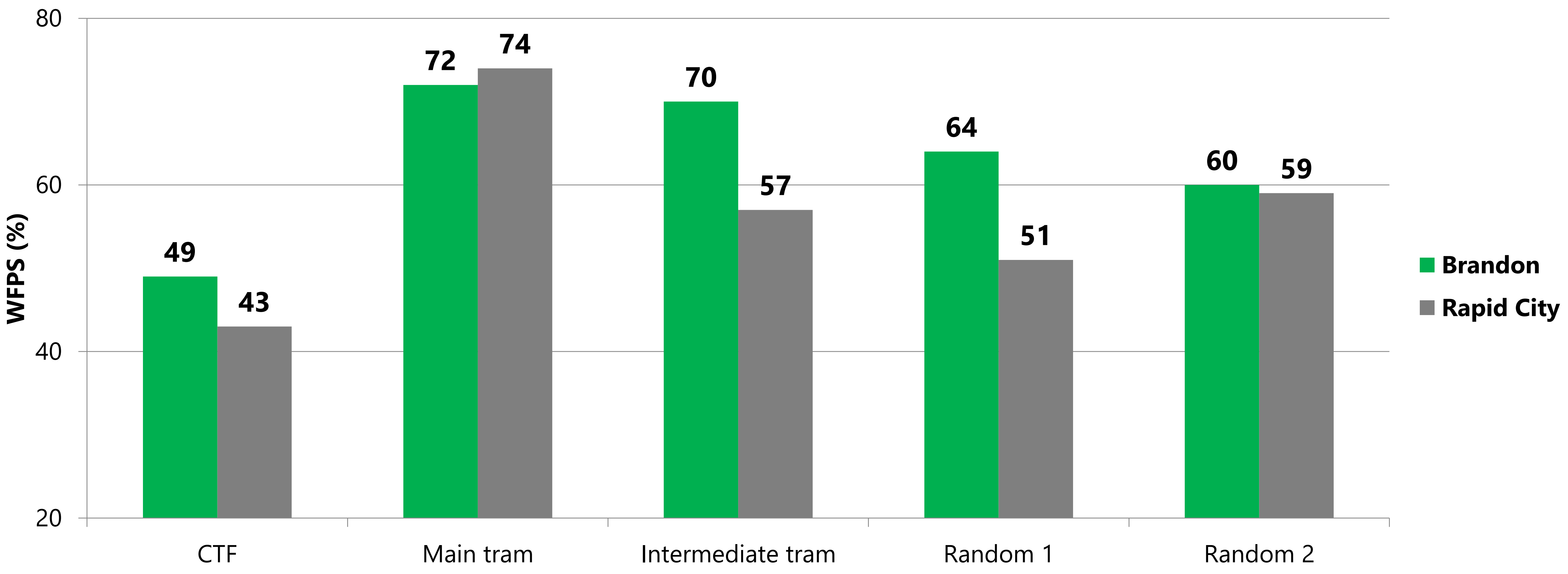
Water-filled pore space (%)



CTF and On-farm Research

- More efficient during harvest because plot sizes are multiple of header width
- Facilitates quality multi-year trials
- Allows for more complex on-farm trials

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My Thoughts 7 years in?

1. CTF works!
2. Benefits to the system are real and measurable
3. Equipment related barriers to adoption also real
4. Economics will vary by region, soil type, crops grown and pre-existing traffic intensity

Link to CTF report

A look at the impact of a controlled traffic farming system on crop yields and soil physical properties on a newdale clay-loam and beresford silty-clay soil located in south-western manitoba

- https://lib.dr.iastate.edu/creativecomponents/24/

III. On-Farm Research

What drives our program?

- Economics is the ultimate driving force
- Quest to ↓ unit cost of production
- Small gains = Big $ over time

What does our On-farm Research program do for us?

1. Clearly defines what and by how much we can cut without compromising profitability
2. Clearly defines where we can make additional investments relating to production
3. Identifies top performing competitive products
4. Identifies system changes worthy of adoption
5. Makes us more competitive

Why do we Replicate?

- **Unreplicated trials are dangerous to our financial health!**
- **May lead to system changes or product adoptions that cost us *time* and *money***
- **One side of the field will almost always yield more than the other *BUT* this does not necessarily indicate a treatment effect (exceptions)**
- ***Replication identifies natural variability and facilitates statistical analysis***

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Natural Variability

- **Average Natural variability in this trial ~ 3 bus/ac**
- **Possible conclusion with split-field of 7 bus/ac response**
- **What if treatment lowered yield slightly?**

Pair	**Seed Primer**		**Untreated**
1	**95.3**	**7 bushel difference!**	**93.6**
2	**93.6**		**92**
3	**89**		**89**
4	**90**		**88**
5	**87**		**91**
Average	***91.0***		***90.7***

LSD = 2.6
CV = 3.1

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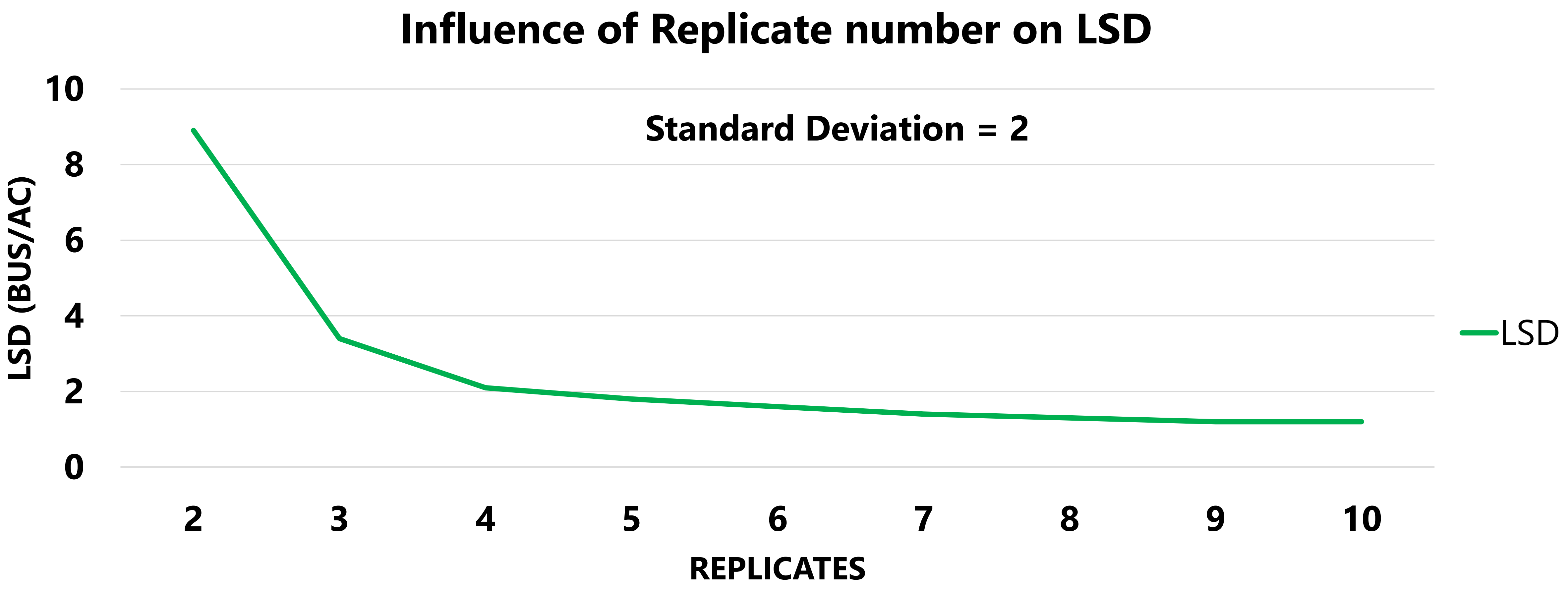
How Many Replicates?



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Why do we Randomize and Block?

- Randomization protects against bias – treatment location pre-determined
- Blocking allows one to account for yield gradients that may exist
- Meets the requirements of the statistical test

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A brief summary from 2012 - 2018

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1. Seeding rates

- 20 – 30% reduction possible in many cases vs. our established rates
- Need to define for own system and crops, know your mortality
- Very easy to do
- Low cost trial potential return is high
- Other things to consider besides yield i.e. quality, maturity, weed control etc.

<u>Seed costs big $ define your economic optimum rate</u>**

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2. Competitive product comparisons

- Competitive products typically cost the same
- Goal is to identify best performing products
- Lack of independent 3rd party product testing
- Low cost trial
- Compare current choice with alternative(s)
- Largest differences in fungicides and varieties

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3. Non-traditional products

- Foliar macro and micronutrients, seed primers, biologicals
- Cost can be $2.50 - $50/ac
- Easy to use, product available for every pass
- If established practice suggest that you properly define benefit

<u> 30 Agritruth trials = 2 small positive economic responses and many that result in significant financial loss</u>**

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4. Seed Treatments

- Established practice
- Newer generation products expensive $10 - $15/ac
- Started as competitive product comparison
- Will test indefinitely, easy to do
- Need to be careful with wireworms

<u> No economic responses to date on Certified wheat and soybean seed</u>**

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5. Fertility

- Nitrogen rates, placement, timing and types – 4Rs!
- Initially suspicious that we use too much Nitrogen fertilizer
- Main focus has been Nitrogen, but starting to look at Phosphorous
- Trials can be low cost or high cost, simple or difficult
- No advantage to EEFs or split nitrogen applications in wheat or canola

<u>Effective on-farm program maximizes returns from fertilizer $</u>**

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Long-term fertilizer rate trial

- Started in 2013 on long-term no-till soil 10+ years
- Soil is a Newdale Clay-loam and is representative of about 65% of our acres
- Organic matter levels about 6%
- NDSU suggested 50lb N credit in wheat for Long-term no-till soils
- https://www.no-tillfarmer.com/articles/990-long-time-no-tillers-get-credit-for-nitrogen
- Compare standard rate to one that is +/- 30% of standard
- Treatments applied to same plots annually RCBD 4x reps
- Plan to run indefinitely

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Long-term Fertilizer rate questions?

- How would fertilizer rate affect profitability over time?
- Were we applying too much fertilizer?
- Would we see a decline in yield over time?
- Would we see differences in soil organic matter show up over time?
- How would fertilizer rate affect the health of the soil?
- Will fertilizer rate affect nutrient density of the harvested seed?

Average applied N and P fertilizer rates (2013 – 2018)

Fertilizer treatment	Average N rate (lbs/ac)	Average P rate (lbs/ac)
Base -30%	78	25
Standard	108	35
Base +30	142	45

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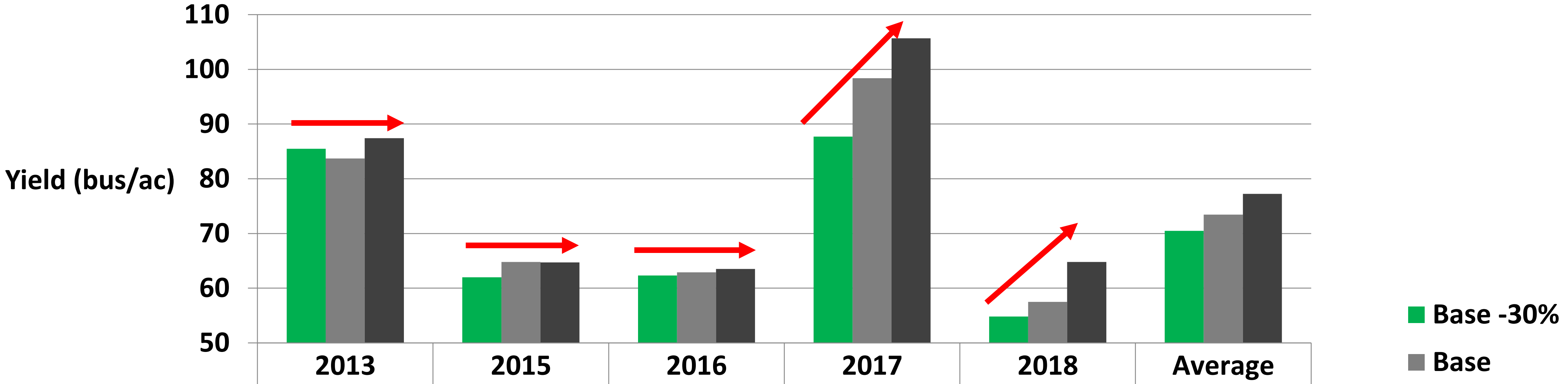
Long-term fertilizer rate trial – Yields (2013-2018)



	2013	2015	2016	2017	2018	Average
Base -30%	85.5	62	62.3	87.7	54.8	70.5
Base	83.7	64.8	62.9	98.4	57.5	73.5
Base +30%	87.4	64.7	63.5	105.7	64.8	77.2

Initially no difference in yield, BUT trend changed in 2017

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Long-term Fertilizer rate Yield Statistics

	2013	2015	2016	2017	2018
Base -30%	B	B	A	C	B
Base	AB	A	A	B	B
Base +30%	A	A	A	A	A

Treatments followed by the same letter are not significantly different at P <= 0.05

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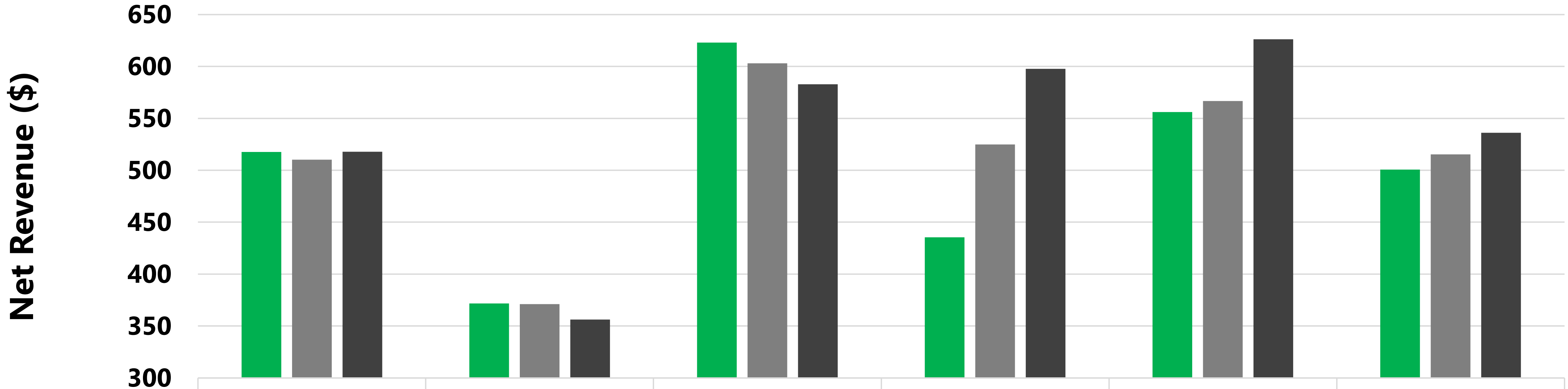
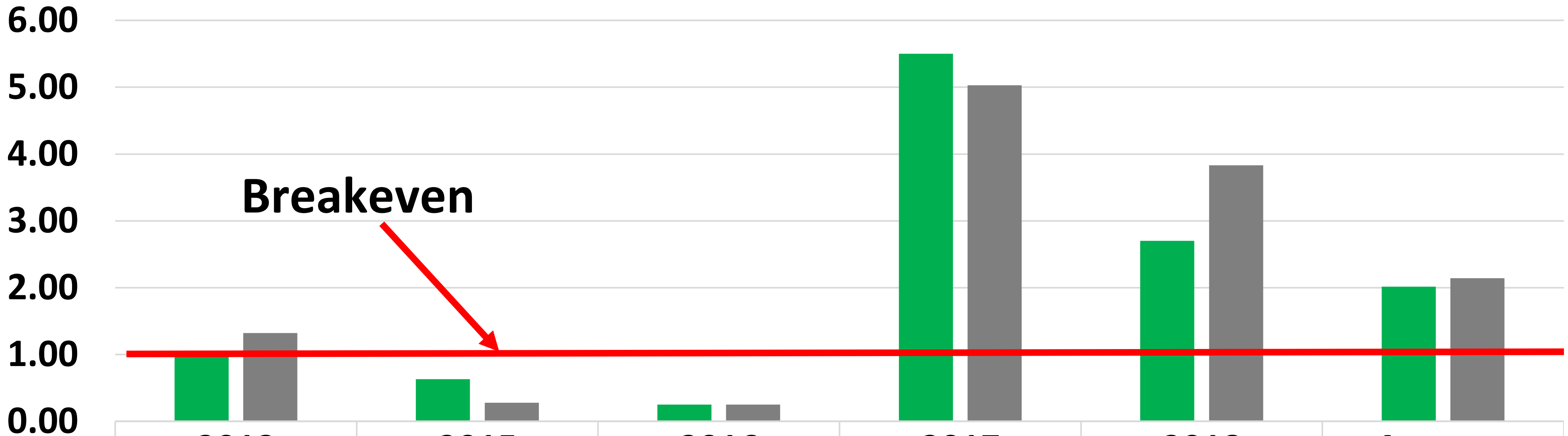
Long-term Fertilizer rate Net Revenue (2013-2018)



	2013	2015	2016	2017	2018	Average
Base -30%	517.55	371.65	623.05	435.48	556.02	500.75
Base	510.25	371.21	602.98	524.91	566.78	515.23
Base +30%	517.84	356.28	582.9	597.68	626.13	536.17

***+30% rate produced highest net revenue to date**

Extra dollars earned from each additional dollar invested in fertilizer



	2013	2015	2016	2017	2018	Average
High vs Low	1.00	0.63	0.25	5.50	2.70	2.02
High vs Standard	1.32	0.28	0.25	5.03	3.83	2.14

Long-term Fertilizer rate summary 2013 - 2018

- Yields and profitability high with all three treatments
- Initially lowest rate was most profitable but trend changed in 2017
- Very large returns from extra fertilizer dollars in 2017 and 2018
- After 5 years, data would suggest that we have been shorting ourselves on fertilizer for canola and wheat
- Average 23% more net income comparing high to low treatments
- What if we had decided to cut our fertilizer rates and not tested it first?

IV. P Management

P Fertility Questions

- Are our current soil test P levels a limiting factor for crop production and profitability?
- Do our P levels vary much across our landscapes and if so how much?
- If we see value in building our soil test P levels with large one time applications, can we save money with variable rate?
- Is there value to seed-placing our P fertilizer in wheat vs side-banding our P with our nitrogen fertilizer?
- Would banding large P applications provide an economic advantage over broadcast and incorporation?

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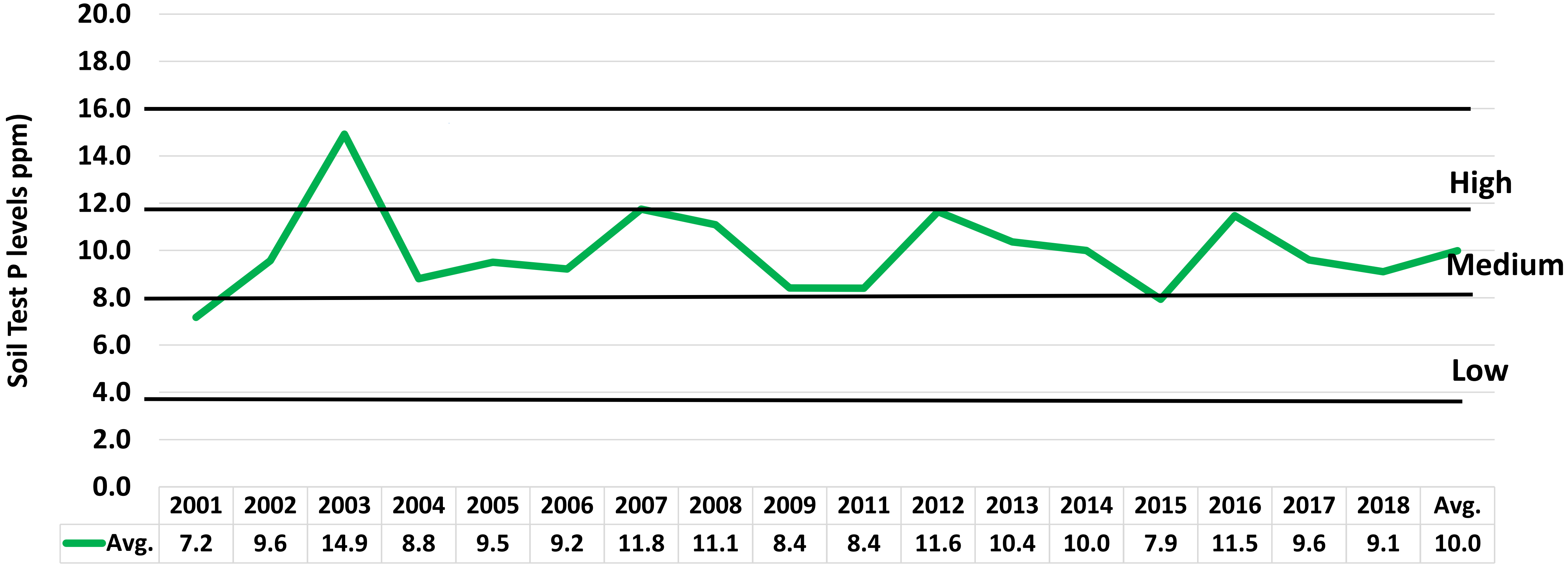
Lost Island Farms Average Soil Test P levels (Olsen) 2001 – 2018 (Lab 1)



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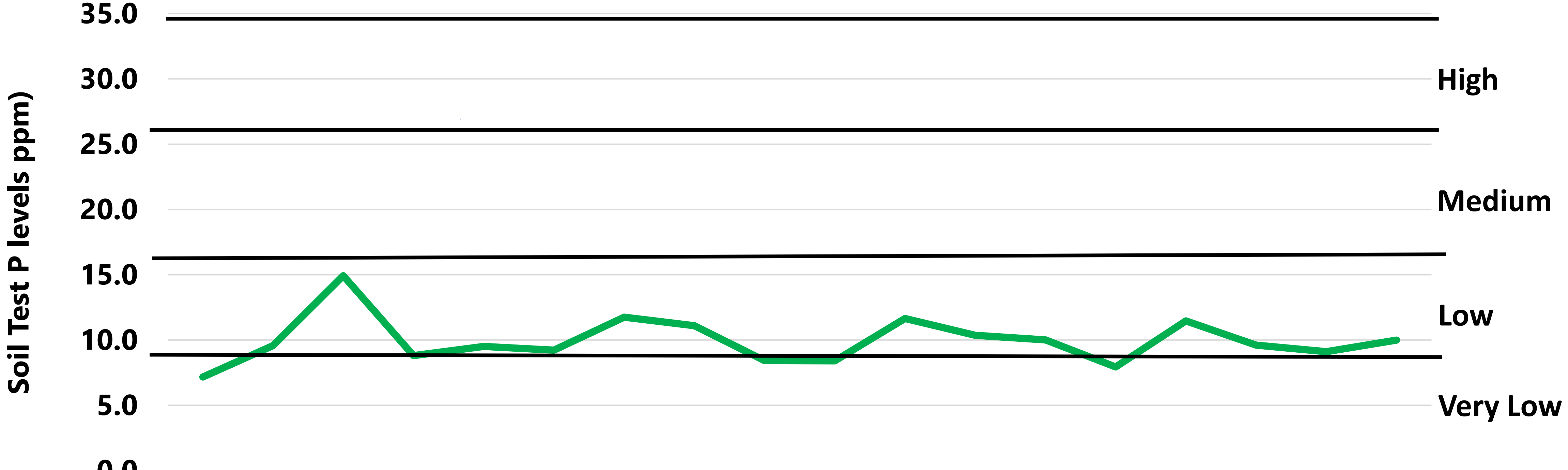
Lost Island Farms Average Soil Test P levels (Olsen) 2001 – 2018 (Lab 2)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2011	2012	2013	2014	2015	2016	2017	2018	Avg.
Average	7.2	9.6	14.9	8.8	9.5	9.2	11.8	11.1	8.4	8.4	11.6	10.4	10.0	7.9	11.5	9.6	9.1	10.0

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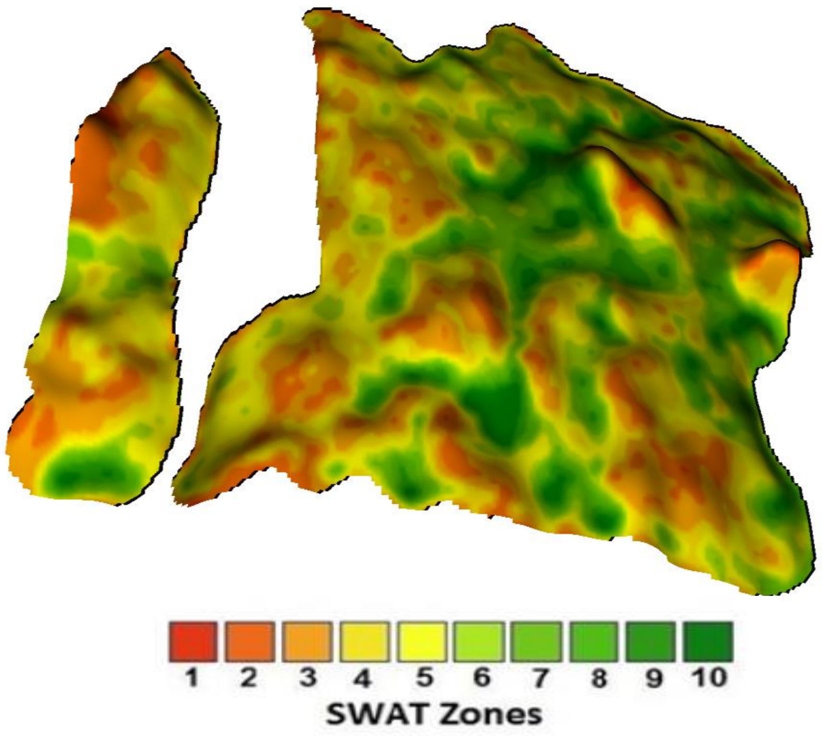
Long-term P site History

- 2001 – 2016 benchmark soil test P levels average 6.5 ppm Olsen
- Newdale Clay-loam 5.2% organic matter
- 20 years of No-till
- Field has been very productive historically with no sign of decline
- Primarily Wheat/Canola rotation with some Flax and Peas
- Selected because consistently low soil test P levels
- Zone sampled fall of 2017



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Organic matter and Soil test P by zone

Zone	OM (%)	Olsen P (0-8") (ppm)
1-2	3.9	30
3-4	5.5	23
5-6	7.2	12
7-8	6.6	12
9-10	5.8	23

Field Average from benchmark site (2001 – 2015)

OM = 5.2%

Olsen P (0-6") = 6.5 ppm

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Long-term P site experimental design

- Spring of 2018 P treatments were banded with Seed-hawk drill at a depth of about 2”
- Used a RCBD with 4 replicates
- Treatments consisted of one time applications of 350 and 700lbs of MAP, a VRP treatment based on zones created fall of 2017 and our standard practice
- Flat rate P treatments targeted 5 and 10 ppm rise in soil test P levels
- VRP treatment averaged 270lbs of MAP
- All treatments received 70lbs MAP during seeding operation
- Nitrogen normalized across treatments at 130lbs N/ac
- Faller wheat seeded 2018

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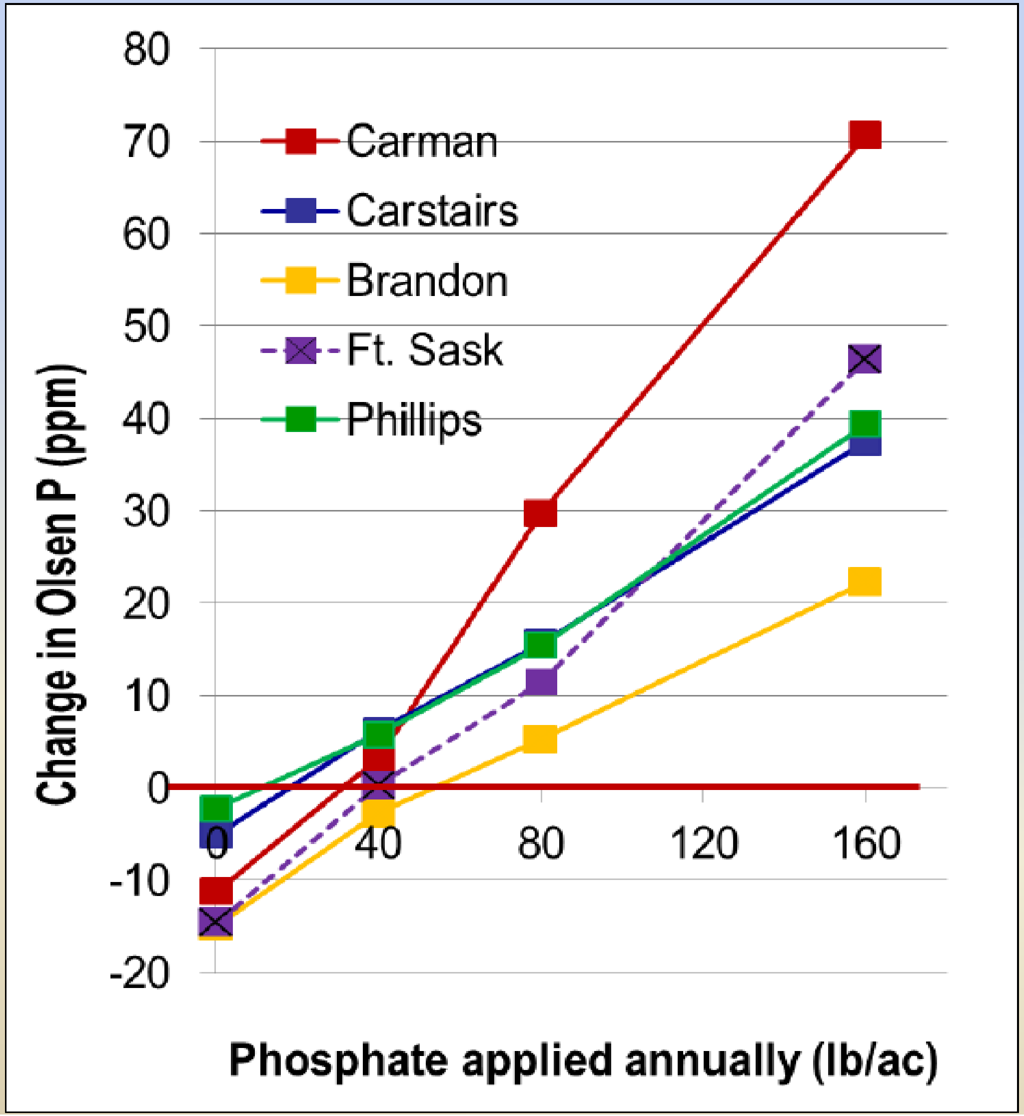
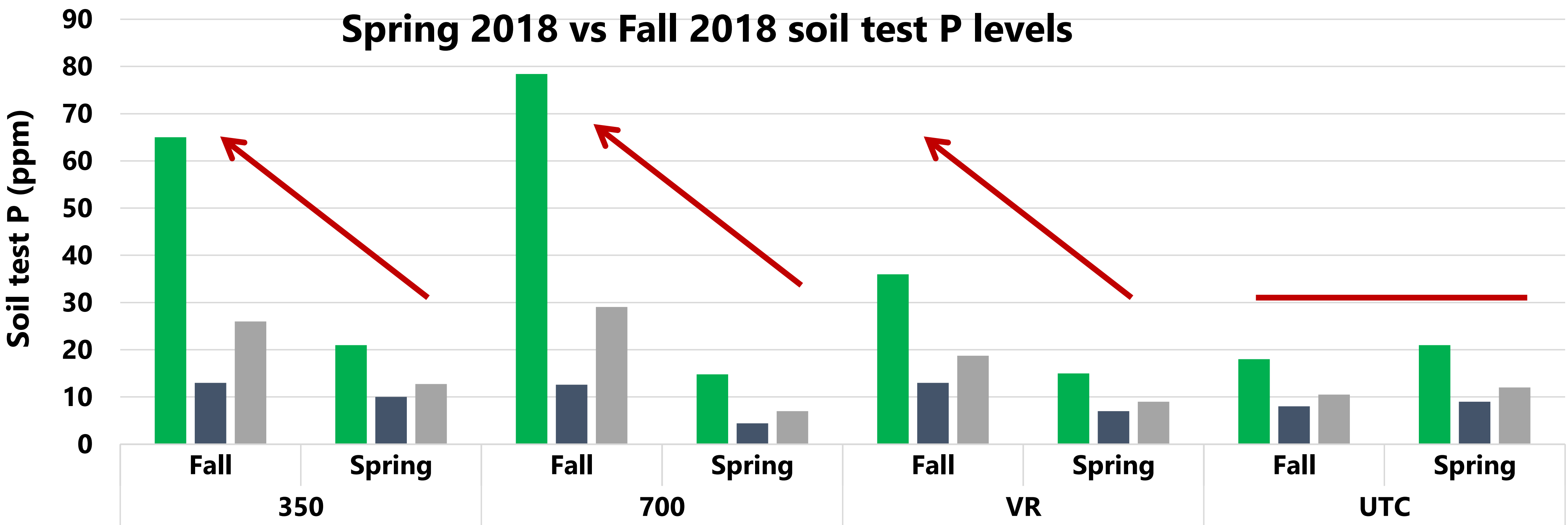
Olsen P also followed P balance in Alberta and Manitoba soils after 8 years of P applications in a durum-flax rotation

- Large increases in Olsen P occurred with high P rates
- Olsen P declined when no P applied
- At 40 lb phosphate/acre/year, Olsen P was maintained at most sites (but flax P removal is low)
- Surplus P to raise Olsen P by 1 ppm:
  - 16-23 lb P_2O_5/ac at Carman
  - 29-32 lb P_2O_5/ac at Carstairs
  - 27-35 lb P_2O_5/ac at Brandon
  - 21-25 lb P_2O_5/ac at Ft. Sask.
  - 32-41 lb P_2O_5/ac at Phillips



Grant et al. unpublished

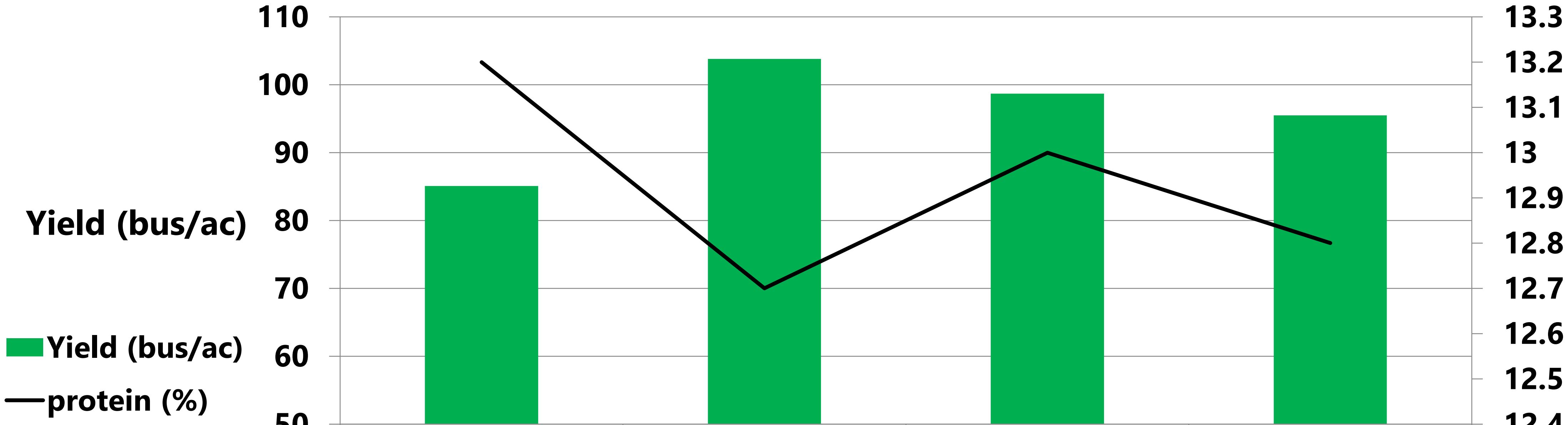
Treatment effect on Soil test P levels



	350 Fall	350 Spring	700 Fall	700 Spring	VR Fall	VR Spring	UTC Fall	UTC Spring
0-2"	65	21	78	15	36	15	18	21
2-8"	13	10	13	4	13	7	8	9
Weighted Average	26	13	29	7	19	9	11	12

0-2"   2-8"   Weighted Average

First year Yield and Protein Data



	standard (C)	700lbs (A)	350lbs (B)	VR MAP (B)
Yield (bus/ac)	85.1	103.8	98.7	95.5
protein (%)	13.2	12.7	13	12.8

Treatments followed by the same letter are not significantly different at $P <= 0.10$

Plan for future years

- Continue to monitor P response at this site indefinitely
- Will expand to additional sites in 2019
  - Want to target some different soil types and historical soil test P levels
  - Will only compare a single rate (350lbs of MAP)
- Will evaluate banded applications to broadcast and incorporated
  - Broadcast is easier to do, but hope to see economic advantage to banded applications
- Large P applications will likely be guided by zone sampling

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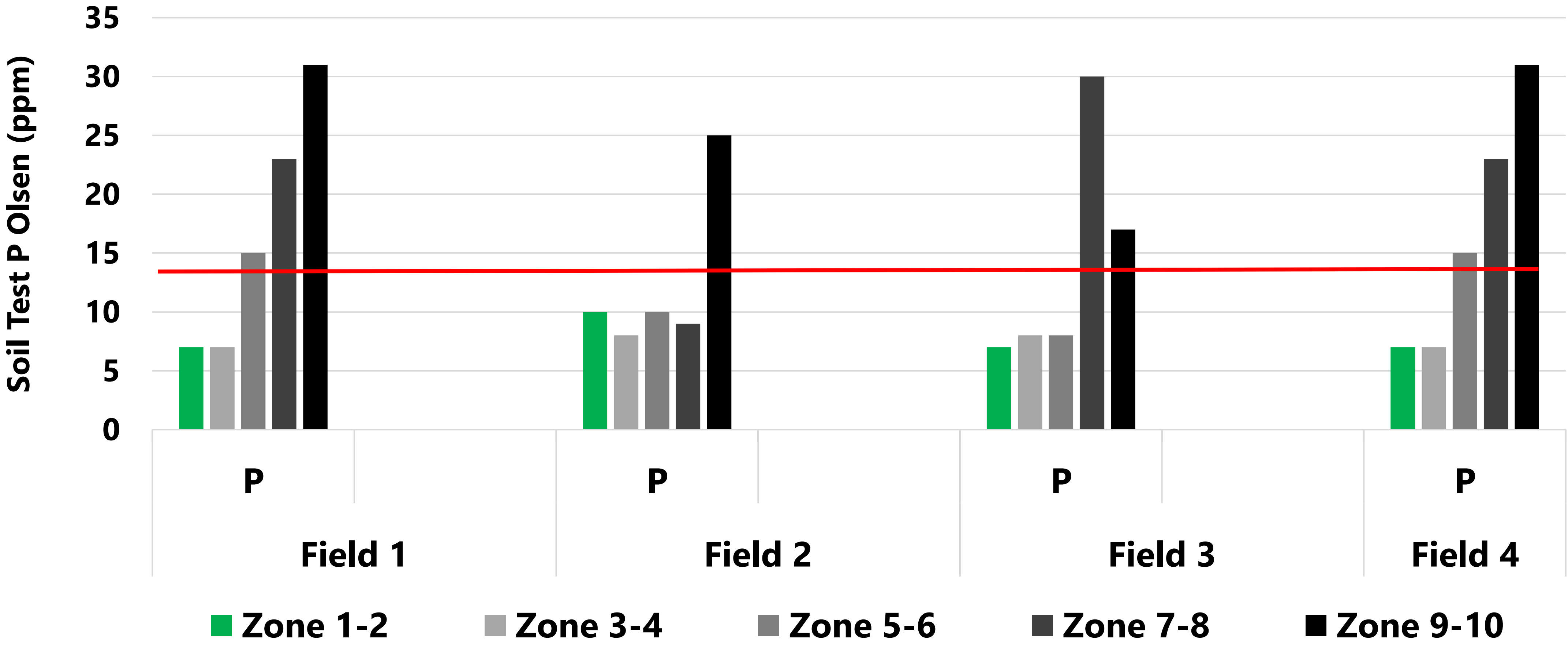
Soil Test P Levels on Newdale soils by Zone



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Many thanks to Trevor Friesen, Cory Willness and Brad Dunnington of CropPro Consulting for soil sampling and prescription maps

CropPro
Consulting

SWAT MAPS
Soil, Water And Topography MAPS

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V. Questions

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