Soil&Water Management Centre

Harper Adams University

Traffic and Tillage Research at Harper Adams University

Dick Godwin & Emily Kate Smith

And lots of others

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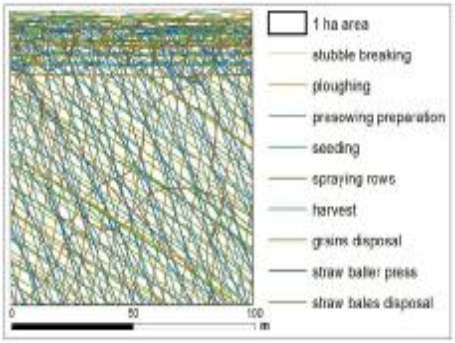
Compaction problems & Potential Solutions

1. Lower Ground Pressure
2. Controlled Traffic



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1. Low Ground Pressure

- Improved operational flexibility
- Easy to adopt
- Minimise compaction

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2. Controlled Traffic Farming

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“Confine soil compaction to the least possible area of permanent traffic lanes”

- Matching machinery widths and wheels
- Environmental benefits
- Reducing input costs
- Increasing yields: 2-16%

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The Harper Adams Study

To determine the effect of traffic and tillage on soil structure and function, crop growth and yield and energy consumption

3 traffic:

1. Random Traffic Farming
2. Low Ground Pressure
3. Controlled Traffic Farming

X

3 tillage:

1. Deep
2. Shallow
3. Zero

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Phases

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Phase 1: Site Normalisation

- Oct. 2011- Sept. 2012
- Assessing variations in soil texture of proposed field trial
- Determining location of trials

Phase 2: Determination of Low Ground Pressure systems

- 2011-2012
- Testing LGP tyres and tracks for in-field experiment

Phase 3: Plot Trials

2012 – 2022?

- Effect of traffic and tillage on soil compaction
- Effect of soil compaction on crop growth and yield
- Effect of soil compaction on energy requirement

Phase 4: Farm scale studies

2015+

- Under discussion e.g. Straw & tramline management

Phase 1: Site Normalisation

- 63 metres above sea level
- Mean annual rainfall = 712 mm
- Mean annual air temperature 14.3°C – 6.1°C
- Sandy loam (Ollerton overlying Salwick)

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Proposed Experimental Site

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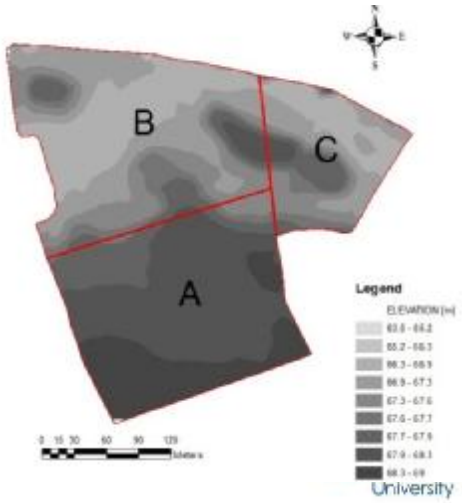
- Large Marsh field: 8.51 ha
- Field initially divided into 3 areas (A,B,C) – based on the historical field boundaries
- Parameters considered for plot trial UNIFORMITY
  - topography
  - soil and water conditions
  - crop performance and yield



After: Kristof et al. 2012

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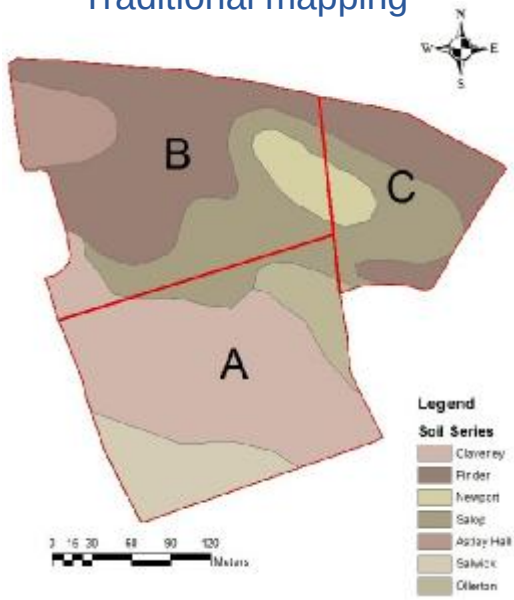
Soil Uniformity

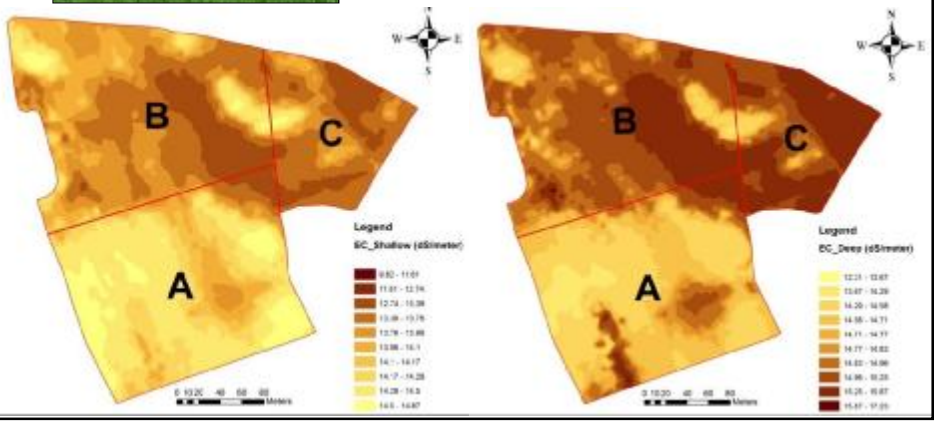
Traditional mapping



After : Beard, Soil Survey and Land Research Centre

Soil Uniformity

Electrical conductivity, EM38, April 2012



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Tillage and Traffic Systems

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Year 1 (2011- 2012)

Site normalisation to investigate the variability of the field after drain installation and subsoiling with a winter wheat crop using CTF

Years 2 – 5 + Plot trials: (2012 – 2017++)

3 Traffic X 3 Tillage treatments

Years 3 – 5 + Field trials: (2015 – 2018++)

Field scale experiments on a range of soils and crops (reduced number of treatments)

Crop Uniformity

Normalised Difference Vegetation Index (NDVI) Crop Circle - May 2012

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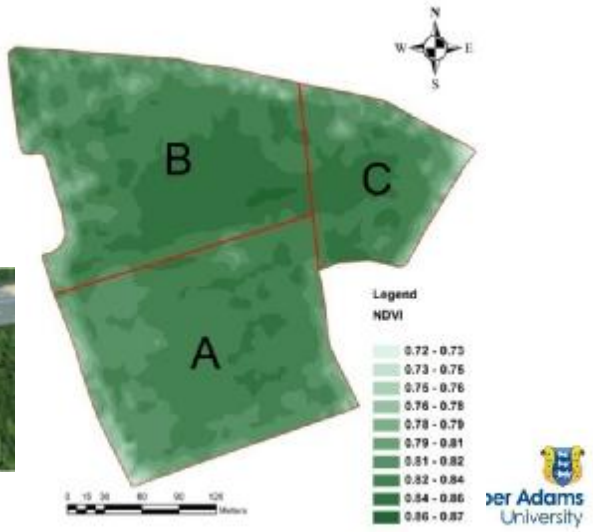

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Crop uniformity - 2012

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Yield Recording

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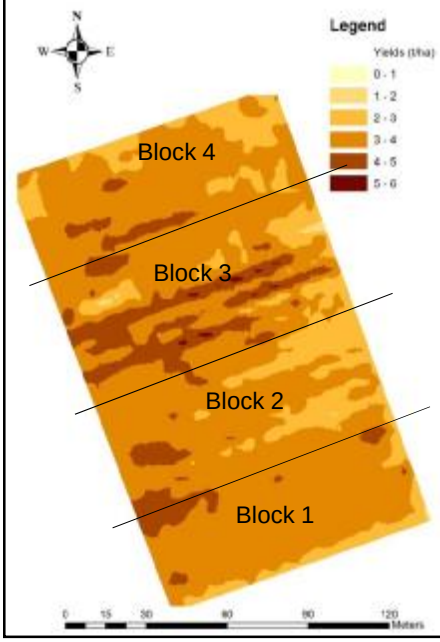

Mean Yield =4.18 t/ha
Standard deviation 0.26 t/ha

RDS Ceres 8000i

Phase 2: Determination of Low Ground Pressure systems

- Improved operational flexibility
- Simple concept to adopt
- Still applies pressure to the soil

Extra costs

Tractor - 280 hp : Ultraflex tyres extra = £1/ha

Combine: Ultraflex = £0.50/ha

Price offset by fuel savings (c.20%)

Mozziconacci, Michelin

Combine: + £3/ha to £4/ha for 5 - 7 year life

Price offset by improved trafficability and narrower operating widths

Tyrell, Claas UK

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Phase 2: Determination of Low Ground Pressure systems

- Buried pressure transducers 300 mm below soil surface

- MachXbib: standard tyres
- Axiobib: LGP specific tyres
- Cat Challenger

Treatment	Tyre inflation pressure (bar)	
	Front	Rear
MachXbib Low	0.7	0.7
MachXbib High	1.2	1.5
Axiobib Low	0.7	0.7
Axiobib High	1.2	1.5
Challenger	Tracks	

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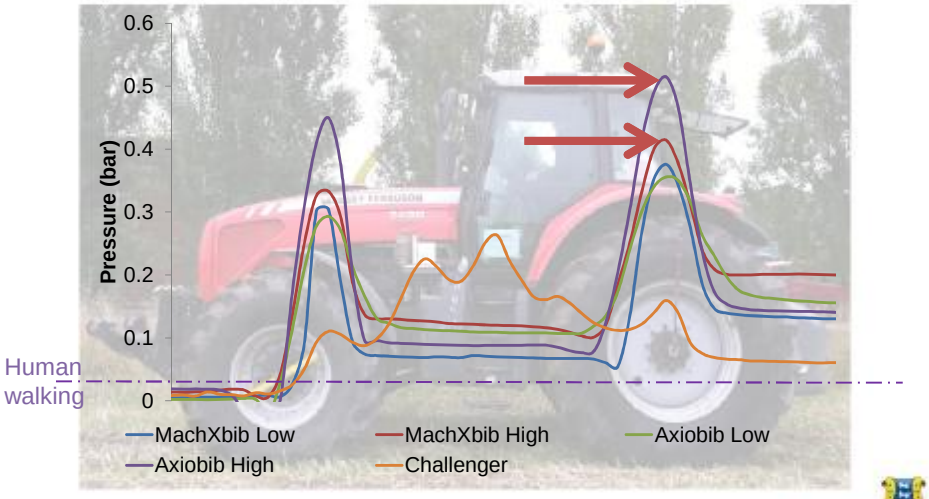
Phase 2: Results

12 ton MF8480



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Phase 2: Results

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Challenger 16 ton

Phase 3: Plot Trials

TRAFFIC	Random Traffic Farming	Low Ground Pressure	Controlled Traffic Farming
TILLAGE	Deep	Deep	Deep
	Shallow	Shallow	Shallow
	Zero	Zero	Zero

- 2012-2013 Winter wheat (Duxford)
- 2013-2014 Winter barley (Cassia)

Replicated in 4 Blocks

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Field Layout

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Traffic

TRAFFIC	Random Traffic Farming	Low Ground Pressure	Controlled Traffic Farming
TILLAGE	Deep	Deep	Deep
	Shallow	Shallow	Shallow
	Zero	Zero	Zero

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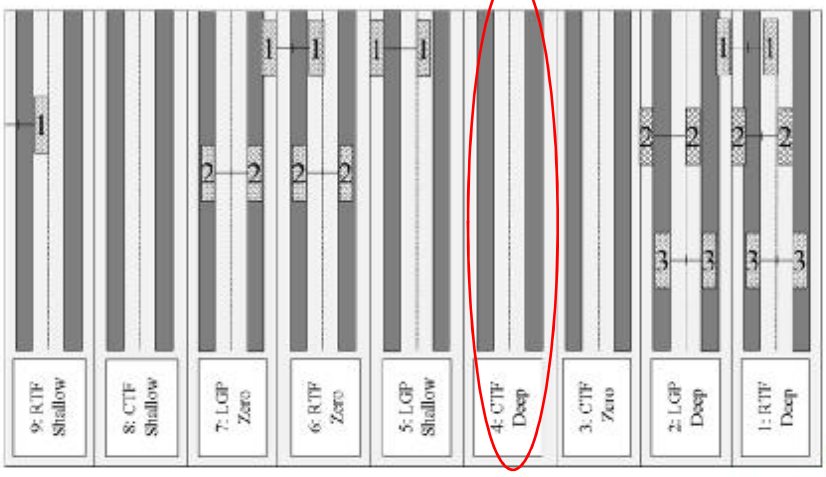
Traffic



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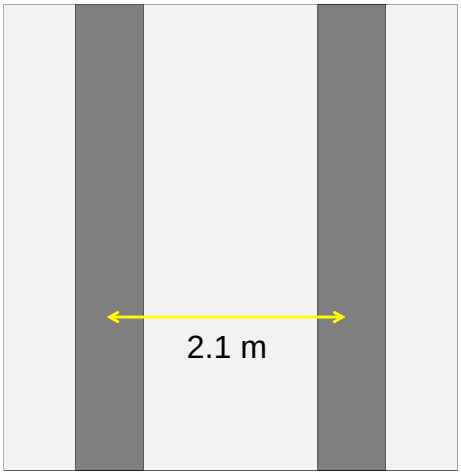
Controlled Traffic Farming



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Controlled Traffic Farming

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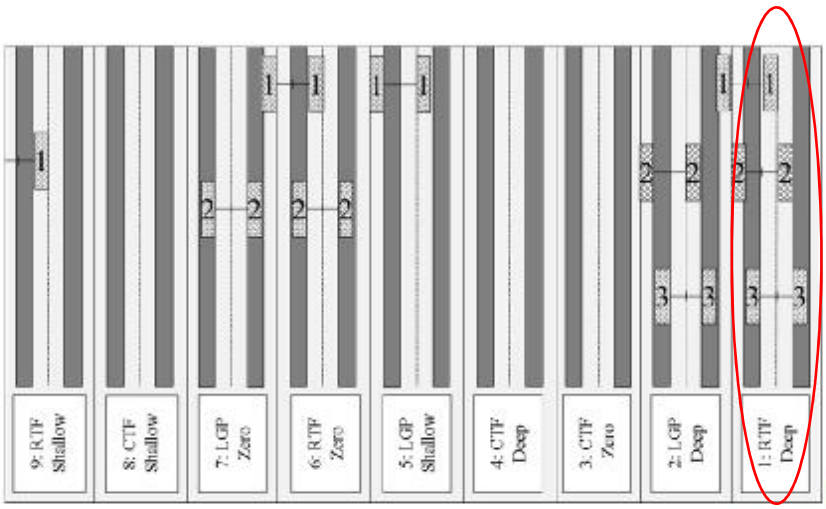
Traffic



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Random Traffic Farming / Deep Tillage

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RTF Deep Tillage | RTF Shallow Tillage | RTF Zero Tillage

LGP Deep Tillage | LGP Shallow Tillage | LGP Zero Tillage

CTF Deep Tillage | CTF Shallow Tillage | CTF Zero Tillage

Traffic wheel marks in October 2012

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Low Ground Pressure Farming

Tyre pressure (bar)

	Front	Rear
Low	0.7	0.7
High	1.2	1.5

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Tillage & Drills

Väderstad TopDown

Deep and Shallow Tillage plots

- Deep: 250mm
- Shallow: 100mm

Väderstad Rapid (2012)

Väderstad Spirit (2013)

Effect of Tillage on Surface Residues

RTF Deep

RTF Shallow

RTF Zero

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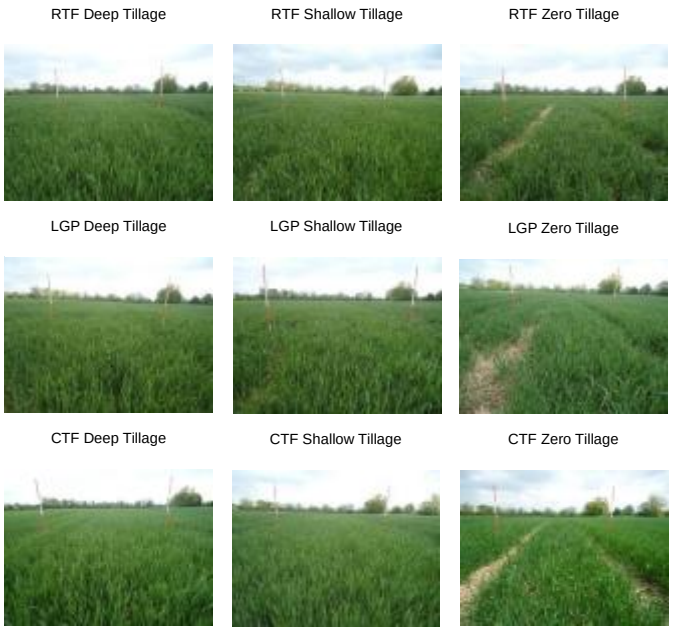

Zero tillage has a problem in wheel marks in all traffic systems

Winter wheat – 29th May 2013

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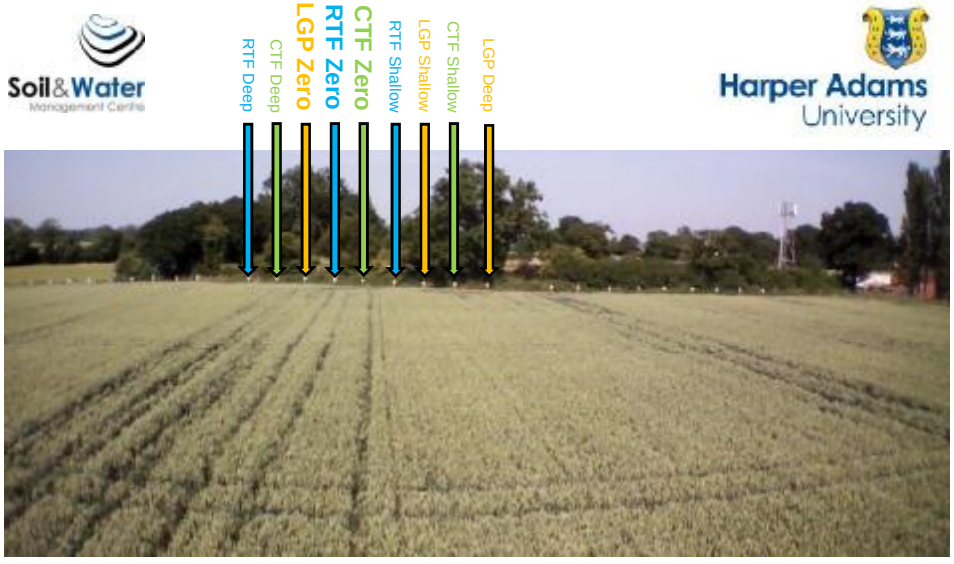

Block Two

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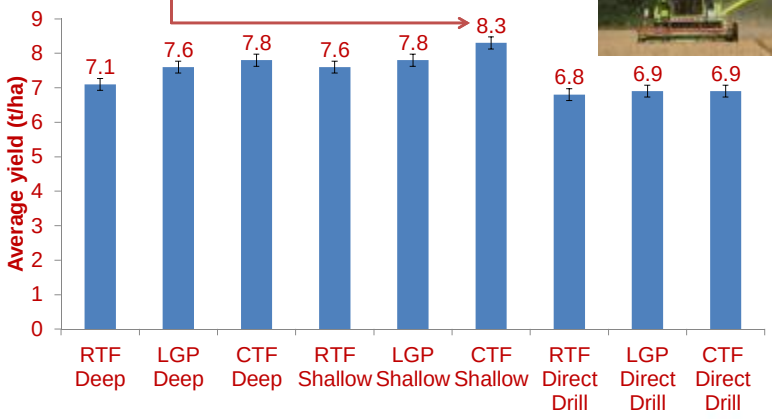
2013 Winter Wheat Yield

Combine Harvest Results

This rises to 8.6 for 10 m system: 21% greater than RTF Deep which is conventional practice



The effect of traffic and tillage on crop growth and yield in a sandy loam soil
Smith, E.K., Misiewicz, P.A., Chaney, K., White, D.R., Godwin, R.J. 2014

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Winter Wheat Yield

4m wide Combine Harvester Results

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- Main effects of Traffic:
  No significant difference
  - CTF 7.8 t/ha
  - LGP 7.6 t/ha
  - RTF 7.3 t/ha

- Main effects of Tillage:
  Zero tillage significantly lower than Deep and Shallow ($p<0.05$)
  - Deep 7.5t/ha
  - Shallow 7.9 t/ha
  - Zero 6.9 t/ha

- Compared to RTF Deep "Conventional"
  - CTF (regardless of tillage) = **+7%**
  - CTF Shallow (highest yielding) = **+15%**

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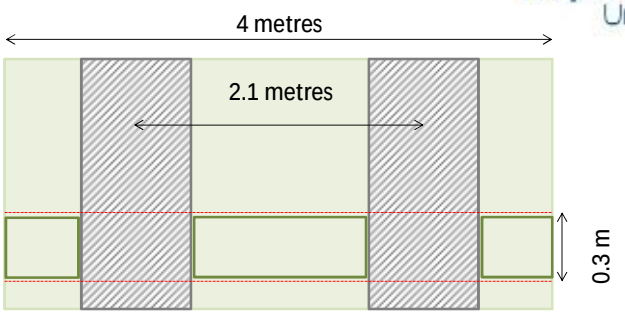
Hand sampling



Winter Wheat Yield

Hand Sample Results

Untrafficked yields significantly higher than wheelways ($p<0.05$)

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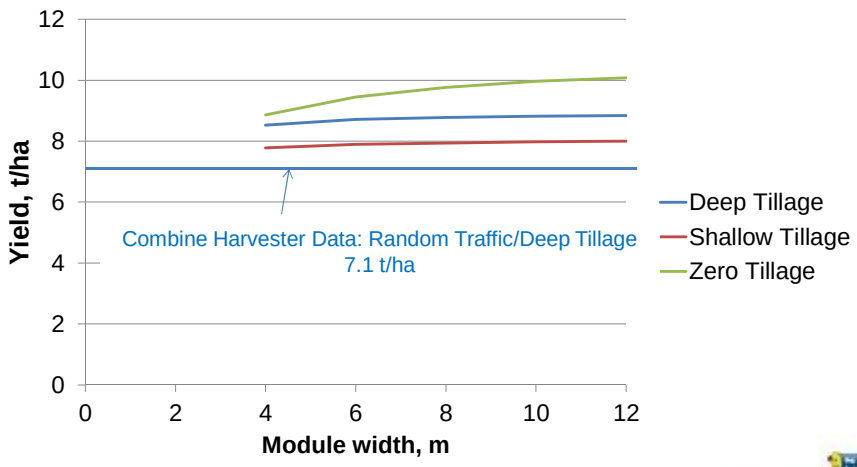
Effect of CTF module width



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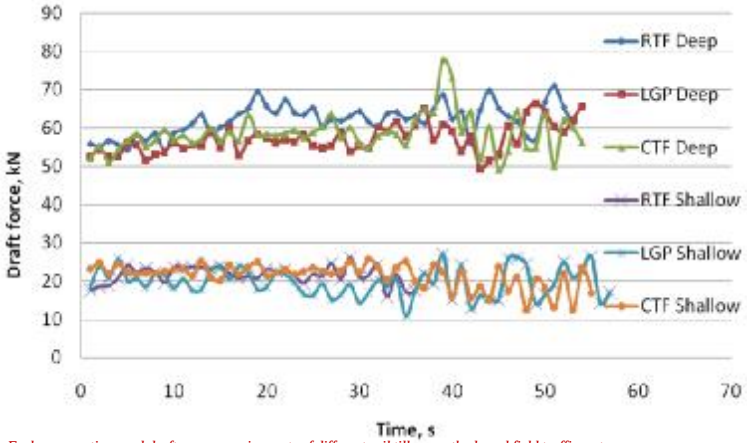
Tillage draft forces



Fuel consumptions and draft power requirements of different soil tillage methods and field traffic systems
Arslan, Misiewicz, Smith, Tsiropoulos, Girardello, White, Godwin; ASABE - Montreal ,2014

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Fuel consumption

Treatment	Fuel consumption (l ha^{-1})	Average tillage fuel consumption (l ha^{-1})
RTF Deep	23,07[a]	22.16
LGP Deep	21,52[a]	
CTF Deep	21,88[a]	
RTF Shallow	16,91[b]	16.42
LGP Shallow	15,77[b]	
CTF Shallow	16,59[b]	
RTF Zero tillage	8,29[c]	8.82
LGP Zero tillage	9,34[c]	
CTF Zero tillage	8,83[c]	

Fuel consumptions and draft power requirements of different soil tillage methods and field traffic systems
Arslan, Misiewicz, Smith, Tsiropoulos, Girardello, White, Godwin; ASABE - Montreal ,2014

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Conclusions

- Significant improvement in wheat yield 15 – 20 % from CTF
- Yield improvement depends upon area trafficked
- Managing wheel marks is critical
- Low ground pressure gives +ve but not significant response
- Potential reduction in draft forces and fuel consumption
- Much improved infiltration
- CTF and Zero Tillage should be good companions

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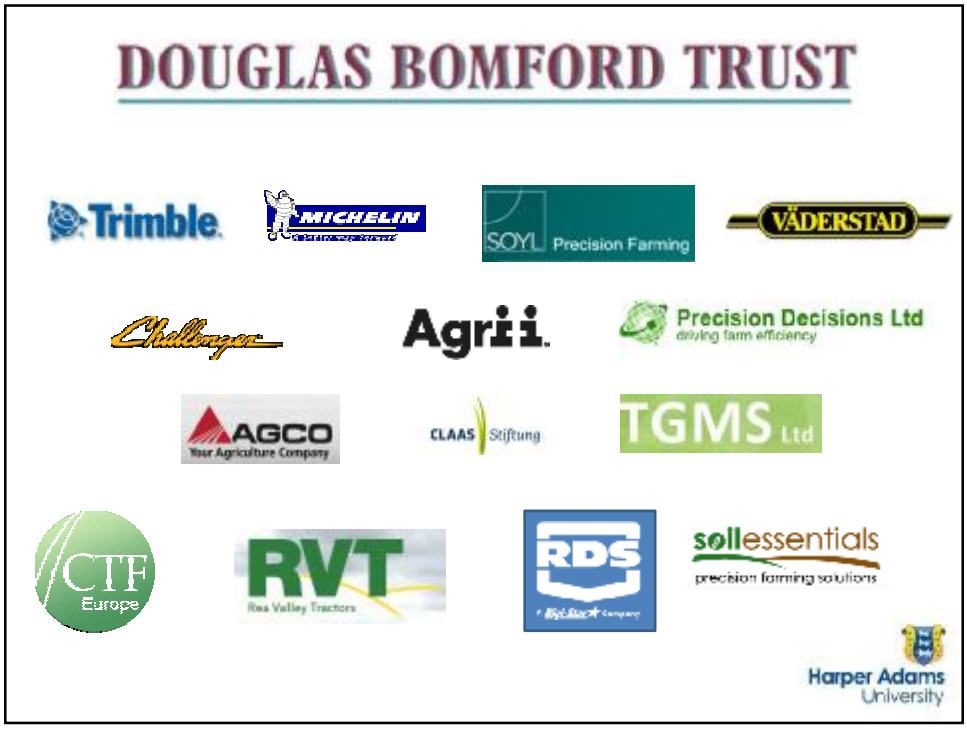

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