Impact of machinery on soils and crops

*Raising knowledge and issues for debate later*

Tim Chamen

CTF Europe Ltd
Soil stress at 0.4 m depth, bar

Loads keep increasing - pressures rising at depth

14 fold increase

7 fold increase

12 t
Tracking is extensive every year

- Typical min-till system
  - Rake, disc x2, drill, roll, harvest
  - 127% tracking
Tracking:

- squeezes the soil together and makes it cloddy
- squashes out air and water
- seals up the surface, even at low contact pressure
- increases implement draught
- absorbs a lot of power in rolling resistance
  – compaction doesn’t come cheap!
- lowers crop yields
Looks great on top, but!
lousy underneath!
Natural restructuring?

October – March
5 cm deep in the soil

Little sign of any change!
A closer look at soil

Soil with good natural structure

 Acts like a sponge: Can hold up to 40% water by volume

With acknowledgement to R.C. Palmer,
Independent Soil Assessment Specialist
rc.palmer@btinternet.com
Water dynamics

• Water drains from soils
  – demonstration of field capacity
    • totally dependent upon soil structure and drainage depth

• Water pulled up from below
  – demonstration of capillary attraction
Capillary attraction demonstration
Capillary attraction or water suction

Hinge - narrow end
Water drainage
Demonstration of pore suction

• I’m looking for suckers!!
Danish work
P. Schjønning et al, Aarhus University

Trafficked plots – pores > 0.3 mm
Danish work
P. Schjønning et al, Aarhus University

Non-trafficked plots – pores > 0.3 mm
Infiltration and drainage test

1 litre of water added to CTF, no ponding, most drained in 150 s

1 litre of water added to RTF, 30 mm ponding, water took 300 s to drain from surface
Conventional, after potatoes & heavy rain
CTF, after potatoes and heavy rain
Arndt and Rose, 1966

• “Excessive traffic necessitates excessive tillage”
Reductions in tillage draught with no traffic

<table>
<thead>
<tr>
<th>Depth of operation, mm</th>
<th>Draught savings, %</th>
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</thead>
<tbody>
<tr>
<td>100 (4”)</td>
<td>60</td>
</tr>
<tr>
<td>200 (8”)</td>
<td>20</td>
</tr>
<tr>
<td>500 (20”)</td>
<td>18</td>
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</tbody>
</table>
RTF compared with CTF

Both fields in no-till for 3 years

First trafficked soil
Effect of compaction on seedbeds
Effect of compaction on seedbeds

- Energy to loosen. Energy to re-compact
- Loss of moisture
- Uneven germination and growth
  - Timeliness effects on subsequent chemical applications
and it’s not just on cultivated soils!
Wheels have a big impact!

One week later!
Compaction:

- increases fuel use by around 50% on cultivated soils
- decreases yields by average 15%
- reduces fertiliser use efficiency (c. 15%)

Effects of compaction on different crop yields

% loss in yield by crop type compared with controlled traffic

- Grass forage
- Barley
- Canola
- Oats
- Peas
- Potatoes
- Wheat
- Sugar beet
Environmental effects

- Soil compaction:
  - implicated in increased emissions of $\text{N}_2\text{O}$ and $\text{CH}_4$
  - reduces earthworm numbers
    - e.g. from 41 – 2/m$^2$
What’s the impact of CTF on the economics and agronomics?
Neesham Farms
9 m OutTrac
Economics

8 m OutTrac system

- Study 1 based on 1400 ha wheat/osr rotation on farm converted to CTF in 2009:
  - Conversion from RTF min till to CTF no till
    - 8% increase in profit
    - 17% increase with 4% (wh) and 7.5% (osr) extra yield
    - 14% return on capital investment
    - £250,000 savings on machinery investment
Economics

9 m OutTrac system

• Study 2 based on 1085 ha wheat/OSR/linseed or spring barley converted to CTF in 2010
  • Conversion from RTF min till to CTF and no-till/some till
    – £14,000 saving on machinery capital
    – profit calculations still in progress
Impact of CTF on agronomy

• Largely precludes ploughing on regular basis
• Tillage inputs drop dramatically
  – intensity and depth
• Most CTF farmers have gone to no-till
  – straw management crucial
  – good drill central to reliability
  – attention to detail
    • weed and pest management
Alopercurus myosuroides – Blackgrass – a moisture loving plant!

- Some evidence that CTF reduces blackgrass competitiveness – due to better soil aeration and drainage
- No evidence that increased levels of herbicide needed compared with equivalent trafficked systems
The no-till debate!

• Mother nature is a no-tiller!
  – weed seeds kept near the surface
    • most germinate at the same time
    • most are better controlled by residuals

• Tillage loses moisture
  – patchy or no germination

• Philosophy should be:
  – why do I need to cultivate this field?
Grey field slug

• Some evidence that CTF is good haven
  – limited tillage, good porosity
• Active management needed:
  – rolling
  – tillage
  – pellets
Practical issues

• Parallel working
  – some cultivators not so effective
• Ridging
  – generally no problems but must choose machines wisely
Practical issues

- Harvest logistics
  - grain harvest efficiency - cross headlands?
Wheeltrack management

Tramline since August 04 - perhaps need to infill every third year

Photo Feb 08
Wheeltrack management

Intermediate cropped wheelway since Sept 06 - no need for infilling

Feb 08
Opportunities released by CTF

• Inter-row tillage for weed control
• Inter-row seeding
• Strip tillage
• Easier operation of no-till drills
  – better penetration
  – improved topsoil conditions
• No compromise of subsoiling operations
Direct planting potatoes after onions, CTF, Tasmania
Constraints to adoption

• Perceived high cost
  – no allowance for immediate payback of guidance and auto-steer
    • mostly economics of guidance a “no brainer”
  – wrong timescale for adoption
    • normally long intervals between machinery replacement
  – incorrect system choice
Constraints to adoption

• Inability to trial CTF alongside traditional practice
  – no yield comparisons
  – changes in agronomy
Unkowns

• Mole ploughing
  – will this be required less often?
  – to what extent will it compromise CTF?
    • should it be considered when setting out fields initially?

• How to manage non-trafficked soil
  – never had it before
  – which soils might need regular cultivation and to what depth?
  – do we ever need to cultivate beyond disturbance created by drill?
Future CTF?
Don’t treat your soils like dirt!
Here with impartial help

CTF Europe

- **CTF Focus Group** (£96 one off)
  - International
  - Workshops
  - Detailed reports
  - Information sharing between practitioners

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www.ctfeurope.eu
Consult us

• If you are a CTF Europe member:
  – we will run a simple test for you based on information supplied
  – provide one hour of phone contact to discuss the results or other issues
  – provide e-mailed independent advice on a wide range of CTF matters

• Fliers available with further information
Left out of hall car park
Immediately left
Through village, keep left (sign White Horse)
After one mile, right at cross-roads
Take second right (after one mile)
Field on right in ¾ mile
Left out of hall car park
Immediately left
After one mile, right at T-junction
Take second right after one mile
Field on right in ¾ mile
Field visit groups

Directions
Left out of hall car park
First left
Right at T-junction
Take second right
Field on right in ¾ mile

<table>
<thead>
<tr>
<th>Field visit groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Richards</td>
</tr>
<tr>
<td>Tim Chamen</td>
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<tr>
<td>Stuart Alexander</td>
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<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
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<tr>
<td>Alistair Jeffrey</td>
<td>Chris Hoskins</td>
<td>Al Brooks</td>
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<tr>
<td>Carl Flint</td>
<td>David Fisher</td>
<td>Andrew Russell</td>
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<tr>
<td>Chris Freeman</td>
<td>David Fisher, guest</td>
<td>Charlie Hood</td>
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<tr>
<td>Greg Taylor</td>
<td>David Purdy</td>
<td>Chris Taylor</td>
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<td>James Painter</td>
<td>Ed Salmon</td>
<td>Christopher Grassam</td>
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<td>Julian Randall</td>
<td>Emily Smith</td>
<td>David Tinker</td>
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<td>Jussi Knaapi</td>
<td>Francis Loake</td>
<td>David Walston</td>
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<td>Keith Ashby</td>
<td>Laurent Mozziconaccci</td>
<td>Martin Parkinson</td>
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<td>Keith Mitchell</td>
<td>Marcus Loake</td>
<td>Paul Cripsey</td>
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<td>Koloman Kristof</td>
<td>Matt Childs</td>
<td>Peter Hewson</td>
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<td>Peter Riley</td>
<td>Mervyn Bailey</td>
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<td>Mick Whitley</td>
<td>Robert Hill</td>
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<td>Richard Salmon</td>
<td>Nick August</td>
<td>Simon Appleby</td>
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<td>Simon Mudd</td>
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<td>Robin Gaymer</td>
<td>Peter Henley</td>
<td>Stephen A.-Business Ptnr.</td>
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<td>Roger Godwin</td>
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<td>Tom Goodman</td>
<td>Simon Fellows</td>
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<td>Tony Clear</td>
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<td>William Forsyth</td>
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