Soil Related Benefits of Controlled Traffic

Soil&Water Management Centre

Harper Adams University

Soil Related Benefits of Controlled Traffic

Dick Godwin



Outline

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- National costs of compaction
- Sources of damage
- Effects of compaction on:-
  - Tillage forces/power
  - Infiltration
  - Runoff
  - Greenhouse gases
  - Yield
- Benefits of CTF
- Concluding comments



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Cost of soil degradation in England and Wales

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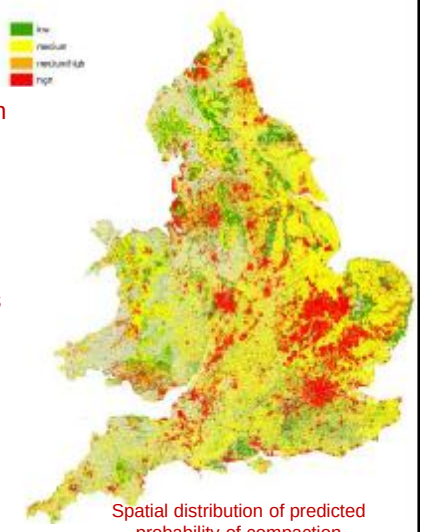
The assessment explored the total costs of soil degradation:

- The total quantified costs of soil degradation are estimated at between £0.9 bn and £1.2 bn per year.
- Compaction and loss of soil organic content account for 39% and 45% respectively of annual costs.
- Silts and sands account 67% of total estimated erosion costs, and clays and sands for 91% of compaction costs.
- Almost 80% of total quantified costs occur offsite.
- In terms of soilscapes, arable farming accounts for over 70% of erosion and compaction related costs.

Defra Report CTE0946 by Cranfield University, 2011



Spatial distribution of predicted probability of compaction

Effects of load, inflation pressure and speed on pressure distribution

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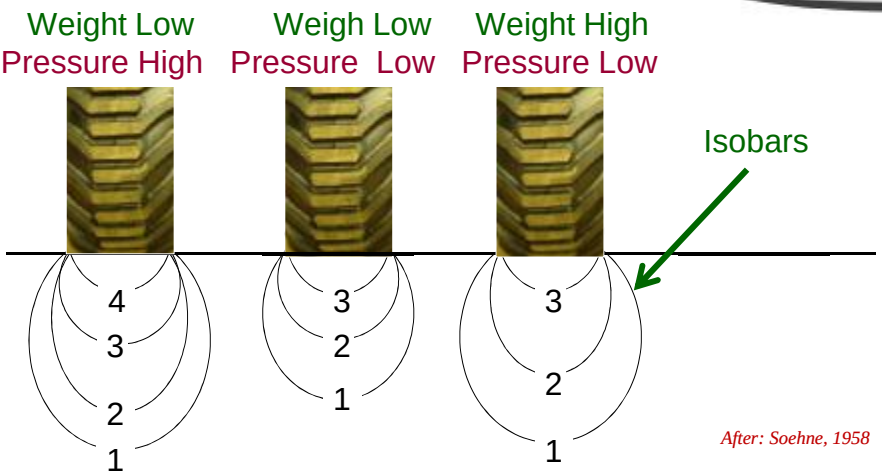

After: Soehne, 1958

Pressure has the greatest influence on the degree of compaction and load influences the depth of soil compaction

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Effect of wheel/track system on pressure at 250mm deep

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After: Dresser and Godwin, 2006

Random Traffic Problems

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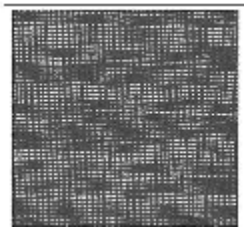
Extensive areas of the field are exposed to trafficking

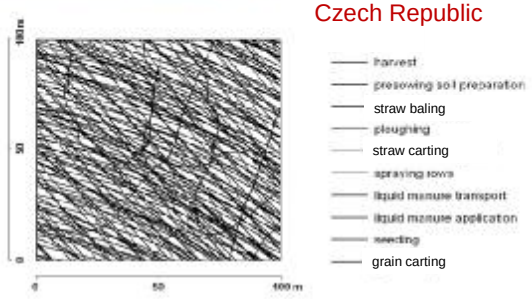
- Random Traffic + plough = 85% covered
- Minimum Tillage = 65% covered
- Direct Drilling = 45% covered



Potatoes
Shropshire

Kroulik , Misiewicz, White and Godwin, 2012

Wheat
Czech Republic



Kroulik et al, 2011

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Relationship between draught force and soil bulk density

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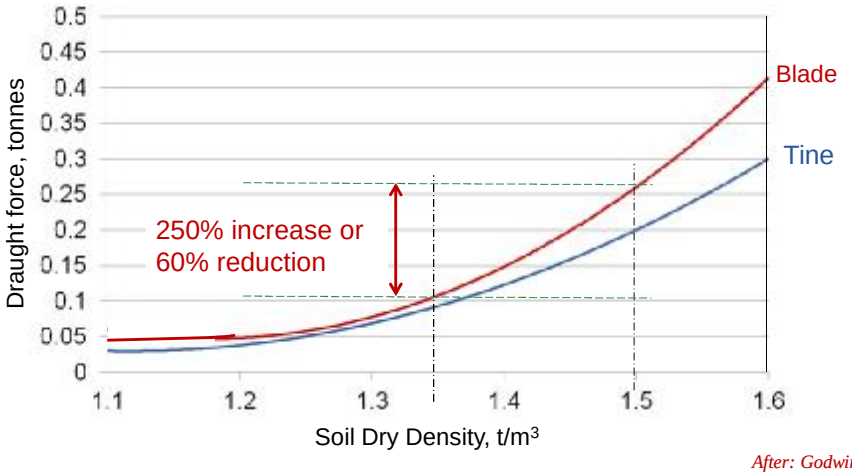
Sandy loam soil



After: Godwin, 1974

Traffic control effects on energy/costs requirements (kWh/ha) (£/ha*)

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**After: Nix 43rd Edition (2013) c £0.25/kWh at 65% Tractive efficiency (Innes and Kilgour, 1980)*

No traffic		Trafficked	
Shallow plough 13 (£5)		Shallow plough 32.5 (£13)	
A 60% reduction			
Harrow	7.0	Spring tine	16.0
Drill	7.5	Power Harrow	30.0
Roll	7.5	Harrow	8.0
		Drill	8.6
		Roll	8.4
TOTAL	22 (£9)		71(£30)
A 70% reduction			

After: Chamen, 1992

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Environmental benefits of CTF

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4 x increase in infiltration

- less run-off and erosion
- reduced pollution of water courses
- more plant available water

Infiltration

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Relationship between four different compaction levels and water infiltration rate

After: Chyba, 2012

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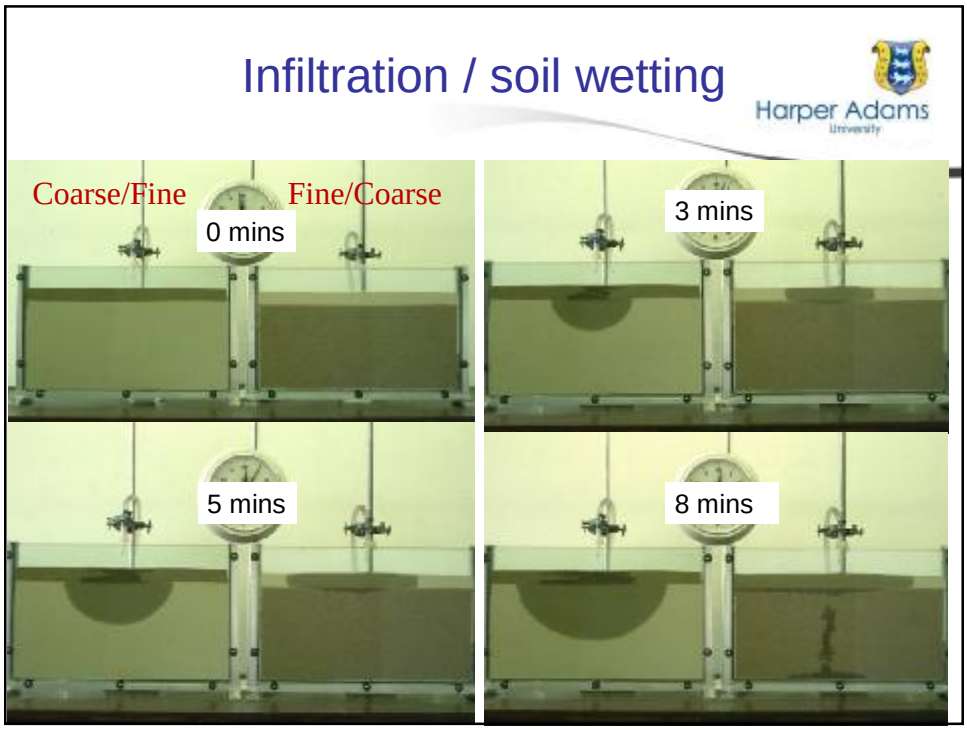

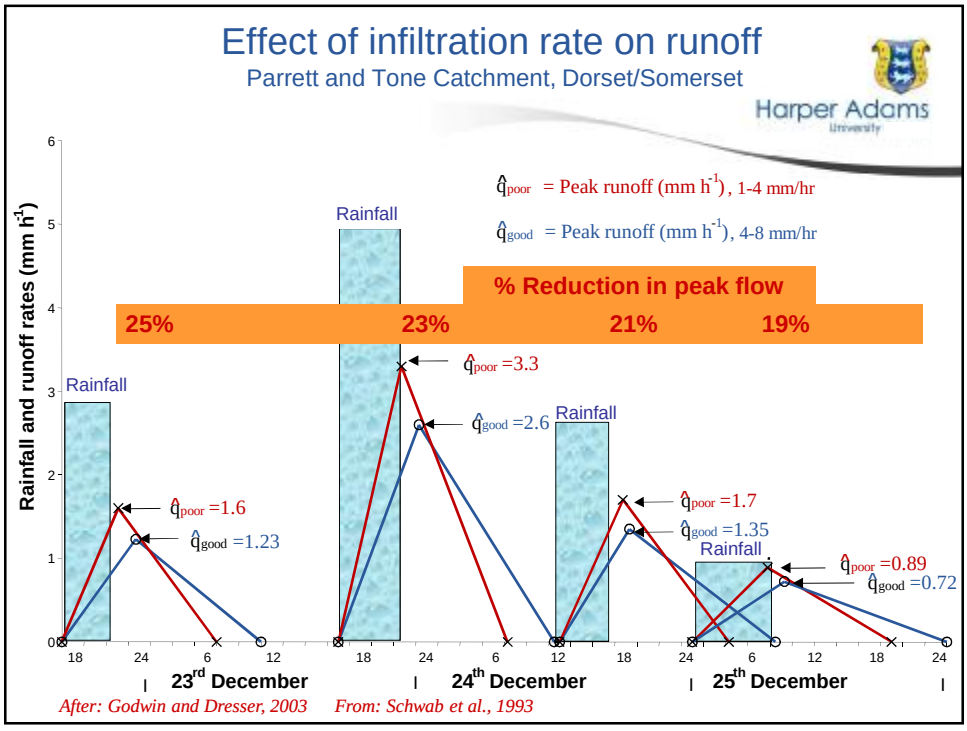

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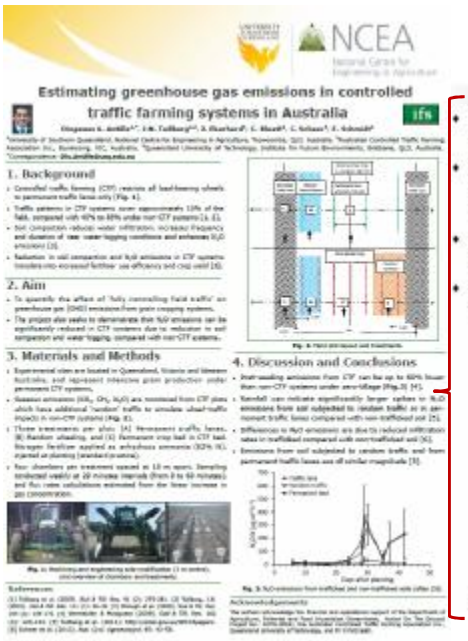
Estimating greenhouse gas emissions in controlled traffic farming systems in Australia

1. Background

2. Aim

3. Materials and Methods

4. Discussion and Conclusions

- Post-seeding emissions from CTF can be up to 60% lower than non-CTF systems under zero-tillage (**Fig.3**) [4],
- Rainfall can initiate significantly larger spikes in N_2O emissions from soil subjected to random traffic or in permanent traffic lanes compared with non-trafficked soil [5],
- Differences in N_2O emissions are due to reduced infiltration rates in trafficked compared with non-trafficked soil [6],
- Emissions from soil subjected to random traffic and from permanent traffic lanes are of similar magnitude [5].

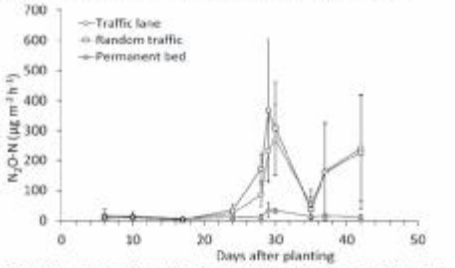

Fig. 3: N_2O emissions from trafficked and non-trafficked soils (after [5]).

Antille et al., International Fertiliser Society Conference, Cambridge, Dec 2013

Relationship between maize silage yield and soil bulk density (Quebec)

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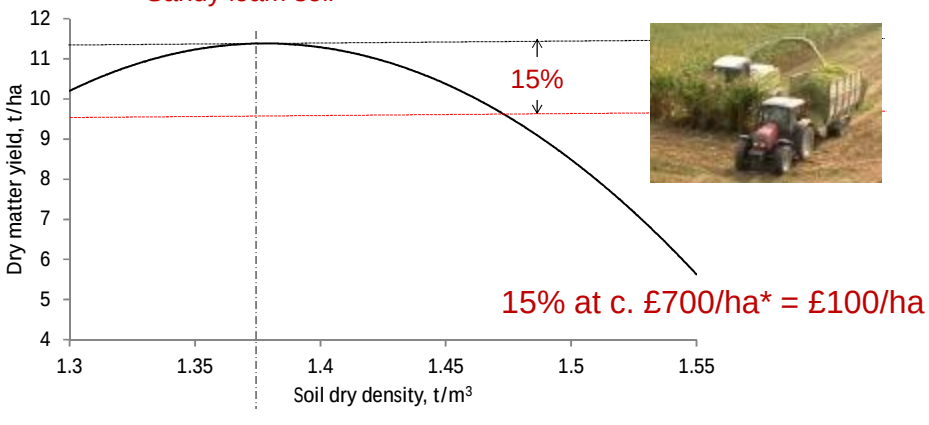
Sandy loam soil



After: Negi et al, 1981

** Nix, 39th Edition*

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CTF/Low Ground Pressure Study

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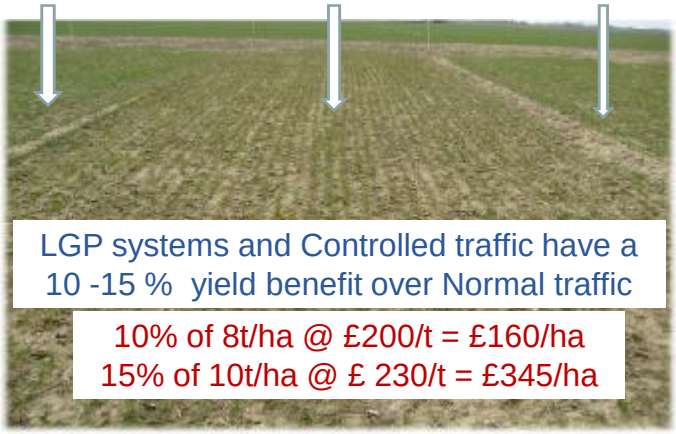
Zero Traffic	Normal random traffic	Zero traffic + tracked vehicle
12. 52 t/ha	10.84t/ha	12.14t/ha



LGP systems and Controlled traffic have a 10 -15 % yield benefit over Normal traffic

10% of 8t/ha @ £200/t = £160/ha
15% of 10t/ha @ £ 230/t = £345/ha

After: Phillpot, Stobart, Orson, Mouasen and Godwin, 2008 TAG/Cranfield University study at Morley

Without traffic compaction crop yields increase

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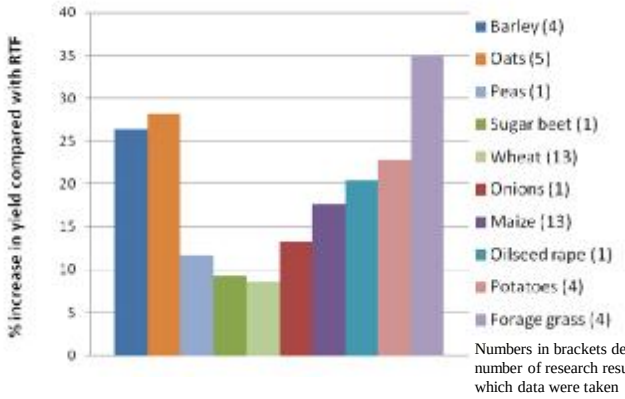
% increase in yield by crop type under controlled compared with random traffic



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

5 t applied at the surface in one year permanently depressed yields by 2.5% due to subsoil compaction

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Benefits of Controlled traffic - Field Scale: Nitra, Slovakia

10% Yield improvement in 2012

April 2011 July 2012

Compacted strips: Mean yield = 4.91t/ha

Controlled traffic: Mean yield = 5.39 t/ha

After: Galambosova and Rataj, 2012

Controlled Traffic Farming (CTF)

- Area exposed to wheels < 30-40% & could be <20%
- Improved soil structure
- Reduced input costs: time; fuel; machinery - Down 22%
- Operating profit up 8% (£75/ha without yield addition)
- Increased crop yields from non trafficked soils + 9 to16%
- Infiltration increased by circa 400% in UK

Pros
+ Simple concept
+ GPS steering/guidance

Cons
- Standardise wheel centres
- Industry resistance to change in broad acre crops
- GPS reliability
- Harvester widths

Source: Chamen, 2011

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Traffic effects on soil fauna

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Bad for earthworms:

- from 40 to 2 per m^2 with 5t wheel loads
- earthworms can have beneficial effects on soil-borne diseases less take-all

No traffic:

"Good for Peter also good for Paul"

- slugs also like better soil structure, therefore - proactive stance and cultural controls

Effect of Organic Matter

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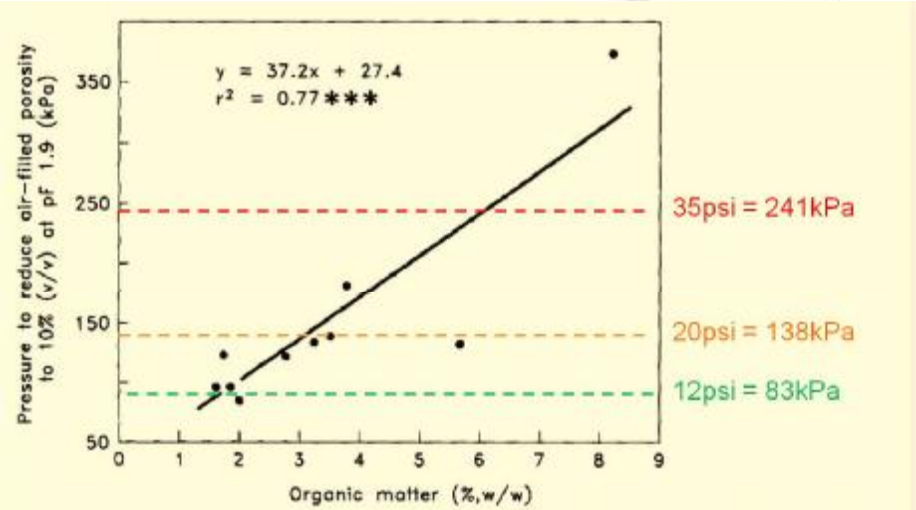

Fig. 1. The pressure required to reduce the air-filled porosity to 10% (v/v) at pF 1.9 as a function of organic matter content (drawn from data presented by Kuipers, 1959).

Soil Related Benefits of Controlled Traffic

There are many savings

1. little need for subsoiling
2. less power per unit width
3. less “aggressive” cultivators
4. shallower tillage
5. better stale seedbeds
6. smaller tractors
7. maximum potential for “No till”

Without traffic

- Crop yield gains and savings in:
  - fuel
  - time
  - machinery
  - labour
- Improvements in:
  - soil health
  - nutrient and water use efficiency
  - timeliness

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Final Reflection

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"Man has only a thin layer of soil between him and starvation".

Anonymous

"The nation that destroys its soils, destroys itself".

F. D. Roosevelt

"There can be no doubt that a society rooted in the soil is more stable than one rooted in pavements"

Aldo Leopold

"To forget our soil is to forget ourselves"

Ghandi

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