





# Machinery, soils and tillage for potatoes

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Economic cost of compaction in England and Wales : c. £0.4 bn/annum

Morris et al. - Cranfield University, 2011



## Effects of load and inflation pressure on pressure distribution



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



Random traffic problems





#### Extensive areas of the field are

exposed to trafficking

Random Traffic

- + Plough = 85% covered
- + Minimum Tillage = 65% covered
- + Direct Drilling = 45% covered



#### Wheat, Czech Republic





Potatoes, UK 84% establishment

Kroulik, M., 2012, Sabbatical Study at Harper Adams University,

## Soil preparation in Shropshire





## **Options for compaction reduction**

Reduced pressure tyres, tracks, reduce axle weight and central tyre inflation pressure systems (for EvoBib)









#### **Controlled traffic**





Smith, E., Misiwicz, P. A., White, D. J., Chaney, K and Godwin, R. J., 2013, Effect of traffic and tillage on soil properties and crop yield. Paper No 1597846, ASABE International Meeting, Kansas City.





After: Ansorge and Godwin, 2007



## Subsoiler – Draught forces in combine ruts



After: Ansorge and Godwin, 2007



- ✓ Simple concept
- Soil structure
   Infiltration + 400%
- ✓ Crop yields
   *"CTF (+LGP) = +10 to 15% yield"*

## **Controlled Traffic Farming**



- Fuel, time and machinery cost savings
   *"70% reduction between trafficked & untrafficked"*
- ✓ GPS guidance and Auto steering
- X Track width and harvester width matching



Source: CTF Europe





*The effect of controlled traffic on soil physical properties and tillage requirements for vegetable production. J.E. McPhee, P.L. Aird, M.A. Hardie, S.R. Corkrey. Soil & Tillage Research 149 (2015) 33–45* 

## Potatoes grow better in soft soil Wheels work better on roads









## Improved soil structure



Figure 6. Soil structure scorecard for clay loam textured topsoils in Tasmania.

#### <u>Score 1 - 2</u>

Large compact clods (50 – 100 mm) with few fine aggregates. Clods are angular or plate-like with smooth sides and no pores.

#### Score 3-4

Mainly firm large clods (20 – 50 mm) that are angular with smooth faces and no pores. Clods and overworked soil break into loose powdery soil.



Score 5-6

Few medium and large firm, rounded aggregates (5 - 30 mm) with mostly finer aggregates (< 2 mm) and some powdery unaggregated soil.

Score 7 – 8 Friable soil with many rounded aggregates (5 – 20 mm). Many fine rounded aggregates (< 2 mm) but little powdery unaggregated soil.

#### Score 9 - 10

Conv

CTF

Porousloosesoil with manyrounded, irregular shaped aggregates (2 – 10 mm). Large aggregates have many holes for good aeration and drainage. Little or no powdery unaggregated soil. Often has abundant very fine roots.



McPhee et al., 2015

Soil structure score after broccoli harvest			
Conventional	Controlled traffic	40 year pasture	
traffic & tillage		fence line	
3 - 4	7 - 8	9 - 10	





Site no.



## **Scottish Study**



Zero and conventional traffic systems for potatoes in Scotland 1987–1989. Dickson, J. W., Campbell, D. J., Ritchie, R. M. Soil Tillage Res. 24, 397–419, 1992.





McPhee et al., 2015

### Soil conditions in the ridges were similar. Soil below the ridge was weaker for zero traffic.

Dickson, J.W., Campbell, D.J., Ritchie, R.M., 1992





Harper Adams University

Yield depressions and clod yield higher on either side of sprayer tramlines.



Dickson, J.W., Campbell, D.J., Ritchie, R.M., 1992



Dickson, J.W., Campbell, D.J., Ritchie, R.M., 1992



Marketable Potato Yield



#### Zero Traffic Conventional Traffic



#### Dickson, J.W., Campbell, D.J., Ritchie, R.M., 1992



Dickson, J.W., Campbell, D.J., Ritchie, R.M., 1992



**Benefits from New Zealand** 



- 4t/ha (45%) less soil to the pack house
- Reduced transport costs, washing time, energy and "waste soil"
- Reduced fuel use, hence increasing area under CTF



See also You Tube video CTF for Potatoes. Simon Wilcox







## Run-off after harvest Tasmania







Conventional

McPhee et al., 2015

Controlled traffic



# Reduction in subsequent tillage operations



Crop transition	Conventional	CTF
green manure – potatoes	3	2
potatoes – green manure	4	2
green manure – broccoli	4	1
broccoli – green manure	3	1
Total number of operations (57% reduction)	14	6

## No-till potatoes after onions Tasmania





McPhee et al., 2015



## RTK-GPS enables < +/- 20 - 30 mm positional error. Issues of repeatability and cost are being addressed

After: Chamen (2007)



Controlled traffic system for vegetable production using RTK- GPS and 300 mm wide rubber tracks. Track positions are at 3.15 m centres

After: Vermuelen (2006)



= 3.66m + 1.83m = 5.49m (ok for 6m TopDown?)

Chamen, CTF Europe, 2017

## Match sprayer to combine



- Match sprayer to 3 x combine cutting width
  - trailers/chasers always run in tramlines
  - may need to extend combine unloading auger
  - may need to modify sprayer





Chamen, CTF Europe, 2017



### Deep soil loosening Beds-Beds 1983



#### **Bed Preparation Pass**



Godwin and Spoor, 2015



CTF in vegetable production More gains but greater challenges



## Example

- System based on 1.83 m (72")
- Suits onion and potato production
- All new machines based on 3 x 1.83 m
- 5.49 m bed former



Chamen, CTF Europe, 2017

## CTF in vegetable production



## Example

- System based on 1.83 m (72")
- Suits onion and potato production
- All new machines based on 3 x 1.83 m
- 5.49 m bed former
- 5.49 m planter
- 5.49 m topper
- 27.45 m sprayer
- 9.15 m (30') combine







Chamen, CTF Europe, 2017

## Non – controlled Harvest Traffic

Soil&Water







## Controlled traffic harvest New Zealand









## CTF in vegetable production



# Maintaining CTF during onion harvesting

- outrigger wheel hydraulically retractable
- elevator modified to give greater reach
- From Jones Engineering







## Aftercare/Repair











Spoor and Godwin, 1978



## Recommendations



- Minimize machine weight and contact pressure
  - Safely reduce inflation pressures, use ultra-flex tyre options
  - Spread the load with multi–axle and tracked vehicles
- Think about traffic intensity, match wheelings
  - Concentrate wheel traffic
  - If possible adopt Controlled Traffic Farming practices
- Target subsoiling operations
  - Focus on headlands, gateways and tramlines
  - Use traffic maps to identify hidden wheel/track passes
- Do not operate on recently loosened soil!

## Route into CTF



CTF can be achieved at many levels

- start with the combine it's probably your heaviest machine
- familiarise yourself with the options (join CTF Europe; £30/year)
- complete an inventory of the machines you might use
- check <u>actual dimensions</u> of any machines you plan to buy
- stick to your normal machinery replacement policy but buy matching widths
- ensure you have an auto-steer system with an RTK correction
  - you do not need for all operations Simon Wilcox





## Thank you for your attention

and thanks to

Tim Chamen (CTF Europe), Milan Kroulik (Czech University of Life Sciences) John McPhee (Tasmanian Institute of Agriculture)

Next 3 slides on TopDown and depth measurement + Some proposal ideas for Demonstration for 2018



## **TopDown Adjustment**





According to our records, Dillington have a 6m TopDown, which has one depth wheel on each folding wing as well as the two main ones within the centre frame.

Lifting the packer out of work (or removing it) leaves just the wheels to control working depth.

The drawbar adjustment is to set the frame level (front to back to ensure equal working depth along the length of the machine) and is not used subsequently in the general operation of the machine.

It is not unusual for both the packer and the wheels to be used in combination as depth control with the potential to leave a reasonably open/weatherproof finish without leaving wheelings.

It is also worth noting that even/consistent working depth is also aided by keeping a close eye on the wearing metal...uneven point wear is an often-overlooked cause of inconsistent effective working depth across the machine width.

I am also copying this reply to our relevant field-based colleagues....a visit to help better set up the TopDown and look at working applications should be helpful for Dillington and we may learn something ourselves at the same time. Michael Alsop, MD Vaderstad, UK

## Disturbance Depth measurement

1. Excavate a trench across two tines to below their working depth.

2. Facing the direction of implement travel, pull the disturbed soil away from the face to expose the limits of soil disturbance.

3. Following adjustment of depth/spacing. Check on any new disturbance boundary at depth can be made by pushing a rod or penetrometer into the loosened profile.







Surface level rises bulks up by about 20%

Godwin and Spoor, 2015

## **Demonstration for 2018**

Prepare soil with Deep Loosening Tines and/or Under - buster tines

- +/- surface wheels at high and low pressures and rubber tracks(?)
- 1. Excavate soil profile as see and photograph mid term benefits
- 2. Use structure score technique to quantify benefits
- Use penetrometer and infiltrometer to show/record benefits
   & if possible
- 4. Evaluate potato response.



## Effect of tracks and tyres on soil strength





## Effect of inflation pressure on soil strength

Penetration resistance, MPa



Dresser, Stranks, and Godwin, 2006

Soil & Water Management Centre



### Soil looseners





#### Chisel tine (Shakerator) Conventional Subsoiler



#### High lift Winged Subsoiler



Low lift wings + leading disc



Paraplow



Moleplough



Effective subsoiling



Limited evidence of crop response to general deep loosening soils unless for spring sown crops in sandy soils in years with low rainfall





After: Spoor and Godwin, 1978

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



After: Dresser and Godwin, 2006

## Lower ground pressure: Tyres and Rubber Tracks

+ Relatively inexpensive

+ Simple

- + Less working time and improved fuel economy, improved trafficability and manoeuvrability
- Pressure is applied (but lower)





Extra costs/tyres Tractor - 280 hp : Ultraflex tyres extra = £1.50/ha Combine: Ultraflex = £0.75/ha Price offset by fuel savings (c.20%) Personal communication: Brooks, Michelin

Extra costs tracks/combine Combine: + £4 to £5/ha for 5 - 7 year life Price offset by improved trafficability, narrower operating widths & operating up and down hills

Personal communication: Tyrell, Claas UK