Soil Care Event- Reducing Soil Compaction

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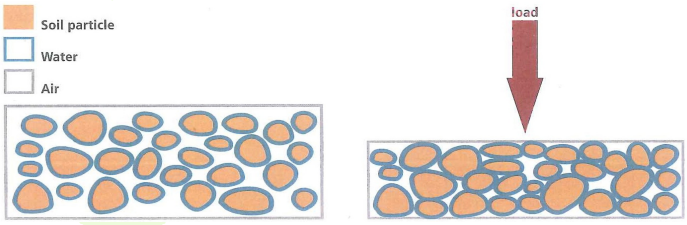
WHAT CAUSES COMPACTION ??

- Soil compaction is...

the consolidation of soil particles as a result of animal or vehicular traffic.



Increases Bulk Density
Reduces Pore Space
Creates Compacted Layer

Compacted Layers

- Restrict movement of water/air/nutrients
- Prevents good root development
- Impedes Drainage
- Increases release of Nitrous Oxide

Impact of Soil Compaction

- Poor plant growth
- Lower Yields
- Poorer Utilisation of fertiliser
- Increased runoff and ponding
- Increased anaerobic conditions
- Increased soil erosion
- More greenhouse gas emissions

Which Soils are at Risk????

WET SOILS
High Clay content
Peaty
Poor soil structure
Low Crop cover
Heavy Stocked
Heavy Trafficking

Identifying Compaction

- **Use a spade to dig a hole at least 30 cm deep**

Examine for:

- **Blocky platy vs crumb structure**
- **Horizontal layers (hard pan)**
- **Poor root penetration and roots running horizontally**
- **Lower earthworm populations**
- **Grey mottling**

What does the most Damage ??

Sheep vs Cattle vs Tractor

What does the most Damage ??

	Sheep	Cattle	Tractor
Standing	12 psi	25 psi	12 psi
Walking	29 psi	55 psi	12 psi

Compaction by Livestock

At or near Surface—usually less than 4”
Affected by

- Mass of Animal
- Stocking Density
- Rate of Rotation
- Sward Type
- Local Issues
  eg Trough /Shelter/Gates

What is he trying to do ?

Compaction by Farm Vehicles

Impacts on Surface and Subsurface

Affected By

Total Axel Weight

Tyre Width /Diameter and Type

Inflation Pressure

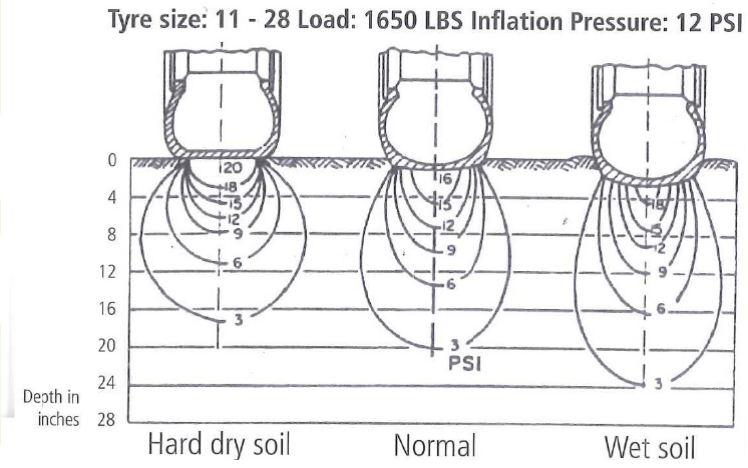
Wheel Slip

Number of Passes

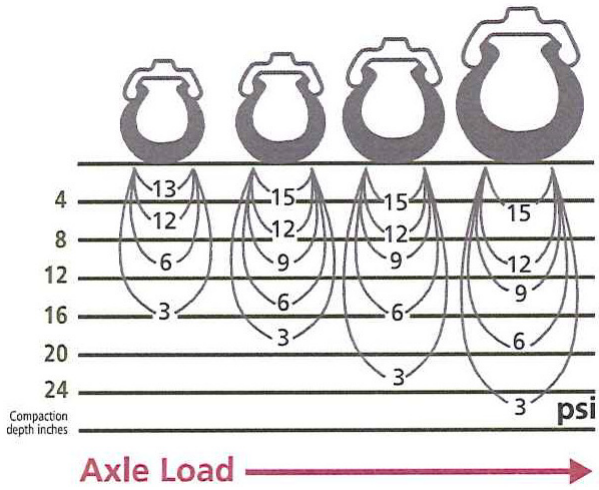
Moisture content

of the soil

Wetter the Soil-greater the impact



Spread the Load



Increase the Footprint-reduce Compaction

Grassland Soil Compaction: Effects on Yield and Nitrous Oxide Emissions

Paul Hargreaves, Bruce Ball and Dave Roberts, SRUC

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Outline

- Soil Compaction
- Nitrous Oxide
- DairyCo experimental work
- Effect on yields
- Effect on Nitrous Oxide emissions

Experiment Location

SRUC Dairy Research Centre
Crichton Royal Farm
Dumfries

DairyCo Compaction Experiment

The compaction experiment has three main treatments:

- **Trampling**
- **Mechanical load**
- **No compaction**

These treatments are related to measurements of grass yield and nitrous oxide (N_2O) emissions.

Sub-treatments

- **Surface aeration**
- **Sward lifting (~20cm)**
- **Nitrification inhibitor**

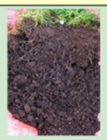
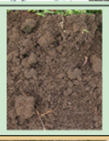
Two sites – Crichton (Scotland) and Harper Adams (England)

Compaction Treatments

Heifers (12) trampled area for 1 hour on two separate occasions – one week apart.

Weighted tractor (10,200kg). Driven over the area once on two separate occasions - one week apart.

Compaction Treatment Effects

Structure quality	Size and appearance of aggregates	Visible porosity and Roots	Appearance after break-up: various soils	Appearance after break-up: same soil different tillage	Distinguishing feature	Appearance and description of natural or reduced fragment of ~1.5 cm diameter
Sq1 Friable Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous Roots throughout the soil			 Fine aggregates	 The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
Sq2 Intact Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present	Most aggregates are porous Roots throughout the soil			 High aggregate porosity	 Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
Sq3 Firm Most aggregates break with one hand	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Porosity and roots both within aggregates.			 Low aggregate porosity	 Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.
Sq4 Compact Requires considerable effort to break aggregates with one hand	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks All roots are clustered in macropores and around aggregates			 Distinct macropores	 Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
Sq5 Very compact Difficult to break up	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			 Grey-blue colour	 Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.

Soil After Compaction Treatments

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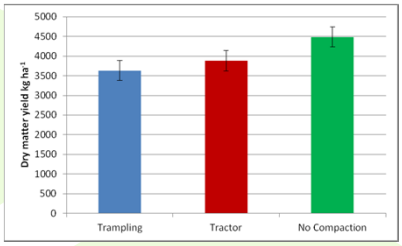
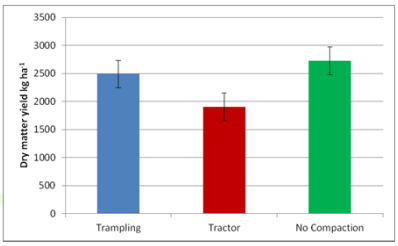
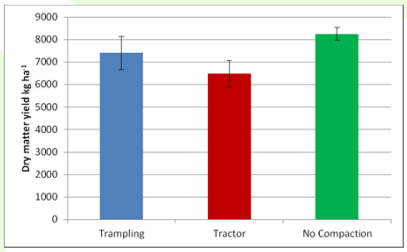
Compaction Results – 1st Silage Cut



2012

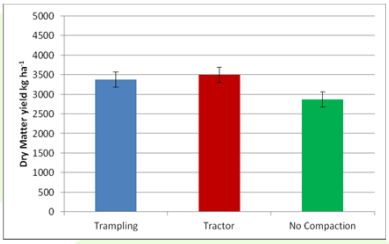


2013



2014

Compaction Results – 2nd Silage Cut



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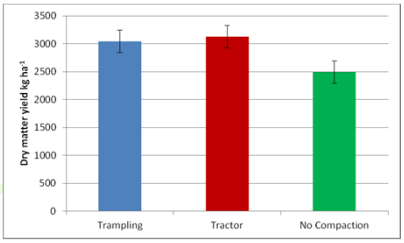
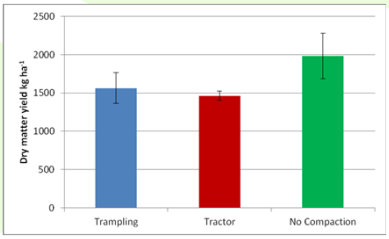
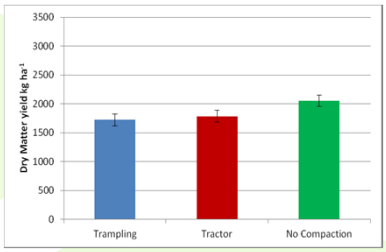


2013



2014

Compaction Results – 3rd Silage Cut



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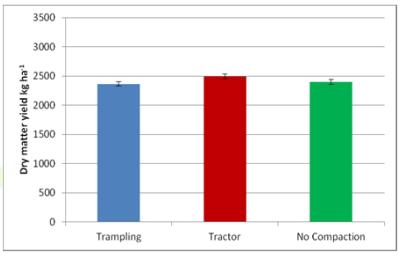

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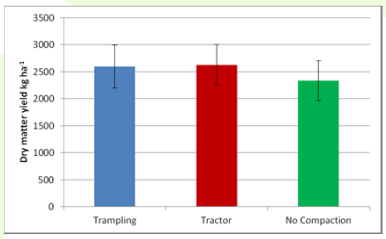


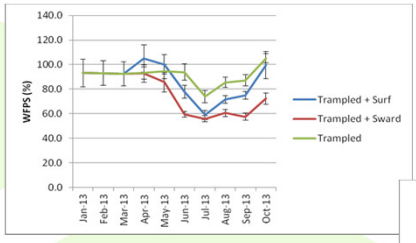
2014

Sward Lifter

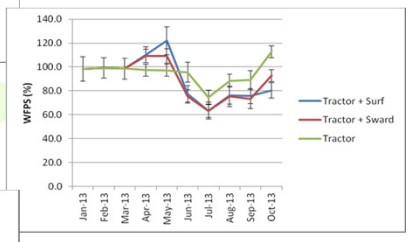
VESS Assessment of Tractor Compacted Grassland before and after Sward Lifting

Before Sward Lifting – February 2013 After Sward Lifting – May 2013

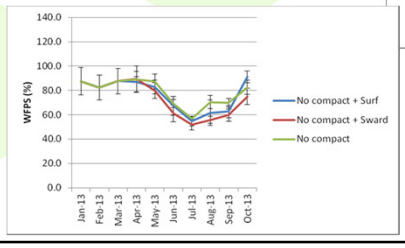
Changes in Water Filled Pore Space (WFPS)



Trampled

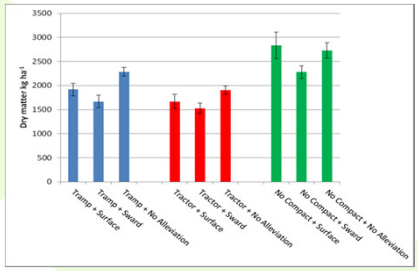


Tractor Compacted

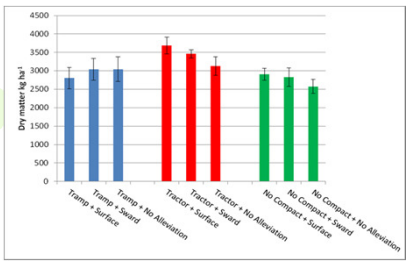


No Compaction

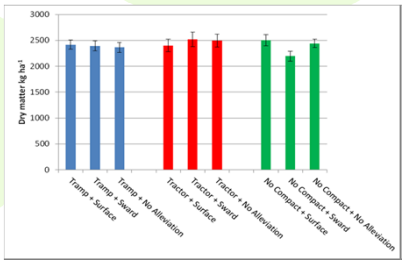
Alleviation and Dry Matter Yield



1st Cut Silage



2nd Cut Silage



3rd Cut Silage

Summary—to date

- Compaction reduced yield especially 1st cut silage
- Poaching damaged the sward in the first year
- Alleviation improved soil structure
- Alleviation increased drainage
- Alleviation did not significantly improve yield

Prevention is Better than Cure

Stay off Wet Soils

Sort Drainage issues

Know where your driest grazing fields are

Wetter fields –rest/graze with sheep/youngstock

Outwintering –when do you bring cattle in ?

Prevention is Better than Cure

Reduce weight

Minimise loads, remove weights
Light machines, more axles

Reduce ground pressure

Wider tyres, low inflation pressure
Tandom or Dual wheels, Tracked vehicles
Specialised low ground pressure machines

Sacrifice yield for timeliness

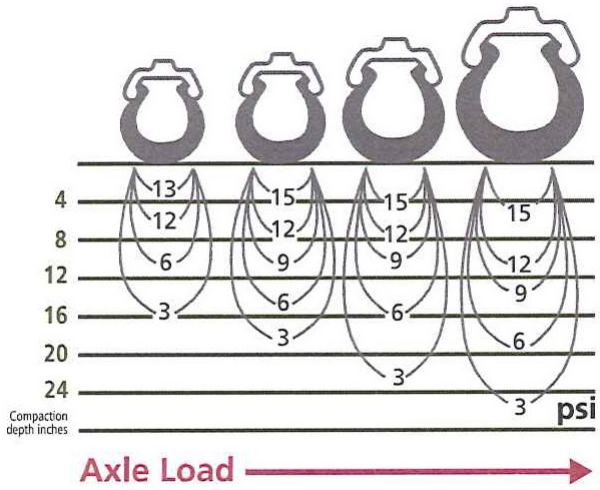
Choose crops to suit your soil type

Avoid uphill operations

Use Tracks/Endriggs/Tramlines

Gates at bottom of field ?

Spread the Load



Sorting Compaction Problems

Must use the **Right treatment**
at the Right depth
at the RIGHT time
OR ELSE waste of time and fuel

Spike /Aerator
Flat-Lifter
Plough
Subsoiler
Mole Plough

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SOIL AERATORS

FLAT LIFTERS

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FLAT LIFTERS/MINI SUBSOILERS

Subsoiler

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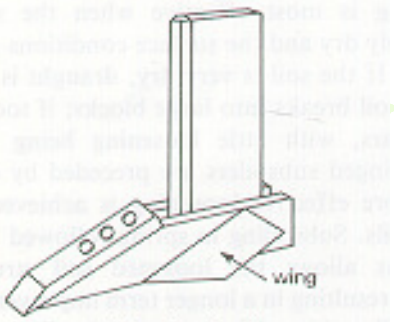
Subsoiler tine



Winged subsoiler

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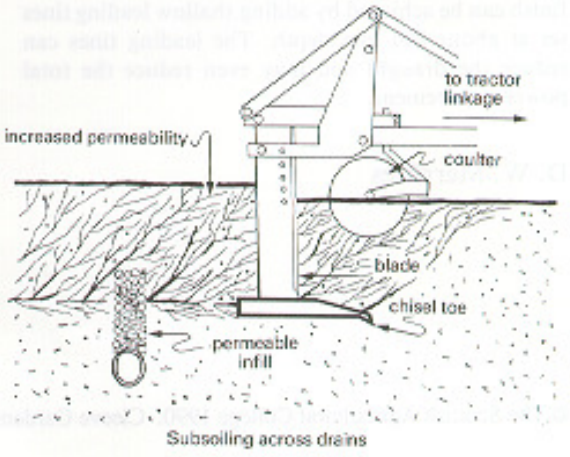
Subsoilers open up the soil



Subsoiling across drains

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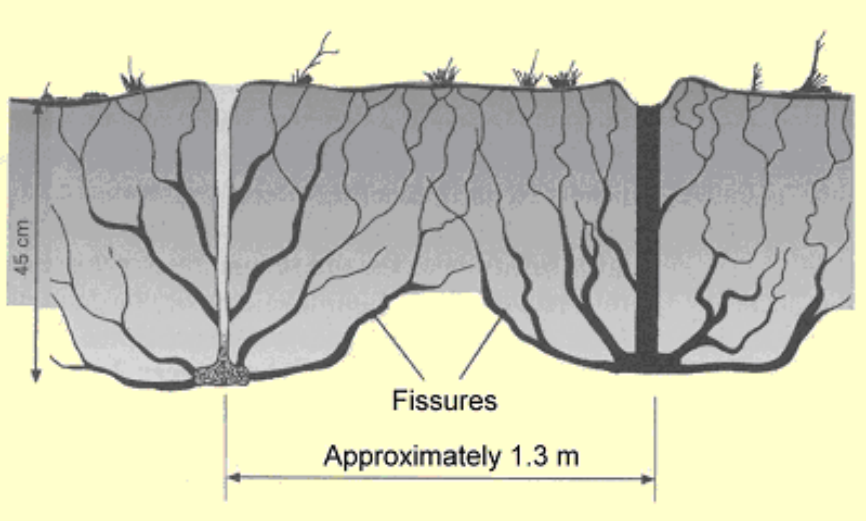
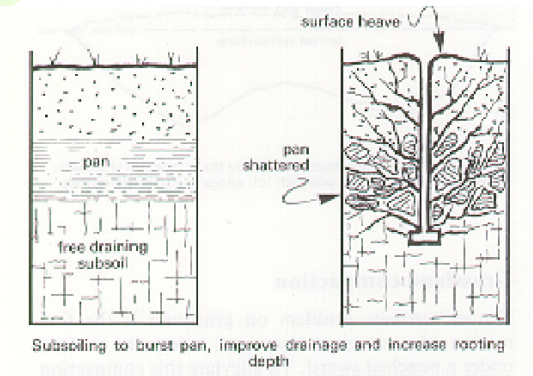
Subsoil shatter



Subsoilers break up pans



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When to subsoil

- Only when necessary - check the subsoil for compaction
- When the subsoil is brittle i.e. not too dry or too wet
- Post Harvest subsoiling is usually best in terms of land access and soil suitability (but not in 2007 or 2008 or 2012)

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How to subsoil

- Set the subsoiler below the compact layer if possible or around 16-18”
- Subsoil across the field drains
- Subsoiler should be at least 10cm above the drains
- Check to see if the operation has worked after the first pass
- Use shallow leading tines with the subsoiler
  - if soil above is too compact then shatter does not happen and the result is an inferior ‘mole’ drain

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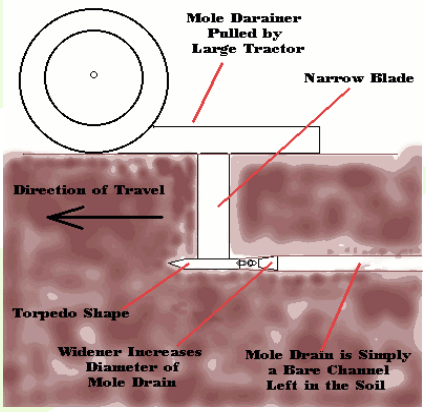
Moling – secondary drainage



- Very closely spaced drains are uneconomic
- Use short lived mole drains to connect permanent drains
- The mole plough has to pass through the permeable fill
- At least 35% clay in the soil and must be **Stone Free**
- The soil should be *plastic* when the mole is pulled

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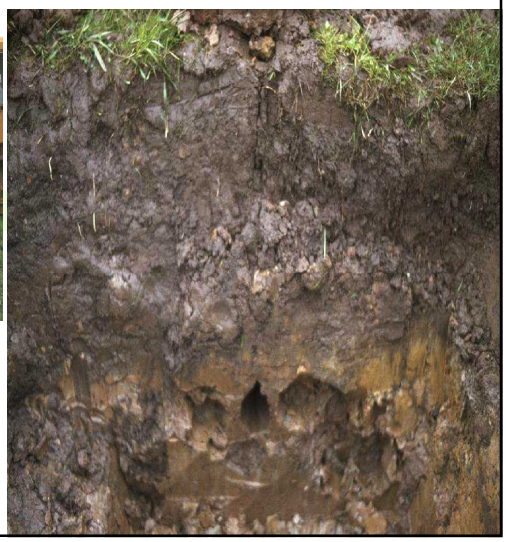
BEAM MOLE PLOUGH

6

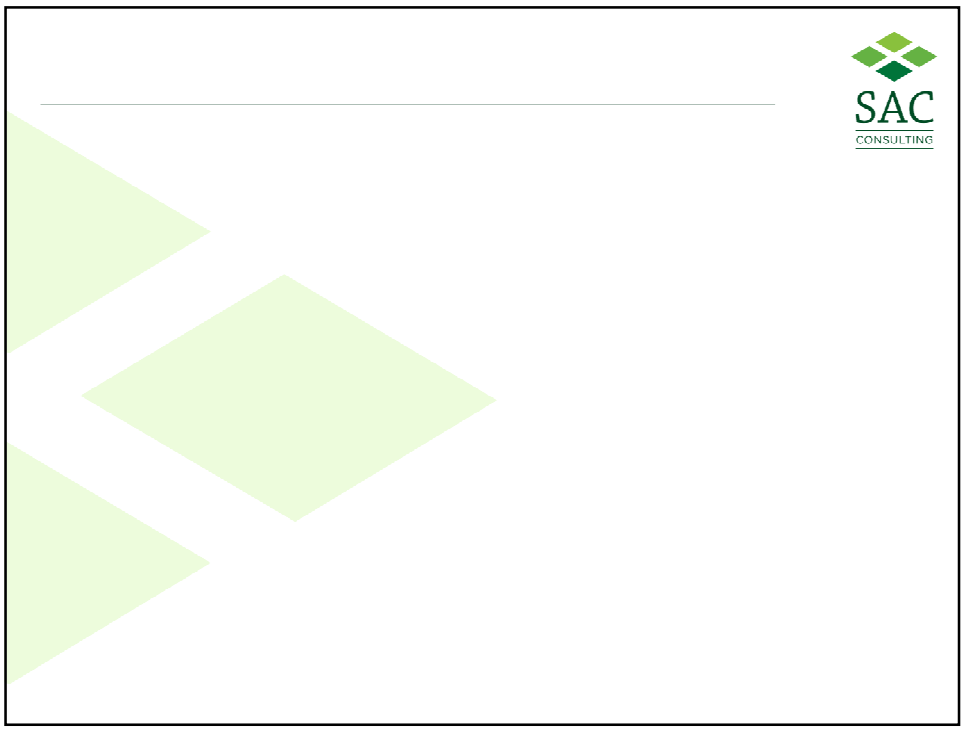
MOLE PLOUGH



Take Home Reminders

Wetting/drying and frosts may remedy surface compaction
Don't assume compaction is the problem (dig a hole)
Avoid working when soil is too wet
Machinery can alleviate compaction in the topsoil and subsoil
Spiking/aerating can disrupt shallow pan (variable response)
Soil loosening – only recommended where compaction is evident
Soil loosening – not a substitute for field drainage
Soil should be dry to working depth
Best time is autumn but not always
Only loosen as deep as required (not below an implement's critical depth) Don't run a soil loosener too deep
Loosened soils can be easily re-compacted

Ensure future compaction is avoided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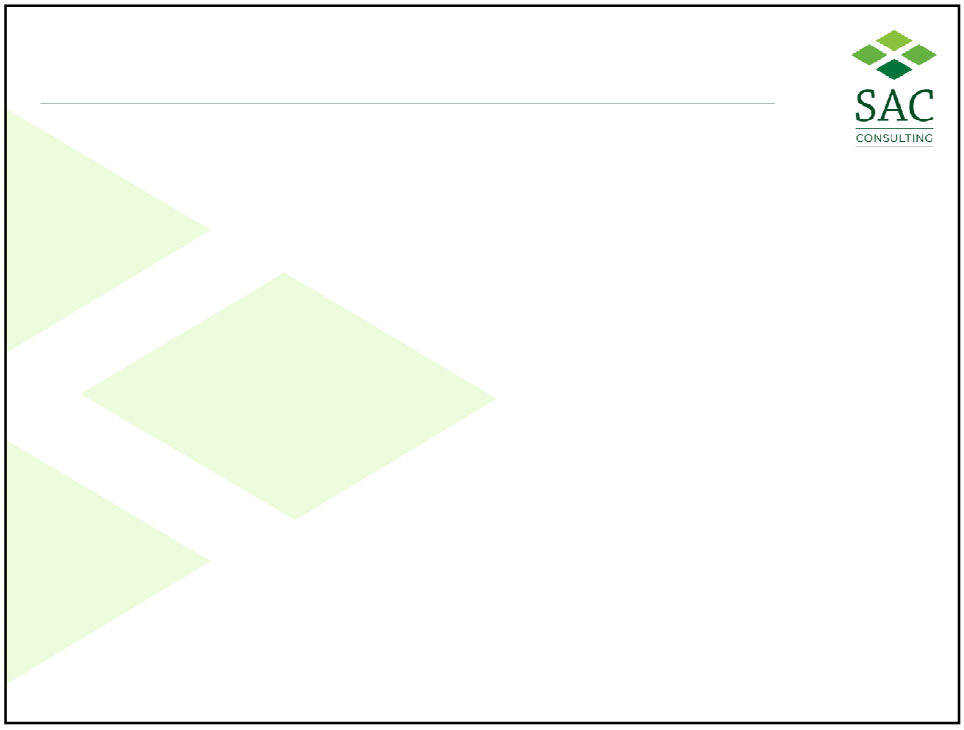
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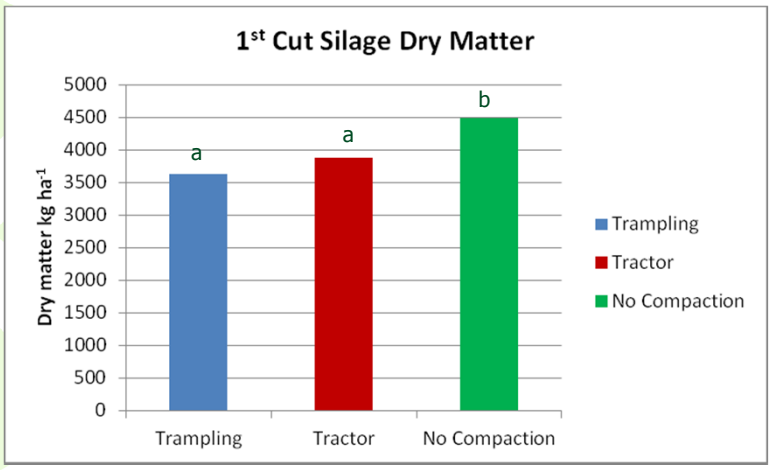
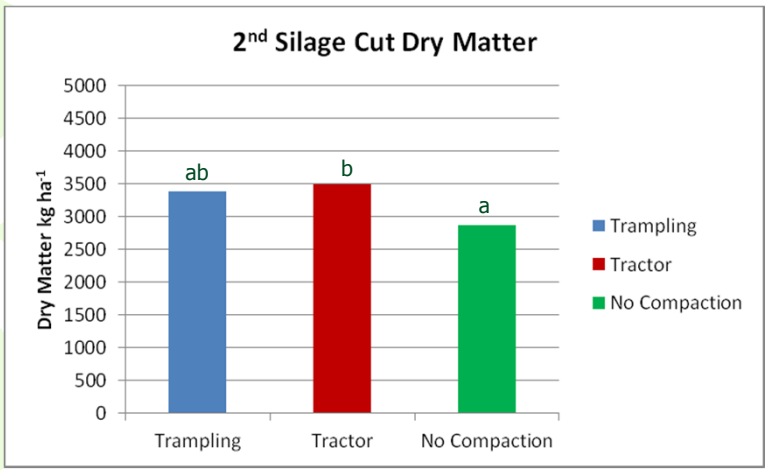
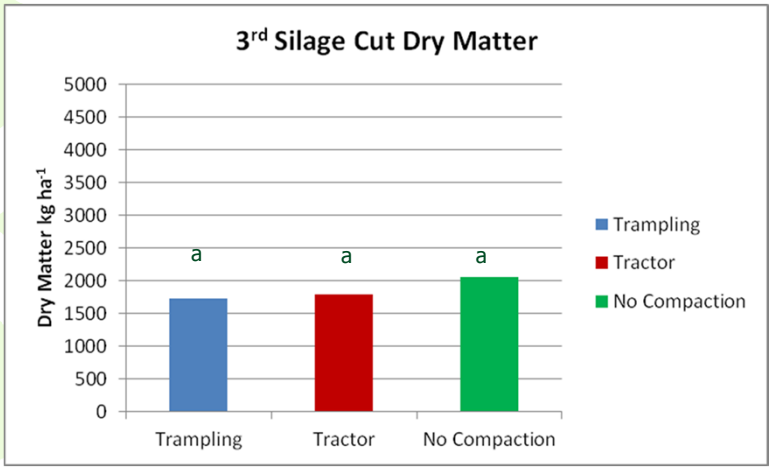
Compaction Results 2012 – 1st Silage Cut



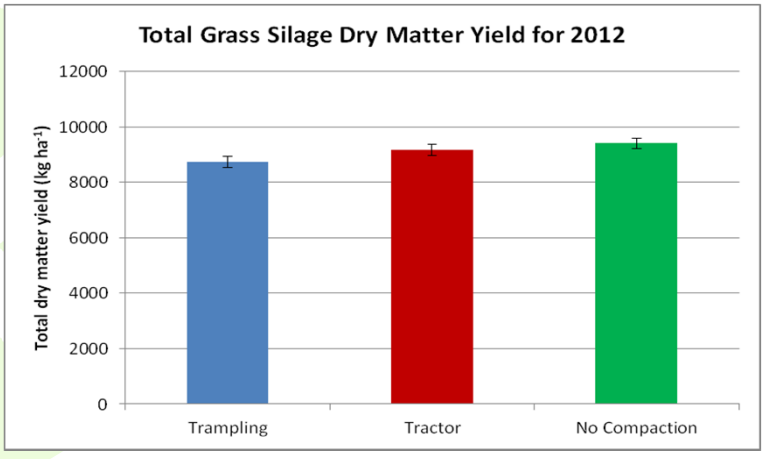
Compaction Results 2012 – 2nd Silage Cut



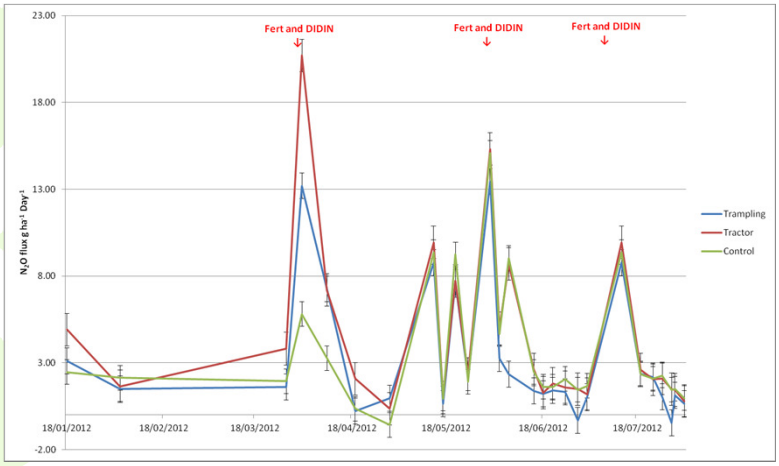
Compaction Results 2012 – 3rd Silage Cut



Compaction Results 2012- Total Yield



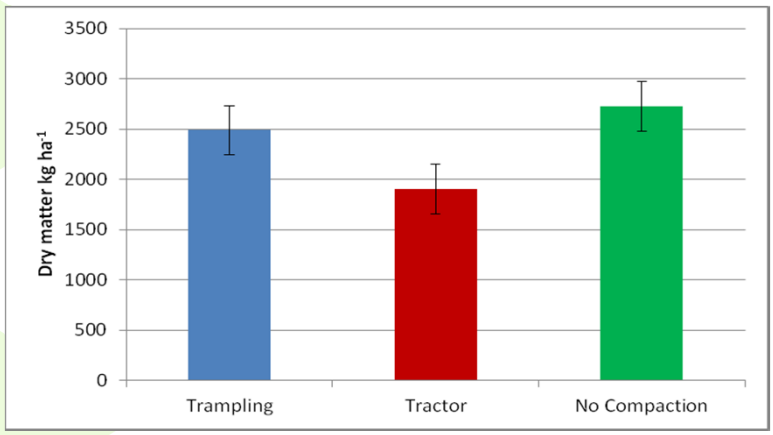
Compaction – Nitrous Oxide



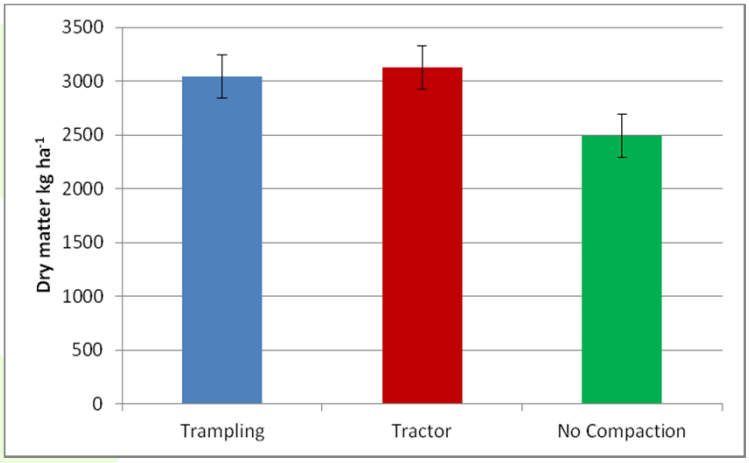
2012 Summary

- Compaction treatments effected yields
- Trampling had a greater effect than tractor
- Compaction increased N_2O emissions
- Tractor compaction had a greater effect than trampling
- Nitrification inhibitor reduced the N_2O emissions but this effect only lasted for a few weeks

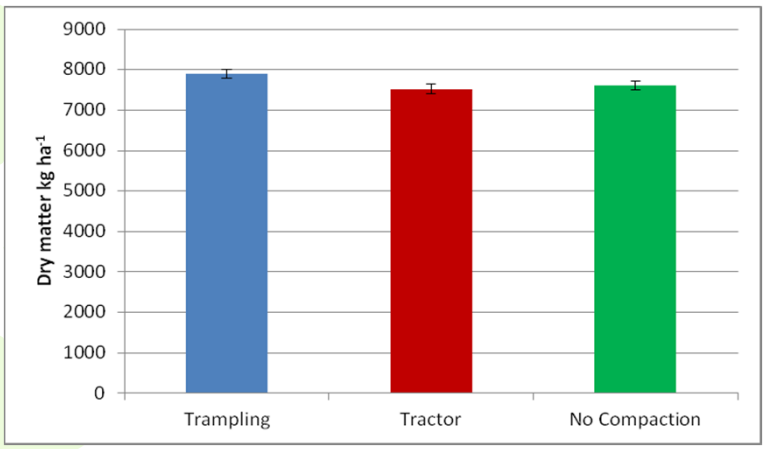
Compaction Results 2013 – 1st Silage Cut



Compaction Results 2013 – 2nd Silage Cut



Compaction Results 2013- Total Yield



Compaction Trial Results

Yield affected for 1st cut

Quality of silage affected

Carried out remedial work comparison –early results show benefit of deep spiking with angled blade more beneficial

Trial ongoing for a 3rd year—2014……..